EVALUATION SCHEME
B. TECH. BIOTECHNOLOGY
II-YEAR (**III-SEMESTER**)

S. No	COURSE CODE	SUBJECT	PERIODS			EVALUATION SCHEME					
						SESSIONAL EXAM			ESE	Total	CREDIT
			L	T	P	CT	TA	Total			
THEORY											
1.	TBT-231	CELL& MOLECULAR BIOLOGY	3	0	0	30	20	50	100	150	3
2.	TES-231	BIOCHEMISTRY	3	0	0	30	20	50	100	150	3
3.	TES-232	MICROBIAL BIOTECH	3	0	0	30	20	50	100	150	3
4.	TES-233	PROGRAMMING LANGUAGE	3	0	0	30	20	50	100	150	3
5.	TES-234	BIODIVERSITY & CONSERVATION	3	0	0	30	20	50	100	150	3
6.	TBS-231	MATHS-III	3	1	0	30	20	50	100	150	4
PRACTICAL											
7.	PBT-231	CELL & MOLECULAR BIO. LAB	0	0	2	10	15	25	25	50	1
8.	PES-231	BIOCHEMISTRY LAB	0	0	2	10	15	25	25	50	1
9.	PES-232	MICROBIAL TECH. LAB	0	0	2	10	15	25	25	50	1
10.	PES-233	PROGRAMMING LANGUAGE LAB	0	0	2	10	15	25	25	50	1
11.	GPP-231	GENERAL PROFICIENCY	-	-	-	-	50	50	0	50	0
SEMESTER TOTAL			**18**	**1**	**8**	**220**	**230**	**450**	**700**	**1150**	**23**

TBT-231	CELL AND MOLECULAR BIOLOGY	3L:0T:0P	3CREDITS

COURSE OBJECTIVES:

1. To enrich knowledge about overview of basic cell and molecular biology.
2. The composition, structure and function of organelles and other cellular components are discussed which lead to understanding of how cells contribute to the overall functioning of the organism.
3. To understand about nucleic acid structure and molecular processes that occurs in cell.
4. Enrich knowledge about the central dogma of life: information flow from DNA to Protein.

UNIT I

Prokaryotic and eukaryotic cells, nuclear structure, nucleolus, nuclear transport and chromatin packing, microtubule, actin and filament based motile systems

UNIT II

Cell membrane and permeability: Chemical components of biological membranes, organization and fluidity of membrane components, the membrane as a dynamic entity, cell recognition and membrane transport.

UNIT III

Organization of transport activity in cell; Signal Transduction, Cell signaling: Types of signaling, Cell surface receptor mediated signaling (RTK, pathway, JAK-STAT pathway), G-proteins and G-protein coupled receptors, Secondary messengers and intra cellular communication, Target cell adaptation.

UNIT IV

DNA replication: Enzymology of DNA replication, Difference in the replication process between prokaryotes and eukaryotes, initiation, elongation and termination of replication; Telomeres and their applications.

UNIT V

Transcription, mRNA processing and Translation: Posttranslational modifications of transcript:capping, polyadenylation, splicing, mRNA stability, Regulation of gene expression in prokaryotes and eukaryotes; Operon model

TEXT /REFERENCE BOOKS:

1. Molecular Biology of cell, 4th ed. Alberts, Bruce (*et.al) (2002) Garland* Science Publishing, New York.
2. Cell Biology-Smith and Wood by Chapman and Hall.
3. Gene IX by B. LewinCelland Molecular Biology, 8thed. RobertisandRobertis (2002) LippincotWilliams and Wilkins Pvt.Ltd.,(International Student Edition) Philadelphia.
4. Molecular Cell Biology 4th ed. Lodish, Harvey and Baltimore (2000) W.H. freeman & Co. New York.
5. Cell and Molecular biology, Concepts and Experiment Gerald Karp, John Wiley and Sons.

COURSE OUTCOMES:

On successful completion of this course students will be able to:

1. Summarize cellular and nuclear organizations.
2. Understand cell signaling, receptors and signal transduction.
3. Articulate the fundamental of models and enzymology of DNA replication.
4. Conclude the mechanism of transcription and Translation.
5. Acquire knowledge of regulation of gene expression in prokaryotes and eukaryotes

PBT-231	CELL AND MOLECULAR BIOLOGY LAB	0L:0T:2P	1 CREDIT

List of Experiments:

1. Extraction and estimation of DNA
2. Extraction and estimation of RNA
3. Extraction and estimation of protein
4. To find Lambda max of nucleic acid
5. To find Lambda max of protein.
6. Isolation of plasmid DNA.
7. To determine the melting curve of DNA
8. To determine base composition of DNA
9. To perform electrophoresis of DNA and Protein
10. To perform Gel documentation
11. To Prepare an onion peel slide and observe it under microscope.
12. To Study plant and animal cell structure with slide.
13. To Study various stages of mitosis with slides
14. To Study various stages of meiosis with slides
15. To study Polytene chromosome with slides

TES-231	BIOCHEMISTRY	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES:

1. Study the structure and properties of water and carbohydrates.
2. Discuss the structure, properties and reactions of proteins and amino acids
3. Discuss the structure, properties of fats and lipids
4. To study the composition, structure and functions of nucleic acids
5. Learn the basic concept of metabolism.

UNIT I

Hydrogen bonding and structure of water molecule, ionization of water, pH, Buffers. Colligativeproperties of water. Carbohydrates-Structure and functions: Structures and properties of monosaccharides, oligosaccharides and polysaccharides. Ring structure and muta rotation. Homo and hetro polysaccharides, Muco polysaccharides.

UNIT II

Amino acids & Proteins: Structure and properties of amino acids. Essential and non-essential amino acids. Peptide bonds.Types of proteins and their classification. Different levels of structural organization of proteins. Lipids-Structure and functions: Classification of lipids and their general functions. Essential fatty acids.Hydrolysis of fats, Saponification value, Rancidity of fats, Cholesterol-its structure and biological functions.

UNIT III

Nucleic Acids-Structure and functions: Structure and properties of purine and pyrimidine bases.Nucleosides and nucleotides.Biologically important nucleotides. Vitamins: Role of Vitamins, metals ions, significance.

UNIT IV

Metabolism: Basic concepts, Anabolism and catabolism, Carbohydrate Metabolism: Glycolysis. Fate of pyruvate under aerobic and anaerobic conditions.Pentose phosphate pathway and itssignificance.Gluconeogenesis pathway.Maintenance of blood glucose level.Beta-oxidation ofsaturated fatty acids.

UNIT V

General reactions of amino acids metabolism-transamination, oxidative and non-oxidative deamination and decarboxylation. Urea cycle and its regulations.Nitrogen cycle. Nucleic AcidMetabolism: Catabolism, de novo-biosynthesis.

TEXT /REFERENCE BOOKS:

1. Principles of Biochemistry: A.L. Lehninger, Nelson and Cox, McMillan Worth Publishers.
2. Lab Manual of Microbiology, Biochemistry and Mol. Biology- J. Saxena, MamtaBaunthiyal,
I.Ravi, Scientific Publication
3. Biochemistry: Voet and Voet, John Wiley and Sons, Inc. USA.
4. Biophysical ChemistryVol.I, II & III: Cantor and Schimel, Freeman.
5. Biochemistry: Zubey, WCB.
6. Biochemistry: Stryer, W. H. Freeman.
7. Understanding Enzymes. Palmer, Horwood

COURSE OUTCOMES

After the completion of the course

1. Students will appreciate the role of chemistry in biological science.
2. Students will develop fundamental understanding about biomolecules and metabolism.
3. The course will help students in understanding advanced subjects such as metabolic engineering.
4. Students will develop the skills to understand the theory and practice of experiments related to biochemistry.

PES-231	BIOCHEMISTRY	0L:0T:2P	1 CREDIT

List of Experiments:

1. Preparation of Buffer.
2. Qualitative and Quantitative tests for carbohydrates – distinguishing reducing from non-reducing sugars and keto from aldosugars.:Anthrone and Fehling's test.
3. Qualitative and Quantitative method for amino acid estimation using ninhydrin – distinguishing amino from imino acid.
4. Determination of Logic properties (pH value of Lysine by titration).
5. Protein estimation by Biuret and Lowry's methods.
6. Protein estimation by Bradford and spectroscopic methods. To find lambda max for proteins.
7. Estimation of nucleic acids by absorbance at 260 nm and hyperchromic effect.
8. Solubility and qualitative test for fatty acid.
9. Determination of acid value of fat/oil
10. Determination of Iodine number of fat/oil
11. Preparation and purification of casein from buffalo milk

TES-232	MICROBIAL BIOTECH	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. To know about Scope and relevance of microbiology
2. To learn about basic microbial structure and function
3. To improve knowledge about microbial growth kinetics
4. To enrich knowledge about history, structure and types of virus.

UNIT I

Scope and relevance of microbiology, History of Microbiology: Contribution of Koch, Contribution of Lister, germ theory of fermentation, Conflicts of Biogenesis and Abiogenesis, Contribution of Metkinikoffs, Classification of Microorganism, Two Kingdom classification, Three kingdom classification, Five Kingdom classification, Eight kingdom classification, Differences between Eukaryote and Prokaryotes, Method of classification based on 16s RNA, DNA homology

UNIT II

Morphology and ultra structure of Prokaryote, Cell shape and size, Cell membrane-structure, composition and properties, Ultra structure of bacterial cell wall, Gram-negative and Gram-positive bacteria, Outer membrane of Gram negative bacteria, Capsules- types, composition and function

UNIT III

Structure and function of flagella, cilia and pili, gas vesicles, chromosomes, carboxysomes, magnetosomesand phycobilisomes, nucleoid, Spores, reserve food materials polyhydroxybutyrate, phosphate granules, Oil droplets, cyanophycingranulesand sulfur inclusions

UNIT IV

Nutritional types of bacteria, culture media used, Pure culture isolation, Preservation methods, Sterilizing techniques, Cultivation of aerobic and anaerobic bacteria Growth kinetics, a synchronous and diauxicgrowth, Batch and continuous cultures, Measurement of growth, Factors affecting growth,

UNIT V

Virology: History, Structure and cultivation of Virus, Types of envelopes and their compositions, Viral genome, their types and structures, virus related agents (viroids, virusoidsand prions), Bacteriophage and its lifecycle (Lytic and lysogenic)

TEXT /REFERENCE BOOKS:

1. Text book of Microbiology: R. C. Dubeyand D. K. Maheshwari, S. Chand and Company.
2. Microbiology; Prescotts
3. Practical Microbiology: Dubeyand D. K. Maheshwari
4. Lab Manual of Microbiology, Biochemistry and Mol. Biology- J. Saxena, MamtaBaunthiyal, I. Ravi, Scientific Publication

COURSE OUTCOMES

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

1. Get acquaint about the historical perspectives important in the development of microbiology and classify various microorganisms and its application in modern biotechnology
2. Understand the basic microbial structure and function and study the comparative characteristics of prokaryotes and eukaryotes
3. Articulate, select and prepare various culture media and their applications and comprehend the various methods for identification of unknown microorganisms.
4. Know the various physical and chemical growth requirements of bacteria and get equipped with various methods of bacterial growth measurement
5. Demonstrate and evaluate the structure and cultivation of virus and its involvement in disease causing.

PES-232	MICROBIAL BIOTECH LAB	0L:0T:2P	1 CREDIT

List of Experiments:

1. Working and principle of instrument used in the microbiology lab
2. Wrapping of glassware
3. To perform various staining techniques for microbes
4. Microscopic measurement of cell-dimensions of microorganisms.
5. Preparation and sterilization of various culture media (Nutrient Agar, and Nutrient broth , Potato dextrose agar and Potato dextrose broth) for routine cultivation of microorganisms
6. Enumeration, isolation purification and preservation of microorganisms from different sources – soil, air, water and milk
7. Biochemical and functional characterizations of microorganism
8. Differentiation of enteric bacteria based on IMViC tests: Indole production, Methyl-red, Voges –Proskauer and Citrate utilization test
9. To study effect of different parameters on microbial growth (pH, temperature & UV irradiation)
10. To perform quantitative determination of growth by Plate Count Method

TES-233	PROGRAMMING LANGUAGE (PERL)	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. Experience learning a programming language "on your own" as is commonly the case in industry.
2. Understand the syntax and semantics of the Perl language.
3. To develop and implement various types of programs in the Perl language.
4. Understand various forms of data representation and structures supported by the Perl language
5. Understand the appropriate applications of the Perl language

UNIT I

Perl: Introduction, use of Perl in Bioinformatics, History of Perl, Availability, Support, Basic Concepts, Scalar data: Numbers, strings, scalar operators, scalar variables, scalar operators functions Arrays and list data: Introduction to list or array, Literal representation, variables, arrays operators and functions, scalar and list context.

UNIT II

Control structures: Statement blocks, Hashes: Introduction to Hash, Hash variables, Literal representation of a Hash, Hash Functions, Hash Slices, Basic I/O, Regular expressions: Concepts about regular expressions, simple uses of regular expressions, patterns, matching operator, substitutions, the split and join functions, Subroutines: System and user functions, the local operator, variable-length parameter lists, lexical variables, Miscellaneous control structures.

UNIT III

File handles and file tests: Introduction to file handle, Opening and closing a file handle, using pathnames and filenames, die, using file handles, The –x file tests, the stat function, Formats: Defining a format, invoking a format, Directory access: Directory tree, globbing, directory handles, opening and closing a directory handle, reading a directory handle, File and directory manipulation.

UNIT IV

Process management: Using system and exec, using back quotes, Other data transformation: Finding a substring, extracting and replacing a substring, Formatting data: Sorting, Transliteration, System information: Getting User and Machine information, Packing and Unpacking Binary data, getting network information, Database manipulation: DBM databases and DBM Hashes, Opening and closing DBM Hashes, Fixed-length random-access databases, Variable-Length (Text) Databases.

UNIT V

CGI programming: The CGI.pm Module, CGI program in context, simple CGI programs, passing parameters via CGI, Perl and the Web, Object oriented Perl: Introduction to modules, Creating Objects, Bioperl: Introduction, Installation procedures, Architecture, Uses of bioperl

TEXT /REFERENCE BOOKS:

1. Advanced Perl Programming by SriramSrinivasan, O-Reilly, 1997
2. Patrick Naughton and HerbertzSchildt, "Java2 The Complete Reference", TMH, 1999
3. Andreas D. Baxevanis. Bioinformatics: A practical guide to the analysis of genes and proteins.
4. Bioinformatics: the machine learning approach by Pierre Baldi, SørenBrunak. MIT Press. 2001

COURSE OUTCOMES

After successfully completing this course, students will be able to:

1. Explain the differences between typical scripting languages and typical system and application programming languages.
2. Apply your knowledge of the strengths and weaknesses of scripting languages to select an implementation language.
3. Create software systems using scripting languages, including Perl.
4. Write server-side scripts using Perl and Python's CGI facilities. Analyze requirements of software systems for the purpose of determining the suitability of implementing in Perl.
5. Analyze and model requirements and constraints for the purpose of designing and implementing software systems in Perl.
6. Evaluate and compare designs of such systems on the basis of specific requirements and constraints

PES-233	PROGRAMMING LANGUAGE (PERL)	0L:0T:2P	1 CREDITS

LIST OF EXPERIMENTS

1. Basic UNIX Commands
2. Working with vi editor
3. Working with emacs editors
4. Advanced UNIX Utilities
5. Creating a Bioinformatics directory
6. Simple Perl Program (Operators)
7. Use of <STDIN>
8. Chop and chomp Operators
9. Control Structures
   IF-If else statement
   While statement
   Foreach and until loops
10. Subroutines , subroutines using array and special variables
11. Random number generation
12. Simple programs using file functions
13. Hash traversal functions
14. Command line arguments
15. Setuid/ setgid Perl scripts
16. Creating a static HTML file by a Perl program.

TES-234	BIODIVERSITY AND CONSERVATION	3L:0T:0P	3CREDITS

COURSE OBJECTIVE:

1. To teach students about biodiversity of the Globe and mother Earth
2. To create awareness among students about the natural wealth of Earth
3. To make understand students about the value of biodiversity
4. To tell students about the richness of Uttarakhand state with respect to biodiversity
5. To make student sensible to check loss of biodiversity

UNIT I

Definition, historical andgeographicalcausesfordiversity, Biogeographic Zones of India,TypesofBiodiversity, Himalayan Mountain System,Biodiversitywithemphasis on Uttarakhand specificallyGarhwaland Kumaonregion

UNIT II

Germplasm,Germplasm Collection, Germplasm Regeneration, ImportanceofGermplasm in evolution.GermplasmActvities, Oragnization Associated with Germplasm in India and abroad, Gene pool, Gene Pool System of classification, Centers of Diversity & Gene Banks, Genetic Erosion.

UNIT III

Natural Resources, Components ofbiodiversity ,PlantGenetic Resources,Anima lGeneticsResources, FishGenetic Resources, their importance and significance and organizations involved in their respective conservation & research, species and population biodiversity, quantifying biodiversity.

UNIT IV

Maintenanceofecologicalbiodiversity,Biodiversityandcentersoforigin, Center of Diversity, Gene Banks, Biodiversity hot spots in India with emphasis to Uttarakhand,Loss of biodiversity, Biodiversity conservation of plant,animal, fish, microbial genetic resources, Bioethics and conservation, The Biological Diversity Act, CBD and its milestones

UNIT V

Measuring, Assessing, analyzingand documenting biodiversity, holistic concept of Bio-conservation, vulnerabilityandextinction of biodiversity, introduction to biodiversitydatabase, Endangered animals, endemism and Red Databooks, IUCN, Global Biodiversity Information System((GBIS)

TEXT /REFERENCE BOOKS:

1. Micheru, S.1885.ConservationofspeciesandGeneticResources. An NGOActionGuide.
2. EnvironmentLiaisonCenter, Nairobi
3. SharmaP.D.2007.Ecologyand Environment.Rastogi Publications. MeerutBSI, 1996.Floraof India.BotanicalSurveyofIndia,Kolkata,India

4. Palni, L.M.S., Miakhuri R.K., RaoK.S.1998.Conservation ofthe Himalaya Agroecosystem:Issuesand Priorities. UNDP, New York,USA
5. Anon.1996.TheWealthofIndia.VolI-XI.CSIR, New Delhi, India
6. Kandari,O.P.andGusain,O.P.2001.Garhwal Himalaya-NatureCulture and Society.Transmedia
Publication, Srinagar(Garhwal)
7. Mayers,N1990.ThebiodiversityChallenge:expanded'hot spots'analysis.-Envir10(4):243-256

COURSE OUTCOMES

On successful completion of the course students will be able to:

1. Know about the biodiversity of the earth
2. Do the protective measures how to get benefitted from biodiversity
3. Get awareness among themselves to protect the biodiversity
4. Able to use the potential of biodiversity surrounding in the GBPEC campus

TBS-231	**MATHS-III**	**3L:0T:0P**	**3 CREDITS**

As per Institute's common syllabus for all branches.

