EVALUATION SCHEME
M. TECH. BIOTECHNOLOGY
I-YEAR (I-SEMESTER)

S. No.	COURSE CODE	SUBJECT	PERIODS			EVALUATION SCHEME					
						SESSIONAL EXAM			ESE	Total	Credit
			L	T	P	CT	TA	Total			
THEORY											
1.	TBT-511	APPLIED BIOCHEMISTRY	3	0	0	30	20	50	100	150	3
2.	TBT-512	MICROBIAL BIOTECHNOLOGY	3	0	0	30	20	50	100	150	3
3.	EBT-51X	ELECTIVE-I	3	0	0	30	20	50	100	150	3
4.	EBT -51X	ELECTIVE-II	3	0	0	30	20	50	100	150	3
5.	TRM-511	RESEARCH METHODOLOGY &IPR	2	0	0	15	10	25	50	75	2
6.	TAC-51X	AUDIT COURSE-I	2	0	0	15	10	25	50	75	0
PRACTICAL											
7.	PBT -511	BIOCHEMISTRY &MICROBIAL TECHNOLOGY LAB	0	0	4	10	15	25	25	50	2
8.	PBT -512	MOLECULAR BIOTECHNOLOGY LAB	0	0	4	10	15	25	25	50	2
9.	GPP-511	GENERAL PROFICIENCY	-	-	-	-	50	50	-	50	0
SEMESTER TOTAL			**16**	**0**	**8**	**170**	**180**	**350**	**550**	**900**	**18**

ELECTIVE-I(EBT-51X, X: 1, 2, 3, 4)

1. EBT-511 NANOBIOTECHNOLOGY
2. EBT-512 FOOD BIOTECHNOLOGY
3. EBT-513 BIOSTATISTICS
4. EBT-514 GENOMICS AND PROTEOMICS

ELECTIVE-II(EBT-51X, X: 5,6,7,8)

1. EBT-515 BIOTECHNOLOGY FOR HUMAN HEALTH
2. EBT-516 NATURA RESOURSE MANAGEMENT
3. EBT-517 PHARMACEUTICAL BIOTECHNOLOGY.
4. EBT-518 HERBAL BIOTECHNOLOGY.

AUDIT COURSE-I (As per Institute's common syllabus for all branches.)

1. TAC-511 ENGLISH FOR RESEARCH PAPER WRITING
2. TAC-512 SANSKRIT FOR TECHNICAL KNOWLEDGE
3. TAC-513 VALUE EDUCATION
4. TAC-514 CONSTITUTION OF INDIA

TBT-511	APPLIED BIOCHEMISTRY	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. Recapitulate the knowledge of biomolecules, enzymes and metabolism.
2. Acquire knowledge about the application of biochemistry in protein engineering, metabolic engineering.
3. Learn the application of biomolecules and their characterization.

UNIT I

- Recapitulation of the knowledge of chemistry of biomolecules (carbohydrates, proteins, fats, lipids, vitamins).
- Concept of Energy, Thermodynamics Principles.
- Recapitulation of cellular metabolism and major metabolic pathways.

UNIT II

- Nomenclature of enzymes, Enzyme kinetics, Mechanism of enzymatic, Catalysis, Active site, Activators and inhibitors, Coenzymes, Isoenzymes, Michaelis-Menten equation, Km and Vmax value, Regulation of enzyme activity (single-substrate and multi-substrate reactions**).**
- Introduction to protein engineering, basic concept for designing a new protein/enzyme molecule. Specific examples of Protein /enzyme engineering, Application of protein engineering**.**

UNIT III

- Basic concepts of Metabolic Engineering
- Different models for cellular reactions, Flexible and rigid in metabolic pathways.
- Metabolic pathway synthesis algorithm.
- Metabolic flux analysis and its applications, Methods for experimental determination of metabolic fluxes by isotope labelling
- Some successful examples of metabolic engineering.

UNIT IV

- Application of biomolecules in drug delivery: Liposome, lipid vesicles, nanosomes, lipospheres and other biomolecules.

UNIT V

- Fundamentals of CD, IR and Raman spectroscopy and their use in study of biomolecule conformation
- Fundamentals of X-Ray, NMR, and cryo-electron microscopy for determination of bimolecular structure.

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. Biochemistry: Zubey, WCB.
5. Biochemistry: Stryer, W. H. Freeman.
6. Understanding Enzymes. Palmer, Horwood

COURSE OUTCOMES

On successful completion of this course:

1. The student will be able to analyse and use basic concept of protein engineering and metabolic engineering particularly metabolic pathway synthesis algorithm and flux analysis for new applications.