EVALUATION SCHEME
B. TECH. BIOTECHNOLOGY
II-YEAR (**IV-SEMESTER**)

S. No.	COURSE CODE	SUBJECT	PERIODS			EVALUATION SCHEME					
						SESSIONAL EXAM			ESE	Total	CREDIT
			L	T	P	CT	TA	Total			
THEORY											
1.	TBT-241	CELL &TISSUE CULTRE TECHNOLOGY	3	0	0	30	20	50	100	150	3
2.	TBT-242	ENZYMOLOGY	3	0	0	30	20	50	100	150	3
3.	TBT-243	IMMUNOLOGY	3	0	0	30	20	50	100	150	3
4.	TBT-244	BIOPHYSICS &STRUCTURAL BIOLOGY	3	0	0	30	20	50	100	150	3
5.	TBT-245	MASS TRANSFER OPERATIONS IN BIOPROCESS	3	0	0	30	20	50	100	150	3
6.	TES-241	GENETICS	3	0	0	30	20	50	100	150	3
7.	TMC-241	CONSTITUTION OF INDIA	2	0	0	15	10	25	50	75	0
PRACTICAL											
8.	PBT-241	CELL &TISSUE CULTRE LAB	0	0	2	10	15	25	25	50	1
9.	PBT-242	ENZYMOLGY LAB	0	0	2	10	15	25	25	50	1
10.	GPP-241	GENERAL PROFICIENCY	-	-	-	-	50	50	0	50	0
SEMESTER TOTAL			**20**	**0**	**4**	**215**	**210**	**425**	**700**	**1125**	**20**

TBT-241	CELL & TISSUE CULTURE TECHNOLOGY	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. To improve knowledge of and expertise in animal and plant tissue culture theory and practice with their role and applications in biotechnology and biochemical research.
2. To learn about media preparation, sterile techniques, aseptic handling, initiation and routine maintenance of cells in culture, common contaminants of plant and animal cell culture.
3. To improve knowledge about the applications of cell culture technology e.g. somatic cell and protoplast fusion; Hybridoma technology.

UNIT I

Historical background and terminology used in cell & tissue culture, Basic techniques of cell and tissue culture ,Tissue culture media-its constituents, selection and preparation, Properties of media, Basic aseptic techniques used in tissue culture, Natural media, synthetic Media (with Serum & Serum free media), complex media.

UNIT II

Cell and suspension culture: isolation of single cell, suspension cultures, Primary cell culture, Disaggregation Techniques, isolation, propagation, immortalization of cell lines.

UNIT III

Somatic embryogenesis, Factors affecting somatic embryogenesis and organogenesis in plants, somaclonal and other variations, Zygotic embryo culture, Micropropagation and cloning of plants, Production of pathogen free plants, applications of micro propagation in agriculture, horticulture & forestry.

UNIT IV

Somatic Hybridization: Fusogens, basis of somatic hybridization technology, Protoplast Isolation and culture, fusion of protoplast, Haploid Production: Introduction, Techniques, factors affecting androgenesis, ontogeny of androgenic haploids, plant regeneration from pollen embryos, gynogenisis.

UNIT V

Contamination and cytotoxicity: Sources and types of microbial contamination, Monitoring: Viability assay, Survival assay and transformation assay, germplasm storage: Long term storage, short or medium term storage, cell banks, transporting cells, storage of hybridoma cells, Productions of monoclonal antibodies.

TEXT /REFERENCE BOOKS:

1. Plant tissue culture: S.S. Bhojwani and M.K. Razdan, El sevierScience,The Netherlands.
2. Cell culture methods and cell biology procedure: A. Doyle.
3. Plant Tissue Culture – A practical Approach: R.A. Dixon, IRL press.
4. Elements of Biotechnology by PK Gupta, Rastogi Publications, Meerut
5. Plant biotechnology: HS Chawla.

COURSE OUTCOMES

On successful completion of this course you should be able to:

1. Explain major components of cell and tissue culture media, e.g. minerals, growth factors, hormones, and what governs the choice of components.
2. Prepare and optimize media for different species and cell lines, without the aid of texts.
3. Perform the common cell culture techniques, e.g. callus culture, Embryo culture and embryogenesis in plants, culture of animal cells.
4. Demonstrate knowledge of cell lines used in mammalian tissue culture, their origins and applications.
5. Competently perform laboratory procedures and demonstrate practical application and conceptual knowledge of cell and tissue culture for biotechnology investigations and applications.

PBT-243	CELL AND TISSUE CULTURE LAB	0L:0T:2P	1 CREDITS

List of experiments

1. Study and use of basic sterilization techniques in tissue culture lab.
2. Preparation of tissue culture media.
3. Selection and preparation of explant for tissue culture.
4. To perform seed culture experiment.
5. To perform micropropagation through meristem culture.
6. To perform suspension culture and callus culture from medicinal plants.
7. Artificial seeds prepration
8. Isolation of protoplasts

TBT-242	ENZYMOLOGY	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. To introduce the concept of enzymology and significance of enzymes.
2. To integrate the practical aspects of enzymology with the kinetic theories of enzymes.
3. To provide a mechanistic overview of enzyme activity and catalysis.
4. To learn methods of immobilization and know its importance.
5. To know industrial application of free and immobilized enzymes.

UNIT I

Introduction to enzymes: Brief history of enzymes, nomenclature and classification of enzymes. Chemical nature of Enzymes: amino acids, the building blocks of protein, Levels of protein Structure: Primary, secondary, tertiary and quaternary structure. Specificity of Enzymes: Types of specificity, the Koshland "induced fit" hypothesis, Strain or transition – state stabilization hypothesis.

UNIT II

Enzyme Catalysis and Kinetics: Factors affecting the rate of chemical reactions, kinetics of uncatalyzed chemical reactions, kinetics of enzyme-catalyzed reaction, methods for investigating the kinetics of enzyme-catalyzed reactions, nature of enzyme catalysis,inhibition of enzyme activity enzyme inhibition- competitive, non-competitive, and uncompetitive, allosteric enzymes and metabolic regulation.

UNIT III

The Investigation of Active Site Structure and Chemical nature of Enzyme Catalysis: The identification of binding sites and catalytic site, three dimensional structure of active site, mechanism of catalysis, mechanism of reaction catalyzed by enzyme without cofactors, metal- activated enzyme and metalloenzyme, coenzymes in enzyme catalyzed reactions.

UNIT IV

Immobilization of Enzymes: Concept, methods of immobilization, Kinetics of immobilized enzymes, effect of solute partition and diffusion on kinetics of immobilized enzymes, use of immobilized enzymes.

UNIT V

Industrial uses of enzymes: Industrial enzymes: Sales value of industrial enzymes, traditional (non-ecombinant) sources of industrial enzymes. Enzyme Engineering: Prediction of enzyme structure, design and construction of novel enzymes.

TEXT /REFERENCE BOOKS:

1. Enzymes by Palmer (2001): Horwood Publishing Series.
2. Fundamentals of Enzymology by Price and Stevens (2002): Oxford University Press.
3. Enzyme Technology by Helmut uhling (1998): John Wiley
4. Introduction to Proteins Structure by Branden and Tooze (1998): Garland Publishing Group.

COURSE OUTCOMES

After completion of the course

1. Students will know the significance of enzymes in biological system and its use in industries.
2. They can illustrate enzyme kinetics, active sites and different types of enzyme catalysis.
3. The student will develop skills to carry on lab experiments related to the subjects such as to plan and execute an enzyme assay; to analyse enzyme kinetic data; to analyse kinetic inhibition data and to determine the mechanism of inhibition.
4. The students will be prepared confidently and competently to work with enzyme systems in both Academia and Industry

PBT-242	ENZYMOLOGY LAB	0L:0T:2P	1 CREDIT

List of Experiments:

1. To prepare a sample of enzyme extract.
2. To determine activity of acid phosphatase from peas/moong seedlings.
3. Purification of an enzymatic protein by salt precipitation.
4. Determination of kinetic properties (Km and Vmax values) of an enzyme.
5. To check time and protein linearity of an enzymatic reaction.
6. To obtain standard curve of p-nitrophenol solution.
7. To find activity of salivary amylase at different concentration
8. Immobilization of an enzyme and study of immobilized enzyme kinetics**.**

TBT-243	IMMUNOLOGY	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. To know the concept of immune-system and its implication for health and diseases.
2. To understand the structure, functions and properties of different cell types and organs that comprises the immune system.
3. To develop knowledge about the principles and applications of immune-assay to evaluate the immune-status.
4. To comprehend the range of immunological agents and the strategies that may be used to prevent and combat infectious diseases.

UNIT I

Immune system and Immunity; History of immunology, Innate and adaptive immunity, Determinants of innate immunity: species and strains, individual differences, influence of age, Herd immunity, Immune responses- innate immunity, mechanism of innate immunity, acquired immunity, Composition and function of cells and organs involved in immune system.

UNIT II

Introduction to Immunotechnology; Antigen, types and properties of antigen, Antigenicity vs Immunogenicity, factors that influence the immunogenicity, parameters of immunogenicity, Haptens, Super antigen, isopecificity, Heterophile specificity and autospecificity.

UNIT III

Cellular and humoral immune responses, activation and function of T and B cells, Fine structure and function of immunoglobulin and Different types of Immunoglobulin, Monoclonal antibody (MAB) and Polyclonal antibody, Hybridoma technology, production of monoclonal antibody, Major Histocompatibilty Complex, Complement System, vaccine schedule, Vaccine and its type, Immunization, types of immunization, Rationale of immunization, role of adjuvant in immunization, Hazards of immunization, Immune response in immunization, Dosage, age of commencement.

UNIT IV

Antigen-Antibody interaction; affinity, cross reactivity, specificity, Precipitation, mechanism of precipitation, application of precipitation, Agglutination and its application, Complement: Direct complement fixation test and indirect complement fixation test, Neutralization test; Immuno assays RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence.

UNIT V

Hypersensitivity reaction, Antibody-mediated-Type-1, Anaphylaxis-Type-II, Antibody dependent cell cytotoxicity Type III, Immune complex mediated reactions Type IV, cell mediated hypersensitivity reactions, Defects in immune system, Transplantation and tumor immunology, Autoimmunity, criteria and causes of autoimmune diseases.

TEXT /REFERENCE BOOKS:

1. Immunology by Janis Kubey.
2. Immunology by Roiet and Roiet.
3. Test book of Microbiology by Annanthnarayan.
4. The elements of Immunology by FahimHalim Khan (Pearson Education).

COURSE OUTCOMES

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

1. Articulate the basics of immunology and knowledge about various characteristics of antigens and its properties
2. Learn about the mechanisms by which a human body interacts with a pathogenic microbe & how it eliminates it.

3. Select and use immunoassay techniques in routine diagnosis, research for human health
4. Learn principle and types of vaccines, autoimmunity and transplantation

5. Identify allergic reaction, and its diagnosis for human health and assess health problems with an immunological background

TBT-244	BIOPHYSICS &STRUCTURAL BIOLOGY	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. To define and know the significance of biophysics.
2. Understand the importance of various types of interaction in biological system
3. To gain conformational knowledge of biomolecules like protein and nucleic acid.
4. Acquire knowledge about the muscular movement..
5. To understand transport and dynamic properties of biological systems.

UNIT I

Scope and definition of Biophysics, Biophysics at macroscopic, microscopic level and at the molecular level, Biophysical Chemistry: structure of atoms, molecules; energy, structure of atoms and molecules, elementary quantum mechanics, stereochemistry, molecular orbitals & chirality.

UNIT II

Van der Waals radii of atoms (equilibrium separation between non covalently bonded atoms) – contact distance criteria; Noncovalent forces determining biopolymer structure; dispersion; forces; electrostatic interactions; van der Waals interactions; hydrogen bonds; hydrophobic interactions; distortional energies; description of various interactions by potential functions; principles of minimization of conformational energy.

UNIT III

Nucleic acid configuration of DNA, RNA, Isomers of nucleotides, Glycosidic bond rotation, base stacking. Proteins: zwitter ionic properties & amino acids and titration curves, peptide bonds, disulfide cross links, Ramachandran plot, alpha-helix, beta-sheet, Helix-coil transition, Protein folding.

UNIT IV

Muscular movement: Molecular structure of muscle - actin, myosin, troponin,tropomyosin, physico& biochemical events, muscle contraction, Mechanical properties of skeletal muscles, mechanical model of muscle, Mechanical events of muscle contraction, Force velocity, Power velocity and Tension, Length relationship curves.

UNIT V

Membrane potentials; origins of membrane potential; electrochemical potentials; Donnan equilibrium; Nernst equation; Goldman equation, Membrane transport; diffusion; facilitated diffusion; membrane transport proteins; carrier mediated transport; channel mediated transport, Neurons, synopsis, Action potential and its propagation through nerve Fiber, Photo chemical events of vision, Neural networks.

TEXT /REFERENCE BOOKS:

1. Biophysics: An introduction Kluwer, Dordrechrt.
2. Biophysics: Cantor -I, II & III vol.
3. Biophysics an introduction; Rodney Cotton II.

4. An introduction to Neural computing - Aleksander& Morten.
5. Biological membranes: architecture & function: Hand book of biological physics: Lipowsky&Sackmann all volumes techniques & methods.

COURSE OUTCOMES

After completion of the course the students will be able:

1. To analyze the various forces responsible for biological molecular structure.
2. To be familiar with different levels of conformation in biomolecules.
3. To gain the knowledge of cellular permeability and ion transport.
4. To understand the dynamics of biological systems.

TBT-245	MASS TRANSFER OPERATIONS IN BIOPROCESS	3L:0T:0P	3 CREDITS

COUSE OBJECTVES

1. To explain the students with the basic principles of mass transfer operations and other separation processes with examples.
2. To impart knowledge on how certain substances undergo the physical change with diffusion/mass transfer of components from one phase to other phases.
3. To describe the students with equipment used in operations involving mass transfer and other separation processes and their advantages and disadvantages.
4. To focus on absorption and distillation operations and the process design aspects of the same operations.

UNIT I

Molecular diffusion in fluids: Binary solutions, Fick's law, equation of continuity, Steady state equimolar counter current diffusion, Stefan's diffusion, estimation of diffusivity of gases and liquids, application of molecular diffusion.

UNIT II

Mass transfer coefficients: Mass transfer coefficients in turbulent flow, theories of mass transfer, analogy between momentum, heat and mass transfer in laminar and turbulent flow, correlations for mass transfer coefficients in simple situations, diffusion in solids.Interphase mass transfer: Concept of equilibrium, diffusion between phases, two resistance theory, material balances in steady state co-current and counter-current stage processes.

UNIT III

Equipment for gas-liquid operations: Sparged vessels, mechanically agitated vessels for single phase liquids and gas-liquid mixtures, tray towers, sieve tray for absorption and distillation, venturi scrubbers, spray towers and spray chambers, packed towers for absorption and distillation, tray towers versus packed towers.

UNIT IV

Absorption: Solubility's of gases in liquids, two component systems, multi-component systems, ideal and non-ideal solutions, choice of solvent for absorption, single component absorption material balances, counter current multistage operations, dilute gas mixtures, on-isothermal operation, tray efficiency, continuous contact equipment, HETP, HTU, NTU concepts for single operation absorption with chemical reaction.

UNIT V

Distillation: Principles of VLE for binary systems, phase diagrams, relative volatility, ideal solutions, azeotropes, enthalpy concentration diagrams, flash vaporization, partial condensation, differential distillation, steam distillation, continuous distillation, McCabe-Thiele method, Ponchon-Savarit method, tray efficiencies, introduction to multi-component distillation, azeotropic and extractive distillations.

TEXT /REFERENCE BOOKS:

1. Mass transfer Operations, Robert E. Treybal, 3rd edition, McGraw-Hill Book Co.,
2. 1."Unit Operations in Chemical Engineering" by McCabe,W.L.,Smith,J.C.andHarriot,P., 5th Edition, McGraw-Hill Book Co.,
3. "Chemical Engineering Hand Book" by J.H. Perry.

COURSE OUTCOMES

After completion of the course students will develop

1. An ability to define the basic principles of mass transfer operations and other separation processes
2. An ability to identify the basic techniques for measurement of diffusivity, mass transfer coefficient, evaporation rate,
3. An ability to understand the importance of mass transfer phenomena in the design of process equipment in distillation operation
4. Skills of the students in the area of Mass Transfer operation. This will be beneficial to for the study of specialized electives and project work

TES-241	GENETICS	3L:0T:0P	3CREDITS

COURSE OBJECTIVES

1. To teach basic concepts of Genetics
2. To make students aware about importance and applications of Genetics
3. To improve student's knowledge of the different type of genetic diseases

UNIT I

Heredity, Historical Perspectives: Definition-of genetics; Origin of life; spontaneous generation: Preformation; Inheritance of acquired characters; Pangenesis; Germplasm theory; Early Ideas on reproduction; Molecular theory on origin of life.

UNIT II

Principles of Heredity and Variation: Mendel and his experiments, mono hybrid crosses, incomplete dominance and co-dominance, dihybrid crosses, multiple alleles (blood group systems), epistasis, lethal genes. Probability in prediction and analysis of genetic data.Pedigree analysis. Genes and Chromosomes: General features of chromosomes, cell division, sexual reproduction. Chromosomal theory of inheritance, sex determination.Sex-linked, sex-limited and sex-influenced inheritance.Variation in chromosome number and structure.

UNIT III

Molecular organization of chromosomes: Genome size and evolutionary complexity, supercoiling of DNA, structure of bacterial chromosome, structure of eukaryotic chromosome. Gene Mutation and DNA Repair: Chromosomal changes and gene mutations, types of mutations, consequences of mutations, occurrence and causes of mutations

UNIT IV

Gene Linkage and Chromosome Mapping: Linkage and recombination of genes in a chromosome, crossing over and genetic mapping, gene mapping by 2-point and three point test crosses. Somatic Cell Genetics: Somatic cell hybrids production and gene mapping.

UNIT V

Population Genetics and Evolution: Allele frequencies and genotype frequencies, random mating and Hardy-Weinberg principle. Inbreeding.Genetics and evolution (Mutation and migration, natural selection, random genetics drift). Genetic disorders and genetic counseling: Applications of genetics, eugenics. Quantitative Genetics: Quantitative inheritance, causes of variation.

TEXT /REFERENCE BOOKS:

1. Genetics: Analysis of Genes and Genomes.5$^{th\ edition}$ (2001) Hartl, D.L.and Jones, E.W., Jones and Bartlet Publishers, Boston.
2. Genetics.5thedition (1998) Russell, P.J., Addison Wesley Longman, Inc., California.
3. Genetics: Analysis and Principles. (1999)Brooker, R.J.McGraw Hill, New York.
4. Basic Genetics. (2000) Miglani, G.S., Narosa Publishing House, NewDelhi.
5. A text Book of animal Genetics. P.Kanakraj, IBDC, NewDelhi

COURSE OUTCOMES

On successful completion of the course students will be able to:

1. To know basic issue of genetics and their relevance
2. To get acquaint basics of heredity and its transmission
3. To develop the strategies for creating awareness about genetic disorder and their counselling

TMC-241	CONSTITUTION OF INDIA	2L:0T:0P	0 Credits

As per the Institute's common syllabus for all branches.

EVALUATION SCHEME
B. TECH. BIOTECHNOLOGY
III-YEAR (**V-SEMESTER**)

S. No.	COURSE CODE	SUBJECT	PERIODS			EVALUATION SCHEME					
						SESSIONAL EXAM			ESE	Total	CREDIT
			L	T	P	CT	TA	Total			
THEORY											
1.	TBT-351	BIOINFORMATICS	3	0	0	30	20	50	100	150	3
2.	TBT-352	BIOPROCESS ENGINEERING	3	0	0	30	20	50	100	150	3
3.	TBT-353	RECOMBINANT DNA TECH.	3	0	0	30	20	50	100	150	3
4.	TBT-354	BIO ANALYTICAL TECHNOLOGY	3	0	0	30	20	50	100	150	3
5.	THS-351	IPR, BIOETHICS & BIOSAFETY	2	0	0	15	10	25	50	75	2
6.	EBT-31X	PROGRAM ELECTIVE-1	3	0	0	30	20	50	100	150	3
PRACTICAL											
7.	PBT-351	BIOINFORMATICS LAB	0	0	2	10	15	25	25	50	1
8.	PBT-352	BIOPROCESS ENGINEERING LAB	0	0	2	10	15	25	25	50	1
9.	PBT-353	RECOMBINANT DNA TECHNOLOGY LAB	0	0	2	10	15	25	25	50	1
10.	GPP-351	GENERAL PROFICIENCY	-	-	-	-	50	50	0	50	0
SEMESTER TOTAL			**17**	**0**	**6**	**195**	**205**	**400**	**625**	**1025**	**20**

PROGRAM ELECTIVE-1(EBT-31X; X=1, 2, 3, 4)

EBT-311: BIOSTATISTICS
EBT-312: BIOFUEL &ALCOHOL TECHNOLOGY
EBT-313: HERBAL BIOTECHNOLOGY
EBT-314: SOLID WASTE MANAGEMENT

TBT-351	BIOINFORMATICS	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. To acquire knowledge how bioinformatics data is stored and organized
2. To explain how to locate and extract data from key bioinformatics databases and resources
3. To describe the methods of sequencing
4. To describe various algorithms for sequence alignment and protein modelling.
5. To explain the concept and methods of gene prediction.

UNIT-I

Introduction to Bioinformatics, Goals, Scope, Applications in Biological Science, Medicine and Limitations, Databases, types of biological databases (primary, Secondary and specialized) Nucleotide sequence databases (EMBL, Gene Bank, DDBJ), protein sequence database (Swiss prot, PIR), Protein Structure Database (PDB,SCOP,CATH), other databases Pfam, EST, TFB sites, PROSITE,KEGG, Data Retrieval with Entrez, SRS, DBGET.

UNIT-II

Principle of DNA sequencing (Chemical chain termination, dideoxy chain termination method, automated sequencer), Protein sequencing (Edmand degradation method), sequence submission to various databases.

UNIT-III

Sequence alignment (global and local), Pair wise and multiple sequence alignment (Scoring matrix, gap penalty, dynamic programming), Sequence alignment algorithm (FAST, BLAST, Needleman and Wunsch, Smith Waterman), Database similarity searches (BLAST, FASTA and PSIBLAST), Amino acid substitution matrices (PAM BLOSUM).

UNIT-IV

Protein structure prediction (Chou Fasman method): Secondary and tertiary structures, Homology Modelling.

UNIT-V

Gene prediction,Gene prediction tools (Genscan, Grail), File format converter tool (BABEL, Read Seq), visualization tools (Rasmol, Pymol, CHIME), Modeling tools (modeler, Swiss PDB), Autodock.

TEXT /REFERENCE BOOKS:

1. Bioinformatics: Principles and applications by Ghosh and Mallick (oxford university press).
2. Bioinformatics by Andreas D Boxevanis (Wiley Inter science).
3. Fundamental concept of bioinformatics by Dane. Krane.
4. Introduction to bioinformatics by Attwood and Parry Smith (Pierson education Publication).

COURSE OUTCOMES

After successfully completing this course, students will be able to:

1. On the completion of this course students shall have knowledge to identify, adapt and develop in silicon models appropriate to the specific study of different biological projects.
2. The students will be familiar with the use of bioinformatics software, tools in their area of research.

PBT-351	BIOINFORMATICS LAB	0L:0T:2P	1 CREDITS

List of Experiments:

1. To learn to use biological databases with reference to Expaxy and NCBI.
2. To retrieve the sequence of the Human keratin protein from Gen Bank database and to interpret the results.
3. To compare the local and global alignments between the given sequences
4. To determine the Post Translational Modifications involved in P53355 and to determine the residues involved in PTM.
5. To determine the conserved domain present in Q8NFM4
6. To perform the local alignment between the given sequences using any two variants of BLOSUM
7. To align more than two sequences and find out the similarity between those sequences
8. To find the similarity between sequences using BLAST
9. To predict secondary structure of the give protein sequences
10. To determine the tertiary structure of P68871 AND P24071

TBT-352	BIOPROCESS ENGINEERING	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. To introduce the engineering principles of bioprocesses including growth kinetics, media requirement, bioreactor components and control system, concept and methods of sterilization.
2. To study the stoichiometry and energetics of cell growth and product formation
3. To evaluate the kinetics and mechanism of microbial growth.
4. To know the importance of diffusion and mass transfer in bioreactor
5. To learn the fermentative production processes for various industrially important compounds.

UNIT I

Overview of bioprocess engineering, Concept of material balance: types of material balance, growth stoichiometry and elemental balance, electron balance, maintenance coefficient and yield concept, Isolation, preservation, maintenance and screening of Industrial important microorganism.

UNIT II

Principle of microbial nutrition, formulation of culture media, selective media, factors influencing the choice of various carbon and nitrogen sources, vitamins, minerals, precursors and antifoam agents, medium optimization.

Microbial growth kinetics: growth, substrate utilization and production kinetics in Batch, Continuous and Fed-batch processes.

UNIT III

Sterilization: concept and methods. Type of Sterilizations, Batch heat sterilization of liquids, Continuous heat sterilization of liquids, Sterilization of air: Methods &Mechanism, Design of depth filter and estimation of its efficiency.Bioreactors: components and control of process parameters, Types of bioreactors: CSTR, Airlift, Fluidized bed, plug flow reactor. Concept of ideal and non ideal reactors

UNIT IV

Role of diffusion in Bioprocessing, Convective mass transfer, Gas-liquid mass transfer, Oxygen uptake in cell cultures, Factor affecting cellular oxygen demand, Oxygen transfer in bioreactors, Measurement of volumetric oxygen transfer coefficient, Oxygen transfer in large bioreactor.

Concept of scale up and scale down in bioreactors.

UNIT V

Fermentative production of Penicillin, Streptomycin, Tetracycline and other Antibiotics, Organic solvents, acetone, ethanol, butanol, Organic acids: lactic acid, citric acid and acetic acid, Enzymes (Proteases, Lipases and alpha-amylase), Amino acids (L- glutamic acid, phenylalamine and L-lysine).

TEXT /REFERENCE BOOKS:

1. Biochemical Engineering: J.M. Lee, Prentice Hall.
2. Bioprocess Engineering: M. Shuler and F. Kargi, Pretice Hall.
3. Comprehensive Biotechnology: M. MooYoung, Editor.
4. Biotechnology: H.J. Rehm and G. Reed, VCH.
5. Lab Manual of Microbiology, Biochemistry and Mol. Biology- J. Saxena, MamtaBaunthiyal, I. Ravi, Scientific Publication.

COURSE OUTCOMES

After completion of the course

1. Students will develop the skills to understand the theory and practice of experiments related to bioprocess Engg.
2. Students can apply the knowledge gained in bioprocess industries.
3. Students can solve problems related to cell growth kinetics and mass transfer in bioreactors.
4. Students will be able to illustrate the fermentative production process of various important compounds.

PBT-352	BIOPROCESS ENGG. LAB	0L:0T:2P	1 CREDIT

List of Experiments

1. Isolation of Pure culture

2. Maintenance and Preservation of Industrial important microorganism by different method.

3.Monod Kinetics in batch culture.

4. Carbohydrate fermentation test.

5. Antibiotic production by Fungi

6. Ethanol production and its estimation.

7. Media Sterilization in the Bioreactor

9. Thermal deactivation kinetics

10. KLa determination in the Bioreactor

11. Estimation of lactic acid in curd.

12. Study of parts of bioreactor.

13. Study of continuous culture

TBT-353	RECOMBINANT DNA TECHNOLOGY	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. To know basics of recombinant DNA Technology
2. To enrich knowledge about different agents used in recombinant DNA Technology
3. To acquire knowledge of solving human health problems through rDNA Technology

UNIT I

History and recent developments in rDNA Technology, Enzymes in rDNA Technology, Restriction Endonuclease, Ligases, Alkaline phosphatase, Polynucleotide kinase, Terminal deoxy-nucleotidyltransferase, S1 nuclease, DNA polymerase, Rnases, Ribonuclease, Reverse transcriptase, Taq polymerase.

UNIT II

Vectors, Plasmids, Size, Copy Number, Amplification, Types , Plasmid pBR322, origin, advantage , pUC, Col E1 plasmid, Ti plasmid , F plasmid , R plasmid . Lamda phage vectors, cosmids and phagemid as vectors.

UNIT III

Animal and Plant Viruses and their use as vectors, Shuttle vectors, Expression vectors.Screening and selection of recombinant clones.

UNIT IV

Gene transfer techniques. Molecular mechanism of antisense technology. PCR, RAPD, RFLP, Safety regulations in recombinant DNA.

UNIT V

Construction of genomic and cDNA libraries, screening of libraries, Site directed mutagenesis, Ethical issue involving in rDNA Technology. rDNA Technology in solving human problems.

TEXT /REFERENCE BOOKS:

1. Gene VII -Benjamin Lewin, 2000. Oxford University Press, UK.
2. Principles of Gene Manipulation and Genomics - Primrose, S.B. and Twyman, R.M. 2006. 7th Edition. Blackwell Publishing Company.
3. Recombinant DNA Second Edition - James D. Watson, Micheal Gilman, MarkZoller, 2001. W.H. Freeman and Company, New York.
4. Biotechnology,Satyanarayana. U, (2008), Books and Allied (p) Ltd.

COURSE OUTCOMES

Students will able to

1. Acquire the knowledge about common tools of rDNA for human welfare
2. Apply the knowledge ofrDNA biotechnology for counseling and curing of complex genetic diseases/disorders
3. Develop the new strategies for bio-entrepreneurship development through r DNA technology

PBT-353	RECOMBINANT DNA TECHNOLOGY LAB	0L:0T:2P	1 CREDITS

List of experiments

1. Extraction and estimation of DNA from plant and microbes.
2. Extraction and estimation of RNA from plant and microbes.
3. Isolation of plasmid DNA from *E. coli*.
4. To determine the melting curve of DNA.
5. To determine base composition of DNA
6. To perform agarose electrophoresis of DNA.
7. To perform SDS-PAGE electrophoresis of protein.
8. To perform Gel documentation.

TBT-354	BIOANALYTICAL TECHNOLOGY	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. A comprehensive knowledge of the equipment used in Biotechnology will be offered in the course along with the applications.
2. To acquire knowledge about bio-analytical techniques along with their theory, working principal, common instrumentation and possible applications.

UNIT I

Introduction, Modern approaches in Bioanalysis and Bioassays, Types of analytical methods, Instrument for analysis, Uncertainties in Instrumental measurements sensitivity and detection limit, pH meter, sensors and their operation.

UNIT II

Microscopic Techniques; Light Microscopy, Fluorescence microscopy, Atomic force microscope, Electron microscope,Scanning electronmicroscopy, Transmission Electron microsope.Applicationofmicroscope in analyzing biological samples.

UNIT III

Spectroscopic techniques: Beer-lamberts law and Apparent deviations, Instrumentation and applications - UV-Visible spectroscopy, Fluorescence spectroscopy, IR spectroscopy, X-ray diffraction and crystallography, CD spectroscopy, and Mass spectroscopy

UNIT IV

Centifugation; General principles, Ultra Centrifugation, Velocity sedimentation and Measurements, equilibrium Ultracentrifugation -Density Gradient centrifugation.
Electrophoresis;Principle, Design of horizontal and vertical gelelectrophoresis apparatus, application of electrophoresis in analyzingmacromolecules.

UNIT V

Chromatographic Techniques: Principles, Column chromatography, HPLC, TLC,Paper chromatography, Analytical techniques for nucleic acid analysis-electrophoresis, blotting techniques, PCR and its types.

TEXT /REFERENCE BOOKS:

1. A biologist Guide to principles and technique of practical biochemistry- By Keith Wilson, Kenneth H. Gouldind 3rd Edition, ELBS Series.
2. Skoog and West, Fundamentals of analytical chemistry, 1982.
3. Vogel, Text Book of quantitative Inorganic analysis, 1990.
4. Ewing, instrumental method of analysis, 1992.
5. Hobert, H. Willard, D. L. Merritt and J. R. J. A. Dean, Instrumental methods of analysis, CBS Publishers and Distributors, 1992.

6. F. Settle. Hand book of Instrumental Techniques for Analytical chemistry, Prentice Hall, 1997.

COURSE OUTCOMES

On successful completion of this course students will be able to:

1. Apply analytical methods for solving a given problem.

2. Handle and calculate instrumental measurements uncertainities.

3. Select microscopic techniques for different samples and purpose.

4. Characterize biomolecules by using analytical techniques.

THS-351	IPR, BIOETHICS AND BIOSAFETY	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. To know basics of IPR
2. To acquire knowledge about importance of IPR with relation to biotechnology
3. To have basic idea of bioethics and bio-safety measures related to biotechnological research

UNIT I

Patents**:** Introduction to patent law and conditions for patentability; Procedure for obtaining patents; Rights of a patentee; Patent infringements; Biotechnology patents and patents on computer programs; Patents from an international perspective.

UNIT II

Copyright: Registration procedure and copyright authorities; Assignment and transfer of copyright Copyright infringement and exceptions to infringement; Software copyright; **Designs:** Introduction to the law on Industrial Designs; Registration and piracy; International perspective; Registration, commercial exploitation and infringement

UNIT III

IPR laws:Rights/protection, infringement or violation, remedies against infringement: civil and criminal; Indian Patent Act 1970 and TRIPS; Major changes in Indian Patent system as post TRIPS effects; Contents of patent specification and the procedure for patents; (a) Obtaining patents; (b) Geographical indication; (c) WTO; Detailed information on patenting biological products; Plant breeders' and farmers' rights; Biodiversity; Budapest treaty; Appropriate case studies.

UNIT IV

Bioethics and Legal Issues: Ethical issues; Public perception related to Biotechnology from developed and developing countries. Legal and socio-economic impacts of biotechnology, public awareness on genetically modified life forms (case study). Ethical implication of biotechnological products and technique.Social and ethical implication of biological weapons.

UNIT V

Biosafety and Risk Assessment:Introduction; Historical Background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety levels; specific microorganisms; Recommended biosafety levels for Infectious agents and Infected Animals; Biosafety guidelines - Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartagena Protocol, GMP and GLP.

TEXT /REFERENCE BOOKS:

1. Patent Strategy for Researches & Research Manegers- Knight, Wiley Publications.
2. Agriculture & Intellectual & Property Rights, V. Santaniello& R E Evenson, University
   Press.
3. Intellectual Property Protection & Sustainable Development, Phillipe Cullet, LdexixNexis
   Butterworths.
4. Biotechnology & Safety Assessment, Thomas, Ane/Rout Publishers.
5. Biotechnology in Comparative Perspective, Fuchs, Ane/Rout Publishers.

COURSE OUTCOMES

Students will be able

1. To use IPR knowledge to obtain recognition and revenue
2. Develop skill to make educationists and other stakeholders aware about the importance of IPR, bioethics and biosafety
3. Acquire knowledge to help researchers to file patents and tell the safety and ethical measures of bioresearch.

PROGRAMME ELECTIVES -I

EBT-311	BIOSTATISTICS	3L:0T:0P	3CREDITS

COURSE OBJECTIVES

1. To learn statistical concepts and terminology and basic analytic techniques.
2. To understand the basic concepts and principles of test of hypothesis and probability and will learn to use them with respect to biological data.
3. To be aware about the classification and graphical representation of various types of data and will learn to apply basic statistical concepts such as measures of central tendencies, measures of dispersion and sampling.

UNIT I

Presentation of Data: Frequency distribution, graphical presentation of data by histogram, frequency curve and cumulative frequency curves, Measure of Location and Dispersion: Mean, Medium, Mode and their simple properties (Without derivation) and calculation of median by graphs: range, mean deviation, Standard deviation, Coefficient of variation.

UNIT II

Probability and Distribution: Random distributions, events-exhaustive, mutually exclusive and equally likely, definition of probability (with simple exercises), definition of binomial, Poisson and normal distributions and their inter-relations, Simple properties of the above distributions (without derivation).

UNIT III

Correlation and Regression: Bivariate data – simple correlation and regression coefficients and their relation, Limits of correlation coefficient, Effect of change of origin and scale on correlation coefficient, Linear regression and equations of line of regression, Association and independence of attributes.

UNIT IV

Sampling: Concept of population and sample, Random sample, Methods of taking a simple random sample, Tests of Significance: Small sample tests (t-test for an assumed mean and equality of means of two populations when sample observations are independent, Paired and unpaired t-test for correlation and regression coefficients, T-test for comparison of variances of two populations, Chi-square test for independence of attributes, Goodness of fit and homogeneity of samples.

UNIT V

Experimental Designs: Principles of experimental designs, completely randomized, Randomized block and Latin square designs, Simple factorial experiments of 22, 23, 24 and 32 types, Analysis of variance (ANOVA) and its use in the analysis of RBD.

TEXT /REFERENCE BOOKS:

1. Statistical methods in biology by Norman T.J. Bailey (3rd Edition), Cambridge University Press (1995).
2. S. C. Gupta and V. K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand and Sons, New Delhi , 2003.

COURSE OUTCOMES

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

1. Apply basic statistical concepts commonly used in Health and Medical Sciences.
2. Apply statistical methods to solve biological problems.
3. Interpret results of commonly used statistical analyses in written summaries.
4. Demonstrate statistical reasoning skills correctly and contextually.
5. Use basic and modern statistical software to analyse the biological and clinical data.

EBT- 312	BIOFUELS & ALCOHOL TECHNOLOGY	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. Different classes and characteristics of raw materials for alcohol production.
2. The various techniques of alcoholic fermentation.
3. Different sources of biofuel/ bioenergy.
4. Techniques for Conversion of biomass to biofuel.

UNIT I

Various biofuels/bioenergy from biomass, Biomass conversion to biofuel, thermochemical Conversion, syngas fermentation, Biomass conversion to heat and power: thermal gasification of biomass, anaerobic digestion.

UNIT II

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, Biochemistry of alcohol production.

UNIT III

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 alcohol production.

UNIT IV

Alcohol distillation-The fundamental, Parameters and factors affecting alcoholic fermentations, Distillery quality control, Alcoholometry, Scaling in distilleries.

UNIT V

The management of fermentation in the production of alcohol, By products of alcoholic fermentation, Fusel oil separation, Study of different recycling process.

TEXT /REFERENCE BOOKS:

1. Text books of alcohol tech by T. P. Lyons.
2. Product Recovery in Bioprocess Technology , BIOTOL Series, VCH,
3. Shreve's Chemical Process Industries
4. Outlines of Chemical Technology by Chmles E.
5. Chemical Process Industries, By Shieve, McGraw.

COURSE OUTCOMES:

At the end of the course the students will learn:

1. This course creates general understanding about alcohol (bioethanol) production; choice of raw materials (first generation and second-generation feedstock),

fermentation and distillation techniques for the production of different grade of alcohol.

2. To familiarize the student with biofuels; sources of biomass for biofuel production and their sustainable and eco-friendly characteristics.

EBT-313	HERBAL BIOTECHNOLOGY	3L:0T:0P	3CREDITS

COURSE OBJECTIVES

1. To acquire knowledge of medicinal plant wealth of Garhwal Himalaya
2. To enrich knowledge about Indian drug system since ancient times
3. To know different techniques for harnessing the potential of medicinal plant wealth to solve the medical problems of the masses

UNIT-I

History, definition and scope of herbal medicine, the great contributors of medicine.Traditional and alternative system of medicine. Medicinal plants of Uttarakhand scope of plant origin medicine in Uttarakhand.

UNIT II

Classification of crude drugs of plant origin.Alphabetical classification, taxonomical classification, morphological classification, chemical classification, pharmacological (Therapeutic classification), Chemotaxonomic classification.

UNIT III

Introduction to parts of medicinal plant cell organelles of plant cell, plant tissue, microscopy of plant, leaves, stems, flowers, fruits, seeds, basks, woods, underground drugs.

UNIT IV

Cultivation Methods Of propagation, methods of pest control, types of insertions used in cultivation and part harvest the of herbal plants Plant growth regulators.