2. The students will acquire skills in using the various biomolecule characterization techniques.

3. Students will develop the skills to understand the theory and practice of experiments related to biochemistry.

PBT-511	BIOCHEMISTRY & MICROBIAL BIOTECHNOLOGY	0L:0T:4P	2 CREDITS

List of experiments

1. Bacteriological examination of food samples
2. Isolation and preservation of industrial important microorganism
3. Development of streptomycin resistant mutant by Gradient Plating Method
4. Development of streptomycin resistant mutant by Selective Enrichment Method
5. To perform UV Mutagensis
6. To perform isolation of genomic DNA form pure bacterial culture.
7. Enzyme assay for various microorganism
8. Enzyme immobilization by yeast cell
9. Production of bioactive compounds by microbes
10. Phytochemical analysis of bioactive compounds
11. Antibiotic sensitivity test
12. Isolation of rhizobia from root nodules
13. Production of antibiotics by microbes
14. *In vitro* plant growth promotion by microbes
15. *In vitro* evaluation of antagonistic activity of PGPR
16. Qualitative and quantitative estimation of carbohydrate.
17. Qualitative and quantitative estimation of amino acid
18. Protein extraction and estimation through Lowry and Bradford method.
19. To test for acid value and saponification value of fat.
20. To test for iodine number of lipid
21. To test for activity and determination of salivary amylase.
22. Study of enzyme kinetics.
23. Study of enzyme inhibition kinetics.
24. Immobilization of an enzyme and study of immobilized enzyme kinetics.
25. Separation of amino acids and chlorophyll pigments by TLC.

TBT- 512	MICROBIAL BIOTECHNOLOGY	3L:0T:0P	3CREDITS

COURSE OBJECTIVES

1. To know about selection and screening of micro-organisms with industrial potential and strain development
2. To provide awareness of the wide scope of applications of microorganisms in industry; the applications of fermentation technology and potentials for future development.
3. To improve knowledge about production and applications of useful microbial products by using fermentation techniques
4. To enrich skill about application of microorganisms in varied fields of environmental microbiology like bioremediation in waste water treatment.

UNIT I

Selection and screening of micro-organisms with industrial potential and other uses, Screening of metabolite, Strain development and improvement by conventional and modern approaches

UNIT II

Fermentation: Principle and practice of solid state and submerged fermentation, scaling up and downstream processing, production of useful products/ bioproducts and their application, Process control and monitoring and kinetics

UNIT III

Processes and production of alcohol, organic acids, amino acids, vitamins, antibiotics and enzymes, Biosurfactant

UNIT IV

Microbial production of enzymes/extremozymes, fermented food, probiotics, single cell proteins, immobilization, Microbes in mining /metal extraction and leaching, Legislative and safety aspects

UNIT V

Mixed Microbial Population: Neutralism, Mutualism, Comensalism and Amensalism, Utilization of mixed population, Microbial biodiversity, Biomass transformation, Biosynthetic processes to waste treatment, Biodegradation of toxic chemicals

TEXT /REFERENCE BOOKS:

1. Biotechnology: A text book of industrial microbiology byCruger w and Cruger A edited by KR Aneja, Medtech Publications
2. Microbial Biotechnology: fundamental of applied microbiology by Alexander, N; Glazer & Hiroshi, Nikaido, W.H. Freeman & Co.
3. Basic Biotechnology, by C. Ratiedge and B. Kristiansen Cambridge Univ. Press, UK, 2003.
4. Principals of Industrial Microbiology, by Rhodes A and D.L. Fletcher, Pergamon Press, Oxford, UK
5. Biochemical Engg. Fundamentals by James E Bailey, David Ollis,, McGraw-Hill.

COURSE OUTCOMES

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

1. Learn and perform various methods for isolation, detection and identification of microorganisms in industries
2. Select and use of microorganisms in production of as Organic acid, vitamin, antibiotics, vaccines, proteins, primary and secondary metabolites, as well as food and dairy products.
3. Acquire, discover, and apply the theories and principles of microbial technology in practical, real-world situations and problems.
4. Explore work opportunities for applied microbiology in emerging biotechnology industries.

PBT-512	MOLECULAR BIOTECHNOLOGY LAB	0L:0T:4P	2 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 restriction enzyme digestion.
7. DNA ligation and recombinant DNA preparation.
8. To perform agarose electrophoresis of DNA.
9. To perform SDS-PAGE electrophoresis of protein.
10. To perform Gel documentation.