UNIT V

Cultivation and utilization of medicinal and aromatic plant in India. Genetic as applied to medicinal herbs research, genetic engineering and recumbent DNA technology. Plant tissue culture as source of biomedical Bio medicinal.

TEXT /REFERENCE BOOKS:

1- Pharmacgrey by hohate, purohitgothallec by Nirali publication.
2- Sumant SS, phar UP palni LMS, medicinal plant of Indian Himalaya. Diversity, Distribution and potential values.GyanPrakashan, Nainital 1928.
3- Jain S.H 1991 Dictionary of Indian Folk medicinal Deep publications New Delhi.
4- Chaula H.S. plant Biotechnology Oxfords IBH publication.
5- Challrzee M.N. and Shindi, R 1995 textbook of medical biochemistry.Japee brother medicinal pub ltd. New Delhi.

COURSE OUTCOMES

Students will be able to:

1. Know that the region in which they are studying is full of medicinal plant wealth
2. Apply the concepts of herbal biotechnology for curing human and animal ailments
3. Develop in to skill manpower for pharmaceutical industry and help in employment

EBT-314	SOLID WASTE MANAGMENT	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. To make the students conversant with different aspects of the types, sources, generation, storage, collection, transport, processing and disposal of municipal solid waste.
2. To identify the key problem and solution in solid waste generation and management.

UNIT I

Sources And Types Of Municipal Solid Wastes-Waste Generation Rates-Factors Affecting Generation, Characteristics-Methods Of Sampling And Characterization; Effects Of Improper Disposal Of Solid Wastes-Public Health And Environmental Effects. Elements Of Solid Waste Management –Social And Financial Aspects – Municipal Solid Waste (M&H) Rules – Integrated Management-Public Awareness; Role Of NGO's.

UNIT II

On-Site Storage Methods – Effect Of Storage, Materials Used For Containers – Segregation Of Solid Wastes – Public Health And Economic Aspects Of Open Storage – Waste Segregation And Storage – Case Studies Under Indian Conditions – Source Reduction Of Waste – Reduction, Reuse And Recycling.

UNIT III

Methods Of Residential And Commercial Waste Collection – Collection Vehicles – Manpower– Collection Routes – Analysis Of Collection Systems; Transfer Stations – Selection Of Location, Operation & Maintenance; Options Under Indian Conditions – Field Problems- Solving.

UNIT IV

Objectives Of Waste Processing – Physical Processing Techniques And Equipments; Resource Recovery From Solid Waste Composting And Biomethanation; Thermal Processing Options – Case Studies Under Indian Conditions.

UNIT V

Land Disposal Of Solid Waste; Sanitary Landfills – Site Selection, Design And Operation Of Sanitary Landfills – Landfill Liners – Management Of Leachate And Landfill Gas-Landfill Bioreactor– Dumpsite Rehabilitation

TEXT /REFERENCE BOOKS:

1. Tchobanoglous, G., Theisen, H. M., AndEliassen, R. "Solid. Wastes: Engineering Principles And Management Issues". McGraw Hill, New York, 1993.
2. Vesilind, P.A. And Rimer, A.E., "Unit Operations In Resource Recovery Engineering", Prentice Hall, Inc., 1981
3. Paul T Willams, "Waste Treatment And Disposal", John Wiley And Sons, 2000
4. Manser A.G.R. And Keeling A.A.," Practical Handbook Of Processing And Recycling Of Municipal Solid Wastes", Lewis Publishers, CRC Press, 1996

COURSE OUTCOMES

The students completing the course will have

1. An understanding of the nature and characteristics of municipal solid wastes and the regulatory requirements regarding municipal solid waste management
2. Ability to plan waste minimisation and design storage, collection, transport, processing and disposal of municipal solid waste

EVALUATION SCHEME
B. TECH. BIOTECHNOLOGY
III-YEAR (**VI-SEMESTER**)

S. No.	COURSE CODE	SUBJECT	PERIODS			EVALUATION SCHEME					
						SESSIONAL EXAM			ESE	Subject Total	CREDIT
			L	T	P	CT	TA	Total			
THEORY											
1.	TBT-361	DOWNSTREAM PROCESSING	3	0	0	30	20	50	100	150	3
2.	TBT-362	ENVIRONMENT BIOTECHNOLOGY	3	0	0	30	20	50	100	150	3
3.	TBT-363	GENOMICS & PROTEOMICS	3	0	0	30	20	50	100	150	3
4.	TBT-364	NANOBIOTECHNOLOGY	3	0	0	30	20	50	100	150	3
5.	TOE-XY	OPEN ELECTIVE-1	3	0	0	30	20	50	100	150	3
6.	THS-361	BIOTECHNOLOGY & ENTERPRENEURSHIP DEVELOPMENT	3	0	0	30	20	50	100	150	3
PRACTICAL											
7.	PBT-361	BIOREACTOR ENGINEERING LAB	0	0	2	10	15	25	25	50	1
8.	PBT-362	ENVIRONMENT BIOTECH LAB	0	0	2	10	15	25	25	50	1
9.	GPP-361	GENERAL PROFICIENCY	-	-	-	-	50	50	0	50	0
SEMESTER TOTAL			**18**	**0**	**4**	**200**	**200**	**400**	**650**	**1050**	**20**

TBT-361	DOWN STREAM PROCESSING	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. To introduce the various techniques of product isolation and purification from fermentation broth like removable of insoluble, primary isolation, purification and final polishing.
2. To analyze and solve problems related to separation technique.

UNIT I

Introduction: History and scope of downstream processing in biotechnology, problems, requirement of purification, Characteristics of biotechnology products and fermentation broth, classes of bioproducts, physicochemical basis of bio separation.

UNIT II

Cell disruption methods for intracellular products, solid liquid separation: Separation of particulate by filtration, centrifugation, settling, sedimentation, decanting and micro filtration, foam based separation.

UNIT-III

Primary isolation methods- Adsorption: Principles - Langumir - Freundlich isotherms, Extraction: Basics- Batch and continuous, aqueous two-phase extraction - supercritical extraction - *in situ* product removal - Precipitation: Methods of precipitation with salts - organic solvents and polymers - Membrane based separations: Micro and ultrafiltration - theory - design and configuration of membrane separation equipment and its applications.

UNIT IV

Basic principles of Chromatographic separations: GC-HPLC - gel permeation - ion-exchange - affinity - reverse phase and hydrophobic interaction chromatography - Electrophoretic separation techniques: capillary - isoelectric focusing-2D gel electrophoresis - Hybrid separation technologies: GC-MS and LC-MS.

UNIT V

Final product formulation and finishing operation: theory and equipments- crystallization, drying and lyophylization, Product recovery trains - a few examples.Typical examples for downstream Processing and effluent disposal in process industries.

TEXT /REFERENCE BOOKS:

1.Biochemical Engineering fundamentals 2nd ed. Bailey J. E. and Ollis D. F. (1986) MacGraw Hill, New York.

2. Principles of fermentation technology, Stanbury, P. F. and Whitaker, A. (1984), Pergamon press.

3. Unit Operation of Chemical Engineering 6th ed. McCabe, W. L; Smith J. C and Harriott P. (2000). MacGraw Hill, New York.

4. Separation Process Principles, Seader, J.D. & Henley, E.J. (1998) John Wiley & Sons, Oxford.

5. Bioseparation: Downstream Processing for Biotechnology, Belter, P. A.; Cussler E. L. and Hu W. S. (2003) John Wiley & Sons. OXFORD.
6. Bioseparations Science and Engineering, Harrison R.G.; Todd P.; Rudge S.R. and Petrides D.P. (2003), Oxford Press.
7. Wastewater Engineering 4th ed. Metcalf and Eddy (2002). MacGraw Hill, New York.

COURSE OUTCOMES

After completion of the course

1. The student will develop skills to carry on lab experiments related to the subjects.
2. Students will have ability to analyze and select the appropriate technique for product recovery and purification.
3. Students will develop theoretical knowledge which they can apply in bioprocess and other industries.
4. Students will be able to demonstrate critical thinking, problem solving and decision making abilities.

PBT-361	BIOREACTOR ENGG. LAB	0L:0T:2P	1 CREDIT

List of Experiments

1. To understand the basic design and operation features of the bioreactor.
2. To evaluate the cell growth kinetics using chemostat model.
3. To determine the residence time distribution in a reactor.
4. To verify the order of reaction and see the effect of various parameters on reaction rate.
5. Determination of mixing time in stirred vessel with both Newtonian and non-Newtonian fluids.
6. Determination of immobilized enzyme kinetics in packed bed reactors.
7. To study tank in series model.
8. To study the modelling and simulation of bioreactor.
9. Enzyme production through solid state fermentation.
10. Solid liquid separation technique; filteration and centrifugation
11. Protein ppt through ammonium salt technique
12. Solvent extraction experiment using separating funnel.

TBT-362	ENVIRONMENT BIOTECHNOLOGY	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. Describe the use of conventional and emerging biotechnological process for treatment of waste water and solid waste management,
2. Learn bioremediation techniques in treating contaminated soil and bio restoration
3. Application of environmental biotechnology in agriculture and energy sector.

UNIT I

Introduction to Environment: Concept of ecology and ecosystem, environmental pollution (Water,soil and air) noise and thermal pollution, their sources and effects. Environmental laws and policies.Molecular biological techniques in the characterization of environmental pollutions by microorganisms.Emerging Technologies, biosensors and microprobes.

UNIT II

Sewage and waste water treatments anaerobic and aerobic treatment, conventional and advanced treatment technology, methanogenesis, methanogenic, acetogenic, and fermentative bacteriatechnical process and conditions, emerging biotechnological processes in waste – water treatment.

UNIT III

Solid waste management: Landfills, composting, earthworm treatment, recycling and processing of organic residues. Biodegradation of xenobiotic compounds, organisms involved in degradation of chlorinated hydrocarbons, substituted simple aromatic compounds, polyaromatic hydrocarbons, pesticides, surfactants and microbial treatment of oil pollution.

UNIT IV

Bioremediation and Biorestoration: Reforestation through Micropropagation, development of stress tolerant plants, use of mycorrhizae in reforestation, use of microbes for improving soil fertility, reforestation of soils contaminated with heavy metals.

UNIT V

Environmental Biotechnology in Agriculture: Biofertilizers and microbial inoculants, biopesticide,bioinsecticides, bioherbicides Biofuel: Plant derived fuels, Energy crops, Biogas, Bioethanol,biohydrogen Environmental genetics: degradative plasmids, release of genetically engineered microbes in environment.

TEXT /REFERENCE BOOKS:

1. Environmental Biotechnology by Alan Scragg (1999); Longman.
2. An Introduction to Environmental Biotechnology by Milton Wainwright (1999): Kluwer Academic Press.

COURSE OUTCOMES

At the end of the course the students will learn:

1. The sources and effects of different types of environmental pollution, concept of ecosystem, environmental laws and policies.
2. How to apply of molecular and biotechnological techniques for environment monitoring.
3. Application of bioremediation in treating contaminated soil and bio restoration.
4. Application of environmental biotechnology in agriculture such as biopescticides, biofertlizers, in energy sector such as production of biofuels and environmental genetics.
5. Create awareness among society towards environmental pollution and its ill effect.

PBT-362	ENVIORNMENT BIOTECH LAB	0L:0T:2P	1 CREDIT

List of Experiments

1. Determination of acidity and alkalinity of given water sample.
2. Estimation of nitrogen by Kjeldahl method.
3. Estimation of cellulose by spectrophotometric method.
4. Determination total dissolved solid in a given sample.
5. Estimation of total solids of a given sample.
6. Determination of hardness of a given sample by using EDTA method
7. Determination of BOD, COD and DO of waste water sample.
8. Microbiological characterization of waste water sample.

TBT-363	GENOMICS AND PROTEOMICS	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. To learn the basics of Genomics and Proteomics.
2. To understand the principles of practical applications of Genomics and Proteomics.
3. To know about applications of bioinformatics to solve genomics and Proteomics problems.

UNIT I

Introduction to Genomics Genome evolution and phylogenetics, Origin of genomes, Acquisition of new genes, DNA sequencing – chemical and enzymatic methods, the origins of introns, DNA and RNA fingerprinting, the human genome.

UNIT II

Structural and Functional Genomics Technology, Sequences Comparison Techniques [BLAST], Genome, Annotation, ESTs, Digital Northerns, SAGE, Relational Data Base Basics, cDNA Microarrays, Oligonucleotide Microarray Chips, Cancer and genomic microarrays, Application of Microarrays with examples ,Microarray Data Analysis; Gene finding tools.

UNIT III

Introduction to proteomics How to analyze a Proteome – 2D-gel electrophoresis, high-throughput proteome analysis with 2D-IEF, MALDI-TOF mass spectrometry

UNIT IV

Protein Structure and Function Structure function relationship, Protein-protein interactions – Large molecular complexes – RNA polymerase II, ribosome; Unstructured proteins – Current concepts and examples, the fly-casting mechanism; Current Degradation Concept.

UNIT V

Application of Genomics and Proteomics Genome sequencing projects (technology of sequencing and assembly, bioinformatics of genome annotation, current status of genome sequencing projects) Genomic browsers and databases. Study of Post translational Modifications: Methods of applications, Aspects of Clinical Proteomics; Protein micro arrays and MS Imaging

TEXT /REFERENCE BOOKS:

1. Genomes II, T.A. Brown(2014)
2. Biotechnology and Genomics by P.K.Gupta(2011)
3. A Primer of Genome Science, Greg Gibson and Spencer V. Muse
4. Database Annotation in Molecular Biology : Principles and Practice, Arthur M.
5. Gene Cloning and DNA Analysis – An introduction (Fourth Edition), T.A. Brown
6. Genes & Genomes, Maxine Singer and Paul Berg
7. Essential of Genomics and Bioinformatics, C.W. Sensen, John Wiley and Sons Inc.

COURSE OUTCOMES:

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

1. Aware about techniques of genomics and proteomics.
2. Develop new systems and technologies by using genomics and proteomics tools forsolving complex genetically critical problems..
3. Characterize and sequence important plant and animal genomes for potential human applications for betterment of human society

TBT-364	NANO BIOTECHNOLOGY	3L:0T:0P	3CREDITS

COURSE OBJECTIVES

1. To provide general and broad introduction to multi-disciplinary field of nanobiotechnology.
2. To familiarize students with combination of top-down approach of microelectronics and micro-mechanics with bottom-up approach of chemistry/biochemistry; a development that is creating new and exciting cross-disciplinary research fields and technologies.
3. To give an insight to the students into complete systems where nanobiotechnology can be used to improve everyday life.

UNIT I

Introduction to nanotechnology and nanobiotechnology: Definition, Fundamental Concepts, Nanomaterial: Nanoparticles, Fullerenes, quantum dots, Dendrimers, Advanced composites, Advanced ceramics, Properties and applications, Nanomaterial Types: Nanowires, Nanotubes and their synthesis, properties, applications.

UNIT II

Method of preparation: Top down, bottom up, plasma forcing, chemical vapor deposition, sol – gel methods. Nanofabrication: Photolithography -Electron-Beam Lithography -Nanoimprint lithography–Softlithography Patterning, Green synthesis of Nanoparticles.

UNIT III

Nanomaterial Characterization tools and techniques (Basics and their role in characterization) : UV-visible spectrophotometry, X-ray diffraction,Fourier transform infrared spectroscopy (FTIR),Scanning Electron Microscopy (SEM), Scanning tunneling microscopy (STM),Transmission electron microscopy (TEM),Atomic force microscopy (AFM),XPS.

UNIT IV

Nanobiotechnological devices: Nanoparticles, Self assembled monolayers, Bio molecular motors and their functions, Biosensors -Antibodies as biosensors, DNA based nanomaterials as biosensors,Nanosensors, Nano crystals in Biological Detection, Gas sensors and other analytical devices, Miniaturized devices in nanobiotechnology - types and applications, lab on a chip concept,medical therapeutics, Microelectronic applications,consumer products.

UNIT V

Current and future market applications: Nanobiotechnological applications in Environment and food-detection and mitigation, Nanobiotechnological applications in health and disease-infectious and chronic, Drug delivery systems, Legal considerations for nanotechnology, Environmental risk assessment, Health risk assessment, and Hazards risk assessment.

TEXT /REFERENCE BOOKS:

1.Introduction to Nanoscale science and technology. Ed. By Mosimilano Di ventra I Edition, Kluwer Academic – 2004.
2.TheNanobiotechnology Hand Book- YobingXie, CRC Press.2012.
3.Nanobiotechnology: Christof M. Niemeyer, Chad A. Mirkin, John Wiley & Sons, 2004.

COURSE OUTCOMES

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

1. Aware about various environmental and health changes made by the use of Nanobiotechnology.
2. Handle various drug delivery systems and will use them for the treatment of various infectious disease.
3. Develop new systems and technologies by using nanobotechnology for making human life healthier and prosperous.
4. Synthesize and characterize different new nanomaterials and nanoparticles for potential human applications and for betterment of human society.
5. Describe basic science behind the properties of materials at the nanometre scale, and the principles behind advanced experimental and computational techniques for studying nanomaterials

THS-361	BIOTECHNOLOGY &ENTREPRENEURSHIP DEVELOPMENT	3L:0T:0P	3CREDITS

COURSE OBJECTIVES

1. To impart basic knowledge how biotechnology can boost up entrepreneurship development
2. To tell students different avenues of entrepreneurship in biotechnology discipline
3. To increase confidence levels so that the students will be good entrepreneur

UNIT I

Need to commercialize biotechnology. Development process, success rates and costs etc., Creating and marketing the image of the biotechnology company. Art of negotiation& effective communication.

UNIT II

Role of venture capitalism, business plan, selection of CEO and personnel, real estate for a biotech start-up., Management portray and role of a biotechnology manager, technology decision-making and resource decision-making etc., Product marketing decision.

UNIT III

Role of research & development, university-industry technology transfer arrangements, benefits of a biotech company.

UNIT IV

Positioning, power and importance of a company name, product, workable marketing and the strength of distribution. Effective advertising and marketing.

UNIT V

Opportunities international marketing and lessons to be learned, Indian and foreign prospective of biotechnology and current challenges for the biotechnology-based products.

TEXT /REFERENCE BOOKS:

1. Positioning by All Rise and Jack Trout (1986), Warner Books.
2. Biotechnology: The science & the business by V. Moser & R.E. Cape (1999) Harwood.
3. Latest review articles and papers on the subject.

COURSE OUTCOMES

On successful completion of the course students will be able to:

1. Have full knowledge of entrepreneurship development through biotechnology
2. To start new business
3. Helpful in employment generation.

EVALUATION SCHEME
B. TECH. BIOTECHNOLOGY
IV-YEAR (**VII-SEMESTER**)

S. No.	COURSE CODE	SUBJECT	PERIODS			EVALUATION SCHEME					
						SESSIONAL EXAM			ESE	Subject Total	CREDIT
			L	T	P	CT	TA	Total			
THEORY											
1.	TBT-471	FOOD BIOTECHNOLOGY	3	0	0	30	20	50	100	150	3
2.	EBT-42X	PROGRAM ELECTIVE-2	3	0	0	30	20	50	100	150	3
3.	EBT-43Y	PROGRAM ELECTIVE-3	3	0	0	30	20	50	100	150	3
4.	EBT-44Z	PROGRAM ELECTIVE-4	3	0	0	30	20	50	100	150	3
5.	TOE-XY	OE-2	3	0	0	30	20	50	100	150	3
6.	THS-471	BIOTECHNOLOGY-SOCIETAL & GLOBAL IMPACT	3	0	0	30	20	50	100	150	3
PRACTICAL											
7.	PBT-471	PROJECT I	0	0	10	25	25	50	50	100	5
8.	PBT-472	INDUSTRIAL TRAINING	0	0	2	0	50	50	0	50	1
9.	GPP-471	GENERAL PROFICIENCY	-	-	-	-	50	50	0	50	0
SEMESTER TOTAL			**18**	**0**	**12**	**205**	**245**	**450**	**650**	**1100**	**24**

PROGRAM ELECTIVE-2 (EBT-42X; X=1, 2, 3, 4)

1. EBT-421: MOLECULAR DIAGONASTICS
2. EBT-422: BIOREACTOR DESIGN
3. EBT-423: MEDICAL BIOTECHNOLOGY
4. EBT-424: VACCINE BIOTECHNOLOGY

PROGRAM ELECTIVE-3 (EBT-43Y; Y= 1, 2, 3, 4)

1. EBT-431: BIOENERGETICS
2. EBT-432: BIOSENSOR
3. EBT-433: SYSTEM BIOLOGY
4. EBT-434: METABOLIC ENGINEERING

PROGRAM ELECTIVE-4 (EBT-44Z; Z= *1, 2, 3, 4***)**

1. EBT-441: INDUSTRIAL SAFETY & HAZARDS
2. EBT-442: MOLECULAR FARMING
3. EBT-443: BIOPROSPECTING
4. EBT-444: PLANT BIOTECHNOLOGY

TBT-471	FOOD BIOTECHNOLOGY	3L:0T:0P	3CREDITS

COURSE OBJECTIVES

1. To learn the principles involving food preservation.
2. To understand the principles that makes a food product safe for consumption.
3. To be aware about the principles and current practices of processing techniques and the effects of processing parameters on product quality.

UNIT I

Scope and importance of food biotechnology, Role and significance of microorganisms in foods, Intrinsic and Extrinsic Parameters of Foods that affect microbial growth (pH, Moisture content, Water activity, Oxidation reduction Potential, Nutrient content, Biological Structure and Other inhibitory substance).

UNIT II

Contamination of Food, Sources of contamination, Microbiological standards of foods, General principle of Spoilage, types and causes of spoilage, Food poisoning and food borne infection by different micro organisms, Food toxins.

UNIT III

Preservation of Food: Aseptic removal of Microorganism, Maintenance of Anaerobic condition, Preservation by Using High temperature, Low temperature and Chemicals, Concept of Thermal Death Point, Z value, D-Value and F-value, Preservation by Radiation Processing of Foods for Irradiation, Application of Radiation, Radappertization, Radicidation, and Radurization of Foods Legal Status of Food Irradiation, Effect of Irradiation of Food constituents.

UNIT IV

Food fermentation: Bread, Beer, Cheese Production, SCP, medical foods, Concept of 'functional food'; GM food products , Mushroom cultivation, citric acid production, probiotics, Industrial Enzyme production: Amylases, proteinases, cellulaese.

UNIT V

Quality control of Food, Detection of food borne pathogen, Microbiological safety of food products, chemical safety of food products, Good Manufacturing Practice, AgMark, and BIS Standards, Food Safety and Standard Act (FSSA), Status of food processing industry in India and Abroad, Prospectus and constraints in development of Indian food industry.

TEXT /REFERENCE BOOKS:

1. Modern Food Micro-Biology by James M. Jay, (2000), 6th edition, An Aspen Publication, Maryland, USA.
2. Food Microbiology: Fundamentals and frontiers by M.P. Doyle, L.R. Beuchat and Thoma J. Montville, (2001), 2nd edition, ASM press, USA.
3. Food Science and Food Biotechnology by G.F.G. Lopez & G.V.B. Canovas (2003), CRCPress, Florida, USA.

COURSE OUTCOMES

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

1. To handle the basic food safety issues in the food market.
2. To develop and evaluate quality of new food products using objective and subjective methodologies.
3. To apply the basic concepts in food chemistry and food analysis.
4. To identify the conditions under which the important pathogens are commonly inactivated, killed or made harmless in foods.

PROGRAMME ELECTIVES -2

EBT-421	MOLECULAR DIAGNOSTICS	3L:0T:0P	3CREDITS

COURSE OBJECTIVES

1. To understand the basis of different types of infections and their mode of transmission.
2. To be familiar with various types of diseases diagnosis methods and progression of diagnosed disease.
3. Impart basic knowledge of Major Metabolic disorders and its causes.
4. To be Familiarize with principle and applications of different Hybridization techniques and DNA sequencing methods and their role in molecular diagnosis.

UNIT I

Introduction and History of diagnostics:Diseases-infectious, physiological and metabolic errors, genetic basis of diseases, inherited diseases. Infection –mode of transmission in infections, factors predisposing to microbial pathogenicity, types of infectious diseases-bacterial, viral, fungal, protozoans and other parasites.

UNIT II

Traditional disease diagnosis methods and tools: Philosophy and general approach to clinical specimens, Sample collection-method of collection, transport and processing of samples, Interpretation of results, Normal microbial flora of the human body, Host -Parasite relationships, diagnosis of infection caused by Streptococcus, Coliforms, Salmonella, Shigella, Vibrio, and Mycobacterium., Diagnosis of fungal infections. Diagnosis of DNA and RNA viruses-Pox viruses, Adenoviruses, RhabdoViruses,Hepatitis Viruses and Retroviruses.

UNIT III

Major Metabolic disorders and its causes: Traditional methods for the diagnosis of metabolic errors. Disease due to genetic disorders -Identifying human disease genes.Cancer-different types of cancers, genetics of cancer-oncogenes, tumour suppressor genes.Methods available for the diagnosis of genetic diseases and metabolic disorders. Genetic disorders-Sickle cell anemia, Duchenne muscular Dystrophy, Retinoblastoma, Cystic Fibrosis and Sex–linked inherited disorders.

UNIT IV

Molecular Diagnosis: Nucleic acid amplification methods and types of PCR: Reverse Transcriptase-PCR, Real-Time PCR, Inverse PCR, Multiplex PCR, Nested PCR, Alu-PCR, Hot-start, In situ PCR, Long-PCR, PCR-ELISA, Arbitrarily primed PCR, Ligase Chain Reaction. Proteins and Amino acids, Qualitative and quantitative techniques: Protein stability, denaturation; amino acid sequence analysis

UNIT V

Hybridization techniques and DNA sequencing methods in molecular diagnosis:Southern, Northern, in-situ (including FISH), microarrays –types and applications;Protein extraction and analysis (including PAGE and its variations); Western Blot Automated DNA sequencing-Principles, Methods and Instrumentation-Advances in DNA sequencing-New Generation

sequencing Methods, Pyrosequencing,· Microarrays-Personalised Medicine-Pharmacogenomics (ADMET).

TEXT /REFERENCE BOOKS:

1. Medical Microbiology, Edited by Greenwood, D, Slack, R and Peutherer, J, ELST Publishers.
2. Parasitology, Chatterjee K.D, Chatterjee Medical Publishers.
3. Bailey & Scott's Diagnostic Microbiology, Betty A. Forbes , Daniel F. Sahm, Alice S. Weissfeld , Ernest A. Trevino,Published by C.V. Mosbym and Maribeth L. Flaws .

COURSE OUTCOMES

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

1. Gain thinking and analysis skills to understand new diagnostic methods.
2. Use their ability to collect information to develop a new diagnostic kit.
3. Handle traditional methods for diagnosis of infectious diseases-bacterial, viral, fungal, protozoans and other parasites.

EBT-422	BIOREACTOR DESIGN	3L:0T:0P	3CREDITS

COURSE OBJECTIVES

1. To provides exposure for the design and operation of various industrial bioreactors
2. Analyze the design and operation of air driven bioreactors

UNIT I

Basics and importance of bioreactors, Guidelines for bioreactor design, Mechanical aspects of bioreactor design, Requirements for construction of a bioreactor,Development of bioreactors

UNIT II

Scale-up of bioreactors-Criteria of scale-up,Scale-up methods,Generalized approaches to scale-up in combination of methods, Common operations in bioreactors.

UNIT III

Design and construction of Bubble column fermenter,Airlift bioreactors: Design and construction of the airliftloop reactor ,Hydrodynamics – Three phase flow – Mixing – Oxygen transfer,Design and operation of fluidized bed bioreactor

UNIT IV

Design and Operation of Sequence batch reactor, Design and Operation of bioreactor with recycle Design of bioreactors for Solid-state fermentation

UNIT V

Design and Operation of Membrane bioreactor, Design and Operation of Immobilized enzyme bioreactor, Design and Operation of Hollow fiber bioreactor, Design and Operation of Plant cell bioreactor design

TEXT /REFERENCE BOOKS:

1. Scragg. H., "*Bioreactors in Biotechnology*", Ellis Horwood series, 1991.
2. Panda. T., "*Bioreactors: Analysis and Design*", McGraw Hill Education (India) Private Limited, 2011
3. Riet. K. V., Tramper. J., "*Basic Bioreactor Design*", 2nd ed., Marcel Dekker, Inc., New York, 1991.

COURSE OUTCOMES

After completion of the course student will be

1. Able to Strengthen the basic notions of bioreactor design
2. Expand knowledge on various modes of operation of industrial bioreactors for microbial, plant and animal cell culture systems

EBT-423	MEDICAL BIOTECHNOLOGY	3L:0T:0P	3CREDITS

COURSE OBJECTIVES

1. To understand infections caused by different bacteria and viruses.
2. To discuss the scope and role of medical biotechnology in the healthcare industry.
3. To aware students about the multiple uses of antibodies and vaccines in medical biotechnology.
4. To study examples of recent advances in medical biotechnology and expected new applications.

UNIT I

Host Parasite interaction in bacterial infections. Pathogenic properties of bacteria (colonization of surfaces, invasion of tissue, production of exo and endo toxins).Anti bacterial defense of the host, Normal microflora of human body: Skin, Respiratory system, and Genitourinary tracts. Source of infection, mode of spread and portals of entry

UNIT II

Parasitic InfectionsAmoebiasis; Giardiasis, Malarial parasites, Intestinal infection by cestodes (Taeniasis and *H.nana* infection); Trematodes; Bacterial food poisoning(toxic and infective); *E.coli*Diarrhoea; Cholera; Salmonella.

UNIT III

Infections of the Respiratory system:Streptococcal infections; Diphtheria; Whooping cough; Bacterial pneumonias (Haemophilus), Mycobacterium tuberculosis, Advance diagnostic technique used in Disease diagnosis.

UNIT IV

Immunization, Types of Immunization, Rationale of immunization, hazards of immunization, Adjuvants, Vaccine schedule, Vaccines, Types of vaccine, difference between Live and Killed vaccine.

UNIT V

Laboratory control of antimicrobial therapy- various methods of drug susceptibility testing i.e. Kirby Bauer Method, Stokes method, Minimum Inhibitory concentration and Minimum Bactericidal concentration, Mechanism action of antibiotics and drug resistance.

TEXT /REFERENCE BOOKS:

1. Gerald Collee J, Andrew G Fraser, Barrie P Marmion, Mackie andMcCartney's Practical Medical Microbiology, Elsevier. 2006.
2. Text Book of Microbiology by Annanthnarayan and Panicer

COURSE OUTCOMES

On successful completion of this course, students will be able to:
1. Describe the function of drugs and how they may be created with combinatorial chemistry.
2. Interpret how high-throughput screening methods are used to discover potential drug activity.

EBT-424	VACCINE BIOTECHNOLOGY	3L:0T:0P	3CREDITS

COURSE OBJECTIVES

1. To learn the importance and types of different kinds of Vaccines and study various factors that influence vaccine design and development.
2. To understand the nature, scope and transmission of different immune related diseases.

UNIT I

History of Immunization, Immunization types: active and passive immunization, Rationale of immunization, Adjuvant, Age of commencement of immunization, Dosage and Dosage spacing, Vaccine schedule, Hazard of immunization.

UNIT II

Vaccine: Difference between live and killed vaccine, Rationale vaccine design based on clinical requirements, Different types of vaccine: subunit vaccine, Recombinant Vaccine, edible vaccine, Subunit vaccine, antidiotype vaccine, live vaccine, killed vaccine etc.

UNIT III

Hypersensitivity: Types of hypersensitivity, IgE-Mediated (Type I) Hypersensitivity, Antibody-Mediated Cytotoxic (Type II), Immune Complex–Mediated (Type III), Type IV or Delayed-Type Hypersensitivity (DTH), Immunity to Infection.

UNIT IV

Autoimmunity, Transplantation, Tumor, immunodeficiency; Active immunization, live, killed, attenuated, Sub unit vaccines.

UNIT V

Recombinant DNA and protein based vaccines, plant-based vaccines; Peptide vaccines, conjugate vaccines; Passive Immunization; Antibody, Transfusion of immune competent cells, Stem cell therapy; Cell based vaccines.

TEXT /REFERENCE BOOKS:

1. Medical Microbiology: Mackie and McCartney.
2. Immunology by Janis Kuby.

COURSE OUTCOMES

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

1. Demonstrate an understanding of the importance of the factors that influence vaccine design and development.
2. Develop an understanding of how research based discovery has driven vaccine development in current, emerging and,re-emerging infectious diseases.
3. Develop the skills to critically assess the different types of vaccines available and their suitability for different diseases.
4. Demonstrate an understanding of the nature and variability of bacterial and virus antigens relevant to vaccine development.
5. Demonstrate an understanding of the importance of strict quality control and regulation in the vaccine production process, and an awareness of issues associated with the manufacturing of vaccines such as good manufacturing practice.

PROGRAMME ELECTIVES -3

EBT-431	BIOENERGETICS	3L:0T:0P	3CREDITS

COURSE OBJECTIVES

1. To make students understand that thermodynamics principle is applicable to cells.
2. To know the significance of ATP as energy currency of cell.
3. To make student understand that biotransformation and enzyme-catalyzed metabolic pathways obey physical and chemical laws to maintain and perpetuate life forms.

UNIT I

Bioenergetics and thermodynamics: biological transformation reaction obeying laws of thermodynamics, concept of standard free energy change, Structure and properties of ATP and other high energy compounds, Coupling reactions of ATP and NDP (nucleotide di phosphate); Biological oxidation reduction reactions.

UNIT II

Biological membrane: structure, permeability, properties, passive transport and active transport, facilitated transport, energy requirement, mechanism of Na^{+} / K^{+}, glucose and amino acid transport.

UNIT III

Metabolism and bioenergetics; Generation and utilization of ATP in different metabolic pathways: Metabolism of Nitrogen containing compounds: nitrogen fixation, amino acids and nucleotides.

UNIT IV

Energetics of Metabolic Pathways; Energy Coupling (ATP & NADH); Stoichiometry and energetic analysis of Cell Growth and Product Formation - elemental Balances, Degree of reduction concepts; available-electron balances; yield coefficients; Oxygen consumption and heat evolution in aerobic cultures; thermodynamic efficiency of growth.

UNIT-V

Electron Flow as source of ATP Energy, Site of Oxidative Phosphorylation, ATP synthetase, Electron- Transferring Reactions, Standard Oxidation, Electron Carrier, electron transport complexes, Incomplete reduction of Oxygen, Mechanism of Oxidative Phosphorylation, Oxidation of Extra mitochondrial NADH, ATP yield and P: O Ratio, Role of Electron Transport Energy, Respiratory Inhibitors, Regulatory control among Glycolysis, the Citric Acid Cycle and Oxidative Phosphorylation.

TEXT /REFERENCE BOOKS:

1. Introduction to Chemical Engineering thermodynamics by Smith and Vannes (McGraw Hill).
2. Chemical engineering thermodynamics by Y.V.C. Rao (New age international).
3. Engineering Thermodynamics by J. B. Hawkins (John Wiley Publication).
4. Engineering Thermodynamics by Spading and Cole (ELBS0).

COURSE OUTCOMES

After completion of the course the students:

1. Will realize that all the cellular/biochemical changes obey the basic thermodynamic principles.
2. Can explain release of free energy during catabolic breakdown of the substances and its utilization during anabolic pathways
3. Can Illustrate the mechanism of various types of transport system in biological membrane

EBT-432	BIOSENSOR	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. Developing an understanding of biosensor technology needed critically for the development of small, sensitive, and selective biosensor devices
2. Detection systems that can reliably operate in real time and in extreme and diverse physical environments.

UNIT I

Definition, Advantages and limitations, various components of biosensors, Biocatalysis based biosensors, bioaffinity based biosensors & microorganisms-based biosensors.

UNIT II

Biologically active material and analyte, Types of membranes used in biosensor constructions, various types of transducers; principles and applications - Calorimetric, optical, potentiometric / amperometricconductrometric/resistormetric.

UNIT III

Biocatalysis based biosensors, Enzyme elctrodes, bioaffinity based biosensors & microorganisms-based biosensors, biologically active material and analyte. Types of membranes used in biosensor constructions. immunobiosensors, DNA biosensors, Cell basis biosensors, nanosensors

UNIT IV

Piezoelectric, semiconductor, impedimetric, mechanical and molecular electronics-based transducers, Chemiluminiscene - based biosensors, Optical Biosensor

UNIT V

Low cost- biosensor for industrial processes for online monitoring; biosensors for environmental monitoring. Biosensors in clinical chemistry, medicine and health care, biosensors for veterinary, agriculture and food, Biosensors are important tools in food safety diagnostics, medical monitors, and detection systems for biological warfare agents.

TEXT /REFERENCE BOOKS:

1. Aboul - Enein, H. V., Stefan, R. and Van Staden, (1999).Chemiluminiscence -Based biosensors - An overview crit Rev. Anal. Chem. 29, 323-331.
2. Pearson, J.E. Gill, A., and Vadgama, P. (2000) Analytical aspects of biosensors Ann ClinBiochem 37, 119-145.
3. Bilitewski, U. Turner, A.P.F. 2000 Biosensors for environmental monitoring Harwood, Amsterdam.
4. Moses, V and Cape, R.E. 1991, Biotechnology the science and business, Harwood, Academic Publisher London.
5. Rogers, K.R. and Mascini, M. 2001, Biosensors for analytical monitoring EPA biosensors group.

6. Advances in biotechnology: Indu Ravi, MamataBaunthiyal and JyotiSaxena, Springer.

COURSE OUTCOMES

Upon successful completion of this course, the students will be gaining the following knowledge, skills and competences:

1. Acquire knowledge about the biosensors.
2. Ability to design a biosensor.
3. Acquire knowledge about advantages of biosensors

EBT-433	SYSTEM BIOLOGY	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. To introduce the core concepts of systems biology & systems biomedicine.
2. To demonstrate the importance of cross-disciplinary interactions for the success of systems
3. To explain cellular processes by describing the interactions between macromolecules in a kinetic network
4. To model networks of chemical reactions coupled with diffusion
5. To analyze and present research results in a professional way and use modern multimedia techniques for the purpose

UNIT I

Introduction to Systems biology - Modeling in biology - System states, Steady state, Variables, parameters and constants - Model behaviour, advantages of computational modeling, model development - Typical aspects of biological systems and corresponding models -Bottom-up and top down approaches of complex system, Mathematical representation of cell -biological system Time andspace, Future of systems biology - Experimental Planning in the Systems Biology Phase of BiologicalResearch

UNIT II

Signal Transduction - Function and Structure of Intra- and Intercellular Communication, StructuralComponents of Signaling Pathways - G Proteins, Ras Proteins, MAP Kinase Cascades, Apoptoticpathway, Two component signalling pathways of bacterial chemotaxis

UNIT III

Metabolism - Enzyme Kinetics and Thermodynamics - The Law of Mass Action, Reaction Kinetics andThermodynamics, Review of network concepts -properties and modelling of feedback/feedforwardsystem. Reaction kinetics, competitive inhibition, co-operativity, Hyperbolic and sigmoidal responses,Michaelis-Menten Kinetics - Metabolic Networks - Systems Equations, Information Contained in theStoichiometric Matrix N, Flux Balance Analysis.

UNIT IV

Biological Oscillations - Glycolytic Oscillations: The Higgins-Sel'kov Oscillator - Cell Cycle - Steps in theCycle, Models of Budding Yeast Cell Cycle - Modeling of Gene Expression - Modules of Gene Expression,Modeling the Elongation of a Peptide Chain, The Model According to Griffith. Noise and oscillation inbiological system.Circadian rhythm-how to build an oscillator. Gene circuit design,

UNIT V

Computer-based Information Retrieval and Examination - Databases and Tools on the Internet – GeneOntology, KEGG, BRENDA - Modeling and Visualization tools - Gepasi, Copasi, Systems BiologyWorkbench -Jdesigner, CellDesigner, Introduction to XML, Systems Biology Markup Language, MathML.Cytoscape.

TEXT /REFERENCE BOOKS:

1. Systems Biology: Definitions and perspectives by L.AlberghinaH.V.westerhoff,Springer 2005
2. Synthetic Biology, A New Paradigm for Biological Discovery, a report by Beachhead
3. Computational systems biology by A.Kriete, R.Eils, Academic Press. 2005
4. Systems Biology in practice: Concepts, Implementation and applications by E.KlippR Herwig, .Kowlad, C.Wierling and H.Lehrach, Wiley InterScience. 2005
5. Systems Biology and Synthetic Biology by Pengcheng Fu, Sven Panke, WileyInterScience. 2009

COURSE OUTCOMES

After finishing the course the student should be able to:

1. Describe how protein folding happens from both an energetic and a structural perspective.
2. Model macromolecular complexes on different time and length scales.
3. Model macromolecular structures with the help of experimental information.
4. Explain cellular processes by describing the interactions between macromolecules in a kinetic network.
5. Model networks of chemical reactions.

EBT-424	METABOLIC ENGINEERING	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. To familiarize the student with quantitative approaches for analyzing cellular metabolism.
2. Use of theoretical and experimental tools that can give insights into metabolic flux analysis and its determination.
3. To identify the fundamental principles involved in metabolic control analysis.
4. Analyzing the importance of metabolic engineering by considering few case studies.

UNIT I

Basic concepts of Metabolic Engineering- Overview of cellular metabolism .Introduction to various pathways. Different models for cellular reactions. Flexible and rigid in metabolic pathways.

UNIT II

Metabolic regulation network at enzyme level and whole cell level- Examples of metabolic pathway manipulations, metabolic pathway synthesis algorithms.Metabolic flux analysis and its applications. Mathematical calculation for the flow of carbon and nitrogen fluxes

UNIT III

Methods for experimental determination of metabolic fluxes by isotope labeling.Metabolic Fluxes Using Various Separation-Analytical Techniques. Validation of Flux Estimates by 13C Labeling Studies in mammalian cell culture**.** Stereochemistry of regulatory molecules. Concepts of regulatory analogs

UNIT IV

Fundamental of Metabolic Control Analysis, control coefficients and the summation theorems, Determination of flux control coefficients. Multi-substrate enzyme kinetics, engineering multifunctional enzyme systems for optimal conversion, and a multi scale approach for the predictive modeling of metabolic regulation.

UNIT V

Successful Examples Of Metabolic Engineering

Product Over Production Examples: Amino Acids, Polyhydroxyalkanoic Acids, By-Product Minimization Of Acetate In Recombinant E. Coli, Extension Of Substrate Utilization Range For Organisms Such As S. Cerevisae And Z. Mobilis For Ethanol Production, Improvement Of Cellular Properties, Altering Transport Of Nutrients Including Carbon And Nitrogen And Xenobiotic Degradation..

TEXT /REFERENCE BOOKS:

1. “Computational Modeling of Genetic and Biochemical Networks” by James M. Bower & Hamid Bolouri.
2. “Metabolic Flux Analysis” by Valino.
3. “Comprehensive Biotechnology” Vol. 3, Moo & Young.
4. “Fundamentals of Biochemical Engg”, by Bailey and Olis.

COURSE OUTCOMES

After completion of the course students

1. Will have Knowledge of stoichiometry and energetics of metabolism.
2. Can apply practical applications of metabolic engineering in chemical, energy, medical and environmental fields.
3. Will learn how to integrate modern biology with engineering principles.
   They can design a system, component, or process to meet desired needs

PROGRAMME ELECTIVES -4

EBT-441	INDUSTRIAL SAFETY & HAZARD MANAGEMENT	3L:0T:0P	3CREDITS

COURSE OBJECTIVES

1. To educate about engineering ethics basic and important methods of handling of equipment, apparatus, big plants and hazardous chemicals
2. To learn the principles of designing equipment eliminating the possibilities of fire, explosion, toxic release *etc*
3. To know how to overcome difficult situations during installations, pre-commissioning,
4. To learn various techniques and measures available to investigate industrial accident.

UNIT I

Introduction, Engineering ethics, Industrial safety, Industrial hygiene and safety aspects related to toxicity, noise, pressure, temperature, vibrations, radiation etc. Explosions including dust, vapor, cloud and mist explosion. Regulation and legislation, government role.

UNIT II

Elements of safety, safety aspects related to site, plant layout, process development and design stages, identification of hazards and its estimation, risk, risk analysis and assessment methods; fault free method, event free method, scope of risk assessment, controlling toxic chemicals and flammable materials.

UNIT III

Toxic substances and degree of toxicity, its estimation, their entry routes into human system, their doses and responses, control techniques for toxic substances exposure, use of respirators, ventilation systems.

UNIT IV

Prevention of losses, fire and its prevention, release of hazardous materials; relief systems: their types and location. Handling, transportation and storage of flammable and toxic materials, disaster planning and management.

UNIT V

Biohazards, classification of microbes with respect to pathogenicity, methods of containment, disposal rules, hazard reduction in biochemical industries.

TEXT /REFERENCE BOOKS:

1. Wood,W.S. and Fawcett H.H.1982.Safety and Accident Prevention in Chemical Operations.& Sons Edition,John Wiley &Sons,New York
2. D. A. Crowl and J.F. Louvar. *"Chemical Process Safety (Fundamentals with Applications)"*, Prentice Hall (1990
3. SanjoyBanerjee,*"Industrial Hazards &Plant Safety"*, Taylor & Francis Group

COURSE OUTCOMES

On successful completion of the course students will be able to:

1. Accessing the various hazards involved in handling of different types of chemicals
2. Steps to be followed during design stages to overcome possible safety threats
3. Measurement and monitoring of safety index

Accident investigation process-root causes analysis

EBT-442	MOLECULAR FARMING	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. Students will learn about molecular farming an emerging branch of plant biotechnology
2. They will know about the range of products from molecular farming such as carbohydrates, fats, proteins, secondary products.
3. They will acquire knowledge about various molecular approaches and strategies of molecular farming.
4. They will have illustrative knowledge of Plant as bio factories and chloroplast as clean high-level expression system for molecular farming

UNIT I

Introduction: Definition and common perception of molecular farming; history, molecular farming hosts,transgenic plants as bioreactors-an attractive alternative to current forms of manufacture of various compounds, Relevance & advantages of plant-based molecular farming.

UNIT II

Various molecular approaches & strategies relevant to molecular farming , Major targets for carbohydrate and lipid molecular farming; Production of carbohydrates: increased starch amount, amylose-free starch, high-amylose starch, cyclodextrins, fructans, trehalose; Production of lipids: medium-chain, saturated & mono-unsaturated fatty acids, improvement of plant oils, Production of rare fatty acids, polyunsaturated fatty acids having pharmaceutical and nutraceutical values.

UNIT III

Genetically engineered plants as protein factories, Enzymes for industrial and agricultural uses, medically related proteins-antibodies (plantibodies), subunit vaccines, protein antibiotics; The oleosin system: hirudin and insulin production, production of biopharmaceuticals in plants;

UNIT IV

Chloroplast: a clean high-level expression system for molecular farming based on single or multiple transgenes. chloroplast derived human antibodies, biopharmaceuticals, Human Serum Albumin, Human insulin like growth factor-1, Human interferon, Antimicrobial peptides, chloroplast derived vaccine antigens, cholera toxin B subunit, Bacillus anthracis protective antigen, Yersinia pestis F1-V fusion antigen, Canine Parvovirus VP2 protein.

UNIT V

Production of Biodegradable Plastics in Plants: Various gene functions involved in the production of polyhydroxy butyrate (PHBs) &polyhydroxyalkanoate co-polymers; Strategies for production of biodegradable plastics in plants. Critical evaluation on various case studies

of molecular farming & their future prospects; Economic, regulatory and biosafety considerations for molecular farming.

TEXT /REFERENCE BOOKS:

1. Slater, A., Scott, N.W., and Fowler, M.R., Plant Biotechnology, Second Edition, Oxford University Press (2008).
2. Primrose, S.B. and Twyman, R.M., Principles of Gene Manipulation and Genomics, Blackwell Publishing (2006).
3. Barnum, S.R., Biotechnology-an Introduction, Thompson Brooks/Cole (2007).
4. Primrose, S.B., Molecular Biotechnology, Second Edition, Panima Publishing Corporation

COURSE OUTCOMES

After completion of the course

1. Students will be able to create awareness about the production of pharmaceutical proteins in plants
2. Students will develop strategies for modification of plants for production of important molecules
3. Students can take decision to select the expression system in plants for various proteins and enzymes

EBT-443	BIOPROSPECTING	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. To introduce the concept of bioprospecting..
2. To provide knowledge about medicinal, nonmedicinal plants, marine and microbial bioprospecting and their applications.

UNIT I

Bioprospecting: Definition, Introduction, Current practices in Bioprospecting for conservation of Biodiversity and Genetic resources. Bioprospecting Act: Introduction, Phases of Bioprospecting, Exemption to Act. Fields of Bioprospecting.

UNIT II

Medicinal Plants Bioprospecting/ Pharmaceutical Bioprospecting: for new drugs, assays in Bioprospecting. Antioxidant assay – NO free radical scavenging assay, Antigenotoxicity assay – MTT assay, Antiviral activities of plants – SRB assay.

UNIT III

Origin, evolution, botany, cultivation and uses of Food, Fodder, Fibers, Oil yielding crops, wood and timber, Non-wood forest products(NWFPS): Bamboos, Gums, Dyes, Resins, Fruits etc.

UNIT IV

Marine Bioprospecting: Sources of marine planktons and their Bioprospecting, Isolation and cultivation of Marine bio resources, Isolation of Marine Yeast and its industrial applications, bioactive chemicals from Seaweeds and their applications.

UNIT V

Microbial Bioprospecting: Isolation of Microbial metabolites and screening for bioactivity, antimicrobials, pharmacologically active agents of microbial origin, bioprospecting for industrial enzymes, plant growth promoting agents, biotreatment, bioprospecting novel antifoulants and anti-biofilm agents from microbes.

TEXT /REFERENCE BOOKS:

1. Joanna R. Freeland, Heather Kirk, Stephen Petersen, "*Molecular Ecology*",McGraw Hill, 2nd Edition "2012.
2. Beebee T.J.C., D G. Rowe," *An Introduction to Molecular Ecology*", McGraw Hill, 2004.
3. Diana Marco Universidad Nacional de Cordoba, Argentina, "*Metagenomics:Theory, Methods and Applications"*, Caister Academic Press, 2010.
4. Diana Marco Universidad Nacional de Cordoba, Argentina "*Metagenomics:Current innovations and Future Trends"*, Caister Academic Press, 2011

COURSE OUTCOMES

After completion of the course

1. Student will have and create basic awareness about bioprospecting.
2. Student will have knowledge about different types of bioprospecting: plant, marine and microbial.
3. Students can illustrate the application of different field of bioprospecting.

EBT-444	PLANT BIOTECHNOLOGY	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. To acquire knowledge of basic tool and techniques of micro-propagation
2. To enrich knowledge about modern and advanced techniques to enhance biomass yield
3. To know different techniques for harnessing the potential of medicinal plant wealth of local himalyan biodiversity by characterizing them

UNIT I

Introduction Definition, Classical versus modern approach. Laboratory requirement for plant tissue culture, culture media and their constituents(MS,B5 and White's media),Cell Culture, Cell and organ differentiation, clonal propagation or micro-propagation, artificial seeds, Production of disease free plants explant, shoot tip culture, shoot tip grafting

UNIT II

Production of haploids, anther culture, ovule culture, uses of haploids in plant breeding,Cryotherapy, Chemotherapy, maintenance of virus free stocks, applications and limitations

UNIT III

Protoplast Related Techniques Protoplast, Isolation, Purification of protoplasts, viability and plating density of protoplasts,, Selection of hybrid cells, regeneration of hybrid plants, somatic hybridization and hybridization, Applications in crop improvement. Plant as Bio-factories Concept, Production of Chemicals, Pigments, Perfume, Flavors, Insecticides, anticancer agents and other important compounds.

UNIT IV

Transformation Techniques Physical methods, *Agrobacterium*, Mediated transformation Transgenic: Basic concept and essential steps of the process, Some examples of transgenic plants, Use of suitable promoters, Gene silencing and measures to overcome it, Commercial aspects of the technology.

UNIT V

Nitrogen Fixation Basic concepts, *nif* genes and their regulation, potential scope in crop Improvement.Transformation of organelles: Methods and success, advantages of organelle transformation. Molecular Markers Concept, SNPs, RAPD, RFLP, ISSR, STMS, role in crop improvement and genome mapping.

TEXT /REFERENCE BOOKS:

1. Plant Tissue Culture: Applications and Limitations. S.S. Bhojwani (1990), Elsevier, Amsterdam.
2. Micropropagation: P.C. Debergh and R.H. Zimmerman (1990), Kluwer Academic Publ.Dordrecht.
3. Elements of Biotechnology: P.K.Gupta(2010).Rastogi Publications
4. Plant Biotechnology : HS Chawla(2014).Oxford & IBH Publications
5. Agricultural Biotechnology – A. Altman.

COURSE OUTCOMES

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

1. Describe the function of plant tissues and their potential in practical applications.

2. Interpret how basic techniques can be helpful in making plant biotechnology a profit oriented profession.

3. Describe the methods for explorations of medicinal plants through secondary metabolite production and characterization through molecular marker tools .

EVALUATION SCHEME
B. TECH. BIOTECHNOLOGY
IV-YEAR **(VIII-SEMESTER)**

S. No.	COURSE CODE	SUBJECT	PERIODS			EVALUATION SCHEME					
						SESSIONAL EXAM			ESE	Total	CREDIT
			L	T	P	CT	TA	Total			
THEORY											
1.	EBT-45X	PROGRAM ELECTIVE-5	3	0	0	30	20	50	100	150	3
2.	EBT-46Y	PROGRAM ELECTIVE-6	3	0	0	30	20	50	100	150	3
3.	TOE-XY	OE-3	3	0	0	30	20	50	100	150	3
4.	TOE -XY	OE-4	3	0	0	30	20	50	100	150	3
PRACTICAL											
5.	PBT-481	PROJECT-II	0	0	16	100	100	200	200	400	8
6.	GPP-481	GENERAL PROFICIENCY	-	-	-	-	50	50	0	50	0
SEMESTER TOTAL			**12**	**0**	**16**	**220**	**230**	**450**	**600**	**1050**	**20**

PROGRAM ELECTIVE-5 (EBT-48X; X=1, 2, 3, 4)

1. EBT-451: STEM CELL TECHNOLOGY
2. EBT-452: MOLECULAR TOXICOLOGY
3. EBT-453: CANCER BIOLOGY
4. EBT-454: ANIMAL BIOTECHNOLOGY

PROGRAM ELECTIVE-6 (EBT-48Y; Y=1, 2, 3, 4)

1. EBT-461: METAGENOMICS
2. EBT-462: DRUG DELIVERY AND DRUG DESIGNING
3. EBT-463: ENZYME AND PROTEIN ENGINEERING
4. EBT-464: PHYTOCHEMISTRY

PROGRAMME ELECTIVES -5

EBT-451	**STEM CELL TECHNOLOGY**	**3L:0T:0P**	**3CREDITS**

COURSE OBJECTIVES

1. To acquire knowledge of basic concepts of stem cell
2. To enrich knowledge stem cell and their application.
3. To know the concepts of curing incurable diseases ailments through stem cell therapy.

UNIT I

Introduction to Stem Cells: Principles and properties of stem cells, types of stem cells, comparison of embryonic and adult stem cells. Stem Cell Niche: Introduction to stem cell niches in gut epithelium, bone marrow, epidermis, testis and neural tissues.

UNIT II

The process of stem cell differentiation, skeltel muscles, transformation of stem cell in to gametes/fertilization entity, Embryonic stem cells, Adult stem cells, induced pluripotent stem cells,epidermal stem cells & their applications, hepatic stem cells & their role in liver regeneration, stem cell treatments.

UNIT III

Types and Regeneration: Stem cells derived from amniotic fluid, extra embryonic membrane, germ cells, hematopoietic organs, neurons and kidney, cord blood transplantation, donor selection, HLA matching, patient selection, peripheral blood and bone marrow transplantation, bone marrow and cord blood collection procedures and cryopreservation

UNIT IV

Experimental Methods: Isolation and differentiation of human adult stem cells, embryonic stem cells and mouse stem cells, stem cell techniques: fluorescence activated cell sorting (FACS), time lapse video, green fluorescent protein tagging

UNIT V

Applications: Stem cells applications in cancer, diabetes, heart disease, muscular dystrophy, regeneration of epidermis; stem cell regulations, debate, social and ethical concerns

TEXT /REFERENCE BOOKS:

1. Twyman R.M.2001.Developmental Biology,Viva Books Private Limited.
2. Albertts et al.2003.Essential of Cell Biology.Tylor and francis Group,2nd edition
3. Stainsfield et al.2004 Molecular and Cell Biology-Schaum's Outline of Theory and Problems.Tata McGraw Hill Publisher

COURSE OUTCOMES

Students will be able to:

1. Know that the incurable disease can be cured with the help of stem cell technology
2. Enrich themselves regarding application of stem cell technology for animal and human welfare the concepts of herbal biotechnology for curing human and animal ailments
3. Develop skill to know stem cell therapy which helps in their own employment.

EBT-452	MOLECULAR TOXICOLOGY	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. To learn about common tasks in toxicological laboratory work including work with toxic chemicals.
2. To acquire knowledge about use of techniques for detection of toxicant and molecular changes caused by environmental chemicals and toxicants.
3. To improve knowledge to identify different cell death mechanisms and an appropriate methodology for identifying these
4. To enrich general knowledge of omics applications within toxicology
5. To know about basic molecular methods used in toxicological research

UNIT I

Introduction to general toxicology, Toxicants: Exposure, characterization, Routes of exposure, Organism environment interaction, Drug discovery and development, Methods in toxicity testing, dose-response characterization

UNIT II

Cell signalling and receptor mediated toxicity, Ion channels: Receptors linked to protein kinases and phosphatases, intracellular receptors, Concept of receptors as a drug target Methods for studying cell signalling, Second messengers: Signalling to the nucleus, general overview of mechanisms of cell death, Calcium- mediated toxicity, Cytokines toxicity: Steroid hormone induced toxicity.

UNIT III

Signalling and apoptosis: Methods of studying receptors, Methods for studying cell signalling, Mechanism of chemical toxicity, Oxidative stress: Apoptosis, necrosis, comparison and significance in toxicity evaluation

UNIT IV

Toxicogeneomics and microarray: Expression profiling in prediction of toxicology, principles problems and prospects. Early predictions, impact to reduce attrition in drug development

UNIT V

New assays: New procedures of evaluation, phototoxicity, comet assay, modified Salmonella assay, transgenic bioassays, neonatal bioassays, validation procedures, uses and limitations, *In-vitro* bioassays: Predictive and mechanistic toxicology, different cell lines their use and limitations

TEXT /REFERENCE BOOKS:

1. Molecular Toxicology by P. David Josephy

2. Advances in Molecular Toxicology by James C. Fishbein

3. Cellular and Molecular Toxicology and *In vitro* Toxicology by Daniel Acosta

4. Lehninger Principles of Biochemistry by M.M. Cox and DL Nelson

COURSE OUTCOMES

Upon completion of the molecular Toxicology program, students will be able to:

1. Articulate the fundamentals of toxicology and the discipline's relevancy to real-world issues
2. Identify gaps in the knowledge and discuss a broad set of toxicology knowledge
3. Demonstrate and apply the scientific method in gaining technical expertise and lab skills
4. Develop skill for broad understanding of techniques used in detection of toxicant and molecular changes caused by environmental chemicals and toxicants.

EBT-453	CANCER BIOLOGY	3L:0T:0P	3CREDITS

COURSE OBJECTIVES

1. To learn the fundamentals of cancer and cell cycle regulation/dysregulation.
2. To know the principle, agents and mechanism of carcinogenesis of metastasis.
3. To understand the role of Oncogenes /tumor suppressor genes and their role in cancer.
4. To understand the Detection and treatment therapies of cancer.

UNIT I

Fundamentals of Cancer BiologyRegulation of Cell cycle, mutations that cause changes in signal molecules, effectson receptor, signal switches, Tumor Suppressiontumour suppressor genes, modulation of cell cycle in cancer. Different forms ofcancers, Diet and cancer.

UNIT II

Principles of Carcinogenesis, Chemical Carcinogenesis, Metabolism of Carcinogenesis, Nature and history of Carcinogenesis, Targets of Chemical Carcinogenesis. Principles of Carcinogenesis II, Principles of Physical Carcinogenesis, X - Ray radiation - mechanism of radiation carcinogenesis.

UNIT III

Molecular Cell Biology OfCancerOncogenes, Identification of Oncogenes, Retroviruses and Oncogenes, detection of Oncogenes, Growth Factor and Growth Factor receptors that are Oncogenes.Oncogenes / Proto Oncogene activity. Growth factors related to transformations.

UNIT IV

Principles of Cancer Metastasis. Clinical significances of invasion, heterogeneity of metastatic phenotype, Metastatic cascade, Basement Membrane disruption, Three-step theory of Invasion, Proteinases and tumor cell invasion.

UNIT V

Detection of Cancers, Prediction of aggressiveness of Cancer, Advances in Cancer detection. New Molecules for Cancer Therapy, Different forms of therapy, Chemotherapy, radiation Therapy, and Immuno-therapy: Advantages and Limitations.

TEXT /REFERENCE BOOKS:

1.Maly B.W.J. Virology a practical approach, IRL Press, Oxford, 1987.
2.Dunmock N.J and Primrose.S.B.Introduction to modern Virology, Blackwel Scientific Publications.Oxford, 1988.
3.The Biology of Cancer by Robert Weinberg. Garland Science, Taylor& Francis Group, NewYork
4.Cotran R.S, Vinay Kumar, Collins.T, Robbins, S.L., 1999, “Robbin’s Pathologic Basis of Disease”, 6th ed., W.B.Saunders, Philadelphia.
5. Maxwell M. Wintrobe, G.Richard Lee, 1998, 10 Ed, “Wintrobe’s Clinical Haematology”, Lippincott Williams & Wilkins Publishers, New York.
6. Molecular Biology of Cancer by F. Macdonald, C.H.J. Ford, and A.G. Casson;Garland Science / Bios Scientific Publishers.
7. Molecular Biology of Human Cancers by Wolfgang Arthur Schulz, Springer

COURSE OUTCOMES

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

1. Explain the cell cycle, its regulation, and how cell cycle dysfunction can lead to cancer.
2. Describe the function of tumor suppressor genes.
3. Clarify how cancer cells escape cell death.
4. Give details on how chronic inflammation and infectious agents can lead to cancer.
5. Explain the role of diet in cancer development and cancer prevention.

EBT-454	ANIMAL BIOTECHNOLOGY	3L:0T:0P	3CREDITS

COURSE OBJECTIVES:

1. To know the History, scope, principle, merits and demerits of animal cell and tissue culture.
2. To understand the Laboratory facilities and culture media for animal tissue culture.
3. To be aware about Cell lines, application of animal cell and tissue culture, biohazards and Biosafety.
4. To know transgenic animals, cryopreservation, apoptosis, Animal cloning.

UNIT I

Introduction to Animal Tissue Culture:Background, Advantages, Limitations, Application, Culture Environment, Cell Adhesion, Cell Proliferation, Differentiation Structure and organization of animal cell and equipments and material for animal cell culture technology.

UNIT II

Design, Layout and Equipment:Planning, Construction, Layout, Essential Equipments, Aseptic Technique, Objectives, Elements, Sterile Handling, Safety, Risk Assessment, General Safety, Fire, Radiation, Biohazards. Media used for Animal Cell culture:Physicochemical Properties, Balanced Salt Solutions, Complete Media, Serum, Serum-Free Media, Disadvantages of Serum, Advantages of Serum-Free media.

UNIT III

Primary Culture: Isolation of Tissue, Steps involved in primary cell culture, Cell Lines, Nomenclature, Subculture and Propagation, Immortalization of cell lines, Cell line designations, Routine maintenance. Need for characterization, Morphology, Chromosome Analysis, DNA Content, RNA and Protein, Enzyme Activity, Antigenic Markers, Transformation, Immortalization, Source of contamination, Type of microbial contamination, Monitoring, Eradication of Contamination, Cross-Contamination

UNIT IV

Cryopreservation: Need of Cryopreservation, Preservation, Cell banks, Transporting Cells, Cytotoxicity its in vitro limitations, Nature of assay, Viability assay, Survival assay, Microtitration assay, Transformation assay, Methods of Producing Transgenic Animals: Embryonic Stem Cell method, Microinjection method, Retroviral vector method, Applications of transgenic animals

UNIT V

Gene Therapy: Animal diseases, diagnosis, therapy, variations of diseases, modes of transmission of diseases, control and management of disease spreading.Ex-vivo gene therapy, In vivo gene therapy, Viral gene delivery system, Retrovirus vector system, Adenovirus vector system, Adeno-Associated virus vector system, Herpes simplex virus vector system, Non-viral gene delivery system, Prodrug activation therapy, Nucleic acid therapeutic agents.

TEXT /REFERENCE BOOKS:

1. Animal Cell Culture by John R.W. MastersOxford University Press
2. Introduction to Cell and Tissue Culture by Jennie P. Mather and Penelope E. RobertsPlenum Press, New York and London
3. Molecular Biotechnology: Primrose.
4. Animal Cell Biotechnology: R.E. Spier and J.B. Griffiths (1988), Academic press.

COURSE OUTCOMES

On successful completion of this course, students will be able to:
1. Handle animal tissue culture and behavior of an animal cell.
2. Use steps taken to establish a primary cell culture, cell lines and subculturing.
3. Apply concepts of characterization, contamination, cryopreservation and cytotoxicity.
4. Explain animal diseases, mode of transmission and gene therapy for disease management.

PROGRAMME ELECTIVES -6

EBT-461	METAGENOMICS	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. To provide focus on next generation DNA sequencing technology to describe the ecological roles of microbial communities in different environments.
2. It also provides how the metabolic functions, taxonomic distribution, diversity, evenness and species richness of microbial communities varies across environment.

UNIT I

Environmental Metagenomics– Introduction; Pure culture and in consortium ;Cultivable and Non-cultivable microbial analysis; Recombination DNA technologyand DNA cloning; Types of vectors, applications of recombination DNAtechnology; Molecular fingerprinting techniques (RFLP, T-RFLP, ARISA, DGGE,rDNA library, and FISH); Stable isotope probing (SIP);Suppressive subtractivehybridization (SSH); Differential expression analysis (DEA);Microarrays &Metagenome sequencing; Next-generation sequencing approaches tometagenomics

UNIT II

Protein separations before digestion; One-dimensional SDS-PAGE, TwodimensionalSDS-page, Problems with 2d-SDS-PAGE, Preparative IEF, Highperformanceliquid chromatography; Protein separations after digestion: Massspectrometers for protein and peptide analysis, Instrumentation, MALDI-TOF-MS.The TOF mass analyzer, Pros and cons of MALDI, Protein identification bypeptide mass fingerprinting, Peptide mass fingerprinting: analytical approach,Peptide mass fingerprinting: complications, Software tools for peptide massfingerprinting, Finding the matches, Applications of Proteomics in Metagenomics;Challenges with Metagenomic Analysis

UNIT III

Cataloging microbes**:** phylogenetic tree and construction - Construction of ametagenomicslibrary; Analysis of Metagenomic Libraries; Sequence-basedMetagenomics Analysis; Function-based Metagenomics Analysis; **Phylogeneticanalysis**and Comparative genomics Softwares& Tools

UNIT IV

Metagenomic analysis of soil microbial communities; Metagenomic analysis ofmarinemicrobial communities; Metagenome of the Microbial Community inAcid Mine Drainage ;Metagenomic Analysis of Bacteriophage; Metagenomicsand Its Applications to the Study of the Human Microbiome; ArchaealMetagenomics: Bioprospecting Novel Genes and Exploring New Concepts.

UNIT V

Application of Metagenomics to Bioremediation; Applications of Metagenomicsfor Industrial Bioproducts; Escherichia coli host engineering for efficientmetagenomic enzyme discovery; Next-generation sequencing approaches tometagenomics; Stable isotope probing: uses in metagenomics; DNA sequencingof uncultured microbes from single cells

TEXT /REFERENCE BOOKS:

1. Joanna R. Freeland, Heather Kirk, Stephen Petersen, "*Molecular Ecology*", McGraw Hill, 2nd Edition "2012.
2. Beebee T.J.C., D G. Rowe," *An Introduction to Molecular Ecology*", Mc Graw Hill, 2004

COURSE OUTCOMES

After completion of the course

1. Students can use metagenomic data to describe the taxonomic make-up, functionalpotentialand ecological processes of microbial communities from a range ofenvironments
2. Students can apply next generation sequencing technology.
3. Students can assemble and annotate genomes by identifying genes

EBT-462	DRUG DELIVERY & DRUG DESIGNING	3L:0T:0P	3CREDITS

COURSE OBJECTIVES

1. To explore the process of drug development from target identification to final drug selection
2. The student will acquire knowledge of the techniques of drug designing

UNIT I

Overview of drug discovery process, Physicochemical Properties in Relation to Biological Action – Effects of route of administration, sites of loss, solubilities and partition coefficients (Ferguson, Hansch), Drug-receptor interactions, Steric features of drugs, The drug receptor, structure-Activity Relationships, Representatives physicochemical properties as relation to biological action.

UNIT II

Drug targets classification-DNA, RNA, post-translational, processing enzymes, metabolic enzymes involved in nucleic acid synthesis, G-protein coupled receptors (monomeric transmembrane proteins), small molecule receptors, neuropeptide receptors, ion channels (monomeric multi-transmembrane) proteins, ligand-gated ion channels (oligomeric trans membrane proteins), transporters (multi-trans membrane proteins, Validation Strategies.

UNIT III

Drug Design Strategies: Structure-based design-Docking and de novo methods, Design and development of combinatorial libraries for new lead generation, The molecular diversity problem, drug characterization – principles of equilibria, diffusion and kinetics, pre-formulation: pKa, partition coefficient, solubility, dissolution, chemical stability, and permeability, optimization of ADME characteristics, physico-chemical properties calculation, chemometrics in drug design.

UNIT IV

QSAR: Statistical techniques behind QSAR, classical QSAR, molecular descriptors 3D QSAR and COMFA, drug design to discovery and development, drug metabolism, toxicity and pharmacokinetics, toxicology considerations, problems and drawbacks on drug discovery and development, Conventional delivery methods; Pharmacokinetic models; Polymeric controlled release systems, Dose Response curves.

UNIT V

Survey of various Drug Classes – Anaesthetics (general, local), Analgesics, Neurotransmitters (adrenergic, cholinergic effects; psychopharmacology), CNS depressants (sedative/hypnotic, major/minor tranquilizers), CNS, Stimulants, Antibiotics (especially β-lactam), Steroids-Mechanism of action and applications.

TEXT /REFERENCE BOOKS:

1. Novel Drug Delivery Systems. 2nd Ed., Drugs and the Pharmaceutical Sciences Volume 50, Maccel Dekker, 1992.
2. Novel Drug Delivery Systems. Yie W. Chien. Edition2, illustrated Publisher M. Dekker.
3. Drug Delivery and Targeting For Pharmacists and Pharmaceutical Scientists. Anya M. Hillery, Andrew W. Lloyd, James SwarbrickEditorsAnya M. Hillery, Andrew W. Lloyd, James Swarbrick illustrated Publisher, Taylor & Francis.

COURSE OUTCOMES:

Students will be able to

1. Demonstrate an awareness of the current approaches to global drug discovery and their advantages & limitations
2. Demonstrate an understanding of the steps involved in the drug discovery and design process

EBT-463	ENZYME AND PROTEIN ENGINEERING	3L:0T:0P	3CREDITS

COURSE OBJECTIVES

1. To make Students learn structural and functional relationships in proteins and altering their structure in order to function 'better'.
2. To provide basic knowledge of enzyme technology and use of enzymes as tools in industry, agriculture and medicine.

UNIT I

Protein structure and function: Introduction to protein engineering; salient features of amino acids and their –R groups; conformation of proteins, the Ramachandran plot, folding, tertiary structure and structural domains and motifs of proteins; analysis of protein structure by CD spectroscopy, MALDITOF, NMR, X ray diffraction studies; prediction of protein structure and conformation from sequence data, relationship between structure and function.

UNIT II

Protein Engineering and Design: Methods in protein engineering and design – physical, computational, biochemical and molecular techniques; protein engineering in lysozyme and pepsin class of enzymes; chemical modifications of proteins; protein design, design of peptide and protein mimics.

UNIT III

Enzyme : Aim and scope of enzyme technology; strategies of isolation and purification of enzymes from different sources; identification of binding and catalytic sites; use of enzymes in free solution and associated problems; stabilization of soluble enzymes; enzyme reactions; applications of free enzymes in food industry, pharmaceutical, medical and analytical purposes;

UNIT IV

Objectives of enzyme immobilization, methods of enzyme immobilization-adsorption, entrapment, direct covalent linkage, cross-linking, applications of immobilized enzymes for industrial-scale,enzymeelectrocatalysis - immobilization of enzymes onto electrodes.

UNIT V

Design of ideal reactors with enzymes (Batch, CSTR, PFR), effect ofdiffusion on enzyme reactor design, effectiveness factor, effect of thermal inactivation andmass transfer limitation on design and performance of enzyme reactors.Some successful application of enzyme engineering.

TEXT /REFERENCE BOOKS:

1. Balasubramanian D, Bryce CFA, Dharmalingam K, Green J, and Jayaraman R, Concepts in Biotechnology, Universities Press (2007).

2. Rastogi SC, Mendiratta N and Rastogi P, Bioinformatics - Methods and Applications, PHI (2006).

3. Satyanarayana, U, Biotechnology, Books and Allied (P) Ltd. (2005).

4. Smith JE, Biotechnology, Cambridge University Press (2006).

COURSE OUTCOMES

Students will be able to

1. Comprehend the importance of R groups of the amino acids in any protein/enzyme.

2. Know about domains and motifs in a protein and the basis of their prediction

3. Know relationship between structure and function of a protein

4. Design different strategies for protein engineering and protein design

5. Know the principles of isolation and purification of enzymes from various sources

6. Comprehend various methods involved in enzyme technology and their commercial applications

EBT-464	PHYTOCHEMISTRY	3L:0P: 0T	3 CREDIT

COURSE OBJECTIVES

1. Understand classification of phytoconstituents and their chemical screening methods
2. Qualitative and quantitative estimation of phytochemicals & techniques

UNIT I

Secondary Metabolites: Definition of primary and secondary metabolites and their differences, Major types - terpenes, phenolics, alkaloids, terpenoids, steroids. Origin of secondary metabolites – detailed account of acetate pathway, mevalonate pathway, shikimate pathway.

UNIT II

Biosynthesis and sources of drugs: Phenols and phenolic glycosides: structural types, biosynthesis, importance of simple phenolic compounds, tannins, anthraquinones, coumarins and furanocoumarins, flavones and related flavonoid glycosides, anthocyanins, betacyanins, stilbenes, lignins and lignans.

UNIT III

General methods of phytochemical & biological screening, isolation and purification of plant constituents, Natural sources, General methods of extraction, isolation and purification of plant constituents of following class of phytochemicals alkaloids, glycosides, flavonoids, tannins, volatile oils, fixed oils, aromatherapy etc.

UNIT IV

Isolation, purification and characterization of phytochemicals of herbal extracts by using Paper Chromatography, Thin layer Chromatography, Column Chromatography, Gas chromatography, Liquid Chromatography, High Performance Liquid Chromatography,

UNIT V

Structure elucidation of phytoconstituents by spectroscopic techniques like UV, IR, NMR and mass spectroscopy.

TEXT /REFERENCE BOOKS:

1. Plant Drug Analysis by Wagner &Bladt.
2. Clark's isolation and Identification of drugs by A.C. Mottal.
3. Wilson and Gisvolds Text book of Organic Medicinnal and Pharmaceutical Chemistry by Deorge. R. F.
4. The Chemistry of Natural Products, Edited by R.H. Thomson, Springer International Edn.

5. Modern Methods of Plant Analysis- Peach & M.V. Tracey, Vol. I &II.

6. Medicinal Natural products – a biosynthetic approach, Dewick PM, John Wiley & Sons, Toronto.

COURSE OUTCOMES

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

1. Select correct and efficient method of screening of chemical content of plants.

2. Identify Phytopharmaceuticals.

3. Isolate and purify Phytopharmaceuticals and may be able to use for pharmaceutical industry.

OPEN ELECTIVES (TOE-2X; X=0, 1, 2, 3, 4, 5, 6, 7, 8)

TOE-20 NAOTECHNOLOGY & NANOSCIENCE

TOE-21 ADVANCED ANALYTICAL TECHNIOQUES

TOE-22 BIOMEDICAL INSTRUMENTATION

TOE-23 BIOTERRORISM

TOE-24 BIOSENSORS & BIOELECTRONICS

TOE-25 BIOMATERIALS

TOE-26 ENVIRONMENTAL SUSTAINABILITY & RENEWABLE ENERGY

TOE-27 BIOFUELS & BIOENERGY

TOE-20	NANOTECHNOLOGY AND NANOSCIENCE	3L:0T:0P	3CREDITS

COURSE OBJECTIVES:

1. To understand the fundamentals of Nanotechnology.
2. To learn general introduction about different classes of nanomaterials.
3. To impart basic knowledge on various synthesis and characterization techniques involved in Nanotechnology.
4. To be familiarize with nanotechnology potentialities in different field of life like electronics, medical field etc.

UNIT I

Basics and Scale of Nanotechnology: Introduction–Scientific revolutions–Time and length scale in structures–Definition of a nanosystem–Dimensionality and size dependent phenomena–Surface to volume ratio-Fraction of surface atoms–Surface energy and surface stress-surface defects-Properties at nanoscale (optical, mechanical,electronic,and magnetic).

UNIT II

Different Classes of Nano Materials: Classification based on dimensionality-Quantum Dots,Wells and Wires-Carbon- based nano materials (buckyballs, nanotubes, graphene)–Metal based nanomaterials (nanogold, nanosilver and metal oxides)-Nanocomposites-Nanopolymers–Nanoglasses–Nano ceramics-Biological nanomaterials.

UNIT III

Synthesis of Nanomaterials: Physical-chemical and mechanical methods of preparation –Top down approach-Chemical Vapor Deposition-High-energy balling-Nanostructure through Lithography.Bottom up approach: Colloidal precipitation –Sol-Gel process–Chemical precipitation –Biosynthesis –Electrospining method.

UNIT IV

Characterization of Nanostructures: Characterization of electrical-optical-mechanical and magnetic propertiesofnanomaterials. Electrical conductivity and permittivity-magnetic permeability-Structural characterization: X-ray diffraction-Electron microscopy-FTIR-XPS. Surface characterization: scanning electron microscopy-atomic force microscopy. Characterization of porous structures.Characterization of quasi-static and dynamic elastic properties.Mechanical testing.

UNIT V

Applications :Potential uses of nanomaterials in electronics, robotics, computers, sensors, sports equipment, mobile electronic devices, vehicles and transportation–Medical applications of nanomaterials, Nanocomposite materials for therapy and food packaging-Functional graphene-carbon nanotube and polymer composite applications in defence and aerospace. Nanomaterials for solar Cells-Nanoscale catalysts for energy and automobile industries. Rechargeable batteries based on nanomaterials-Nanomaterials for electrodes and wearable electronics-Nano based coating and paints, Nanomedicine and Nanobiotechnology–Nanotoxicology challenges.

TEXT /REFERENCE BOOKS:

1.PradeepT., "A Textbook of Nanoscience and Nanotechnology", Tata McGraw Hill Education Pvt. Ltd., 2012.
2.Hari Singh Nalwa, "Nanostructured Materials and Nanotechnology",Academic Press, 20

COURSE OUTCOMES

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

1. Develop new systems and technologies by using nanobotechnology for making human life healthier and prosperous.
2. Synthesize and characterize different new nanomaterials and nanoparticles for potential human applications and for betterment of human society.
3. Describe basic science behind the properties of materials at the nanometre scale, and the principles behind advanced experimental and computational techniques for studying nanomaterials.

TOE-21	ADVANCED ANALYTICAL TECHNIQUES	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. To bridge the gap between academics, research and industry.
2. To review the basic bio analytical technique and an introduction to general terminologies.
3. Acquire knowledge of analytical techniques along with their theory, working principal, common instrumentation and possible applications.
4. To provide scientific understanding of variousadvancedanalytical techniques such as light and electron microscopy, chromatography and electrophoresis.

UNIT I

Electromagnetic spectrum.Quantisation of energy, Electronic, vibrational and rotational spectroscopy. Franck–Condon principle, Jablonski diagram, radiative, nonradiative pathways, fluorescence and phosphorescence. Absorption of radiation, Beer- Lambert's law, deviation of Beer-Lambert's equation and its limitations.Principals, instrumentation, sampling and application of few spectroscopic techniques**:** UV-Visible spectroscopy, Fluorescence spectroscopy, IR/Raman spectroscopy, NMR Spectroscopy and Mass spectroscopy.

UNIT II

Microscop**y:** Principals, instrumentation and applications of imaging techniques: Dark-field, Phase contrast, Fluorescence, Confocal microscopy, Atomic force microscopy, and Transmission and Scanning electron microscopy

UNIT III

Crystal geometry and structure: Introduction to lattice and lattice systems, Bragg's plane, miller indices, point groups and space groups ,Principle of diffraction and X-ray diffraction: X-rays production, X- ray spectra, Bragg's law and intensity of X- rays, Mosley's law, powdered XRD, percentage crystallinity, single crystal XRD, macromolecular XRD (protein crystallization, data collection and structure solution).

UNIT IV

Chromatography: Classification of chromatographic techniques and their principles, Theory of chromatography, band broadening, rate and plate theory factors responsible for separation. Column chromatography, TLC, Paper chromatography.Liquid Chromatography and HPLC: Instrumentation, pumps, solvent delivery system, isocratic and gradient programming modes, sample introduction system, columns, detectors, reversed phase and normal phase chromatography. Gas Chromatography: Instrumentation, carrier gas supply, injectors, columnspacked and capillary columns, column oven and temperature programming, different detectors. Introduction to hyphenated techniques in chromatography, GC-MS and LC-MS.

UNIT V

Electrophoretic Techniques: Principle, equipment and process, Agarose gel electrophoresis, horizontal and vertical gel electrophoresis, electrophoresis techniques, Isoelectric focusing, capillary electrophoresis and application of electrophoresis in analysing macromolecules.

TEXT /REFERENCE BOOKS:

1. Principle of laboratory techniques and methods by MeenaSrivastava and Rajesh Singh Yadav.
2. A biologist Guide to principles and technique of practical biochemistry- By Keith Wilson, Kenneth H. Gouldind 3rd Edition, ELBS Series.
3. F. Settle. Hand book of Instrumental Techniques for Analytical chemistry, Prentice Hall

COURSE OUTCOMES

After the completion of course

1. The student will be able to use selected analytical techniques.
2. Student will be able to understand the strengths, limitations and creative use of techniques for problem-solving.
3. Student can apply the knowledge of tools and techniques to various scientific areas including, life science, chemical science, material science and environmental science
4. Students will develop the skills to understand the theory and practice of bioanalytical techniques.
5. Students will be able to analyze and interpret the results.

TOE-22	BIOMEDICAL INSTRUMENTATION	3L:0T:0P	3CREDITS

COURSE OBJECTIVES

1. To understand the application of biomedical instrumentation.
2. To introduce the student to the various devices of electrical origin and nonelectrical origin.
3. To provide awareness of electrical safety of medical equipments.
4. To know the important and modern methods of imaging techniques.

UNIT I

History and development of biomedical instrumentation, biometrics, Basic transducer principles: active and passive transducers, tranducers for biomedical applications; origin of biopotential and its propagation, sources of bioelectric potentials, electrocardiogram, electro encephalogram, electromayogram and other bioelectric potentials. Biopotential Electrodes: types of electrodes- surface, needle and microelectrodes, biochemical tranducers.

UNIT 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 breathin, gas exchange and distribution, respiratory therapy equipment.

UNIT III

Noninvasive 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.

UNIT IV

Instrumentation for the clinical laboratory, Automation of chemical tests, Biomedical instruments for surgery, Haemodialysis machines. X-ray machines and digital radiography.

UNIT V

Medical Imaging equipments, the computer in biomedical instrumentation and applications, microprocessors, Electrical safety of medical equipment, physiological effects of electric current.

TEXT /REFERENCE BOOKS:

1. Biomedical Instrumentation and Measurement by Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer
2. Biomedical Instrumentation: Technology and Applications by Raghbir Singh
3. Medical Instrumentation for Health Care by Leslie Cromwell
4. Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation by Robert B. Northrop
5. Introduction to Bioinstrumentation: With Biological, Environmental, and Medical Application by Clifford D. Ferris.

COURSE OUTCOMES

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

1. Integrate the engineering sciences with the biomedical sciences and clinical practice.
2. Design new equipment, measurement methods and instrument systems in the field of medicine and biotechnology.
3. Develop an understanding of how electrical equipment can measure physiological data and improve medical care.
4. Inspect common biomedical signals and distinguish characteristic features.
5. Identify common signal artifacts, their sources and formulate strategies for their suppression.
6. Identify, explain and judge patient safety issues related to biomedical instrumentation.

TOE-23	BIOTERRORISM	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. This course aims to provide a basic understanding about Bioterrorism preparedness and recognize, response, and treat the victims of biological warfare.
2. This course provides management strategies for Bioterrorism event.

UNIT I

Terrorism And Bioterrorism: Definition-Traditional terrorists-New terrorists-Nuclear, chemical, and radiological weapons-The psychology of Bioterrorism. Biological warfare : Past, present and future. Recognition of a Bioterrorism event.

UNIT II

Categories Of Bioagents:Primary classes of Microbes-bacteria, virus, and other agents-Immune system-Interaction between microbes and the immune system.

UNIT III

BiologicalWeapons:Characteristics of microbes and the reasons for their use-Symptoms-Pathogenecity-Epidemiology-natural and targeted release, techniques of dispersal, and case studies of Anthrax, Plague-Botulism, Small pox, and Tularemia and VHF. Potential risks of food borne Bioterrorism.

UNIT IV

Prevention And Control Of Bioterrorism: Surveillance and detection- Detection equipment and sensors –Diagnosis-Treatment-Vaccinations-Supplies-Effectiveness-Liability-Public resistance-Response-First responders-Infectious control-Hospital-Prevention -Protection-Decontamination. Role of Law enforcement-Economic impact.Personal protection equipments.INDIA s preparedness for Bioterrorism.Role of FDA in biosafety and biosecurity.The Bioterrorism act.

UNIT V

BioterrorismManagement:Ethical issues: personal, national, the need to inform public without creating fear, cost-benefit rations-Information management-Government control and industry support-Microbial forensics. Bioterrorism protection measures and role of pest management in bio-security.International dimensions in biosafety: Catagena protocol on biosafety, Bioterrorism and convention on biological weapons.

TEXT /REFERENCE BOOKS:

1. Bioterrorism: Guidelines for Medical and Public Health Management, Henderson, Donald, AmericanMedical Association, 1st Edition,2002
2. Biological Weapons: Limiting the Threat (BCSIA Studies in International Security), Lederberg, Joshua(Editor), MIT Press ,1999

3. Bioterrorism and Infectious Agents: A New Dilemma for the 21st Century (Emerging Infectious Diseases ofthe 21st Century), I.W. Fong and Kenneth Alibek, Springer, 2005
4. Fleming, D.A., Hunt, D.L., (2000). Biological safety Principles and practices (3rd Ed). ASM Press, Washington.

COURSE OUTCOMES

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

1. Identify Bioterrorism event and future threats.
2. Categorize bioagents and their potential.
3. Investigate effects of bioagentson immune system.
4. Assimilate the knowledge of biological weapensand their characteristics.
5. Demonstrate and take measures for prevention and control of Bioterrorism.
6. Follow Bioterrorism regulations and take suitable steps for Bioterrorism Management.

TOE-24	BIOSENSORS& BIOELECTRONICS	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. This course aims to provide understanding of biomolecules as recognition elements for detection of a particular analyte.
2. To develop understanding of bioelectronic devices.
3. To understand use of biological elements such as proteins in place of silicon chips.

UNIT I

Overview of biosensors and their electrochemistry: Molecular reorganization: Enzymes, Antibodies and DNA, Modification of bio recognition molecules for Selectivity and sensitivity, Fundamentals of surfaces and interfaces.

UNIT II

Transducers in Biosensors: Various types of transducers; principles and applications - Calorimetric, Optical, Potentiometric / Amperometric, Conductometric / Resistometric, Piezoelectric, Semiconductor, Impedimetric, Chemiluminiscene - based Biosensors

UNIT III

Application of enzymes in analysis; design of enzyme electrodes and their application.Application and uses of Biosensors: Biosensors in clinical chemistry, medicine and health care, biosensors for veterinary, agriculture and food. Low cost - biosensor for industrial processes for online monitoring; biosensors for environmental monitoring.

UNIT IV

Bioelectronics : Bioinstrumentation and bioelectronics devices: Optical Biosensors based on Fiber optics, FETs and Bio-MEMS.Introduction to Chemometrics, Biosensor arrays; Electronic nose and electronic tongue. Potential advantages & Developments towards a biomolecular computer, development of molecular arrays as memory stores; molecular wires and switches; mechanisms of unit assembly.

UNIT V

Design for a biomolecular photonic computer:Assembly of photonic biomolecular memory store; Information processing; commercial prospects for biomolecular computing systems.

TEXT /REFERENCE BOOKS:

1. Brian R Eggins - Biosensors an Introduction , First edition, John Wiley &SonsPublishers, 1996.
2. Loic J Blum, Pierre R Coulet - Biosensors Principles and Applications, Firstedition, Marcel Dekker,Inc, 1991.
3. Elizabeth A Hall - Biosensors, First Edition, Open University, Milton Keynes,1990.
4. Graham Ramsay - Commercial Biosensors, First edition, John Wiley & Sons, Inc.1998.
   Tran Minh Canh - Sensor Physics & Technology - Biosensors , First Edition,Champan& Hall, 1993.

COURSE OUTCOMES

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

1. Articulate the fundamentals of biosensors and their electrochemistry.

2. Distinguish and select between various Transducers in Biosensors.

3. Select and apply Biosensors for food, medical, agriculture and other sectors.

4. Apply various Bioelectronic devices for human welfare.

5. Assimilate the principles and applications of a Biomolecular photonic computer.

TOE-25	BIOMATERIALS	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. Strategies to modify and/or design materials that are biocompatible.
2. Explain what biocompatibility is and how it affects biomaterial design
3. Understand material selection and structure-function relationships

UNIT I

Classes of materials used in medicine, Metals, Ceramics, Synthetic polymers, Composites, Hydrogels, Bioresorbable and Biodegradable materials, Natural materials, Structure and properties relationships of biological materials.

UNIT II

Materials characterization - definition ; importance and application, Principles and general methods of compositional and structural characterization, techniques of X-ray, electron and neutron diffraction, EDAX, Thermal methods - DTA, TGA, DSC, DMA, temperature dependent rheology.

UNIT III

Concept of biocompatibility, Structure and properties of biological cells & tissues, Cell-material interactions and foreign body response, Assessment of biocompatibility of biomaterials, In vitro biochemical assays (cellular adhesion, cellular viability using MTT, osteogenic differentiation using ALP assay; Bio mnuneralisation using Osteocalcin assay), In vivo testing and histo-compatibility assessment, Geno-toxicity assessment (Physical damage to DNA by biomaterial eluates)

UNIT IV

Material Response: Material and Tissue interaction, biological environment and host response - Inflammation, Wound Healing and Foreign Body Response - Failure mechanisms; corrosion, fracture, degradation of Implanted Materials – Polymers, Metals, ceramics.

UNIT V

In-vitro Applications, in-vivo applications, Biomedical application: Cardiovascular, Dental implants, Orthopedic application, Skin, Ophthalmologic applications, Wound healing, Biomedical and Biosensor applications.

TEXT /REFERENCE BOOKS:

1. B. D. Ratner, A. S. Hoffman, F. J. Schoen and J. E. Lemons, Biomaterials Science, Second Edition: Wiley Science (2004).
2. L. Hench and J. Jones, Biomaterials, Artificial Organs and Tissue Engineering (Woodhead Publishing in Materials (2002).
3. J. Breme, R. Thul and C. J. Kirkpatrick, Metallic Biomaterial Interfaces Wiley (2008).
4. Temenoff J.S. and Mikos A.G., Biomaterials: The intersection of Biology and Materials Science, Pearson, (2009).

5. Kinam Park, Controlled Drug Delivery: Challenges and Strategies. Washington (DC): American Chemical Society (1997)

COURSE OUTCOMES

After successfully completing this course, students will be able to:

1. Understand common use biomaterials as metals, ceramics and polymers and its chemical structure, properties and morphology.
2. Describe general structure and function of cells, extracellular matrix and tissue.
3. Understand and account for methods for categorization of biomaterials.
4. Explain methods to modify surfaces of biomaterials and choose material for desired biological response.

5. Understand the interaction between biomaterial and tissue for short term and long term implantations; distinguish between reactions in blood and in tissue.
6. Apply and account for methods to characterize interactions between materials and tissue.

TOE-26	ENVIRONMENTAL SUSTAINABILITY AND RENEWABLE ENERGY	3L:0T:0P	3CREDITS

COURSE OBJECTIVE:

1. To learn about basic concepts of Environmental Sustainability and renewable energy.
2. To impart knowledge about different type of renewable energy.
3. To know efficient and profitable use of renewable energy resources.

UNIT I

Basic concepts of sustainable and renewable energy, Energy chain, World energy status, Energy scenario in India, types of renewable energy resources, Technological basis of their uses and applications

UNIT II

Introduction to Solar Energy, Instruments for measurements of solar radiation, Solar radiation data analysis, Principals and operation of different types of solar radiation collectors, Methods of solar power generation

UNIT III

Physics of solar cells-cell and module, characteristics of cells and module for manufacturing, Performance parameters, Grid connected systems, Photovoltaic and concentrated Solar Power(CSP)

UNIT IV

Different types of bioenergy sources of power generation, Biofuels, Energy generation through fermentation, Gassification, various types of gasifiers, Pyrolysis, Bio-enegy through digestion,

UNIT V

Resource assessment, Wind energy, types of wind turbines, Selection of components, Power regulation, Wind farms, Solar Wind Hybrid Energy Systems, Basic principal of small hydro power systems, energy through waves and tides

TEXT /REFERENCE BOOKS:

1. John Anderwset al.2013, Energy Science: Principles, Technologies and Impacts .Oxford Universities Press.
2. Godfrey Boyle, 2012.Renewable Energy, Power for a sustainable future. Oxford Universities Press
3. Fang Lin You et al.2012.2012 Renewable Energy Systems, Advanced Conversion Technologies and Applications. CRC Press.

COURSE OUTCOMES

1. Articulate the fundamental principles, terminology and key issues related to the major onshore and offshore renewable energy technologies.
2. Critically compare the challenges for the development and operation of the major technologies, including government regulation and policy.
3. Identify gaps in the knowledge and discuss potential opportunities for further development, including technology and economic potential.

TOE-27	BIOFUELS AND BIOENERGY	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. This course aims to provide different strategies to convert biomass to biofuels
2. To provide the review of the available and advanced technologies and how these could meet the growing demand for energy in the future
3. To assess environmental impacts and economy of biofuels

UNIT I

Energy perspective: Current methods, Biomass possibilities. Fundamental concepts in understanding biofuel and bioenergy production: Mass Balances, Energy Balances, Thermodynamics, Organic compounds, Chemistry of plant materials resources.

UNIT II

Fossil versus renewable energy.Production of biorenewable resources**:** Herbaceous crops,Woody crops**,** Algae. Conversion of biomass into heat and power**:** Direct combustion**,** Thermal gasification**,** Anaerobic digestion. Processing of biomass into chemicals and fuels: Sugars, Alcohols, Biodiesel, Thermochemical conversion, Fischer Tropsch Fuels.

UNIT III

Combustion Engines, Turbines and FuelRatings.Microbial fuel cell, Advanced power plant concepts (IGCC, NGCC), Gas to liquid processes(GTL), Carbon dioxide capture and storage, Chemical Looping.

UNIT IV

Comparison of Bio-energy Sources, Biorefinery, Biofuels for Transportation, Vegetable Oils as Engine Fuels.Biodiesel as Engine Fuel:Engine Emissions from Biodiesel, Biodiesel production by using various microorganisms, algae and Transesterification process, methods of biodiesel production.

UNIT V

Environmental impact of the bioeconomy**:** Land use**,** Pollution**,** Climate change.
Economics of biorenewable resources**:** Feedstock costs**,** Capital costs**,** Operating costs.
Economics of biogas plants. Algae biofuels: versatility for the future of bioenergy.

TEXT /REFERENCE BOOKS:

1. C. M. Drapcho, N. P. Nhuan, T. Walker, Biofuel Engineering Process Technology, McGraw Hill 2008
2. D. M. Mousdale, Biofuels, CRC Press 2008
3. Carlson, R. 2007. Laying the foundations for a bio-economy.Systems and Synthetic Biology.
4. Gaskell, G. et al. 2011. The 2010 Eurobarometer on the life sciences.Nature Biotechnology. 29:113-114

COURSE OUTCOMES

After completing this course the students will be able to:

1. Summarise the basic fundamental concepts of biofuel and bioenergy.
2. Evaluate clearly and concisely the benefits and problems relating to the production of biofuels from biomass.
3. Apply approaches in biofuels including Microbial fuel cell, Advanced power plant concepts (IGCC) and etc.
4. Calculate the energy generating potential of biomass as an energy source
5. Investigate the potential of biodiesel as an engine fuel.
6. Critically assess the economy of biorenewable resources and environmental impact of the bioeconomy**.**