ELECTIVE-I

EBT-511	NANO BIOTECHNOLOGY	3L:0T:0P	3CREDITS

COURSEOBJECTIVES

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 Nanobiotechnology: Origin, Fundamental Concepts, Nanoscale Properties (Electrical, Optical, Chemical), Bottom-up versus Top-down approaches, Nanofabrication: Current research, Tool and Techniques, Microfabrication methods (photolithography, soft lithography ,replication), Applications and Implications and Nanofabrication.

UNIT II

Nanomaterials and Nanoparticles:Carbon nanotubes and related structures, Properties, Synthesis, Applications, Bucky balls, Quantum Dots, Nanoparticles types and their synthesis, Application of Gold, Silver and Zinc oxide nanoparticles, Interaction of nanoparticles with biomembrane and genes.

UNIT III

A brief idea about Nano-characterization tool and techniques**:** UV-visible spectrophotometry, Fourier transform infrared spectroscopy (FTIR),Scanning Electron Microscopy (SEM), Scanning tunneling microscopy (STM),Transmission electron microscopy (TEM),Atomic force microscopy (AFM), Nanolithography techniques, Production of nanoparticles: Collision / Coalescence mechanism of primary particle formation, nanoparticles agglomerates & aerogels Biological nanoparticles from Fungi, bacteria, yeast and actinomycetes, Microbial nanoparticle production.

UNIT IV

Nanomedicine and Sensor Technology**:**Use of nanoparticles as biosensors: Cabon nanotubes, Gold Nanoparticales, conducting polymers and electrode designing, Nanosensors: Temperature Sensors, Night Vision System, Nano tweezers, Nano crystals in Biological Detection.Nanorobots, Nanocellulose, Bionanomotors, Overview of natural Bionanomachines: ATP synthetase, Actin and myosin.

UNIT V

Health and Environmental Impacts of Nanotechnology**:** Nanobiotechnology for human health and food applications: nanoparticles for drug delivery, gene delivery, understanding the mechanism of macromolecular interactions, Nano medicines-introduction and various devices like quantum dots etc and their applications in Nano medicine ,Emerging

Nanotechnologies, Nanoparticles for cleaning environment particularly heavy metal bioremediation.

TEXT /REFERENCE BOOKS:

1. Introduction to Nanoscale science and technology. Ed. By Mosimilano Di ventra I Edition, Kluwer Academic – 2004.
2. Nanotechnology, GrejoryTimp – I Edition, Springer International – 2005.
3. Nanotechnology. Michel Kohler – I Edition, Wiley VCH-2004.
4. Nanotechnology: Environmental implications & solutions by LousTheodove& Robert A. Kung.
5. Introduction to Nanotechnology- C.P. Poole & F.S. Owens.
6. Nanotechnology : Basic science & emerging technologies- M.Wilsin, K. Kannaranga, G. Smith, M. Simmons & B. Raguse.
7. An introduction to materials engineering & science for chemical & material engineers – B.S. Mitchell.
8. Essay: The coming technological revolutions, from the websites of the center for responsible nanotechnology; www.crnano.org/magic.htm.

COURSE OUTCOMES

On successful completion of this course, students will be able to:
1. Acquire the knowledge about recent trends in Nano Biotechnology and career scope in this field.
2. Develop new systems and technologies by using nanobotechnology for making human life healthier and prosperous.
3. Synthesize and characterize different new nanomaterials and nanoparticles for potential human applications and for betterment of human society.

EBT-512	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

•Types of food based on processing before consumption: Raw food, germinated food, fermented food, roasted food, boiled food etc. and their importance; Processed and preserved foods; canned, ready mixes, frozen and dried food stuffs etc, Concept of 'functional food', designer food, yield and health specific foods.

• Factors influencing microbial growth in food- intrinsic and extrinsic factors.

• Food as substrate for microorganisms, Contamination and spoilage of food products.

UNIT II

•Principles of food preservation: (Asepsis – Removal of microorganisms, Anaerobic conditions, low temperatures, high temperatures, drying, radiation, chemical preservatives and Food additives and its mechanism of action), D, Z, and F values.

•Introduction to nutraceuticals and pharmaceuticals and their role and applications in food processing.

• Food-borne infections and intoxications: Bacterial and nonbacterial- with examples of infective and toxic types- *Brucella, Bacillus, Clostridium. Escherichia, Salmonella, Shigella, Staphylococcus, Vibrio,* and *Yersinia*, Aflatoxins- structures and function.

UNIT III

• Food produced by Microbes: Fermented foods, microbial cells as food (single cells proteins) mushroom cultivation.

• Bioconversions- production of alcohol- fermented beverages-beer and wine, Steroid conversion-industrial enzymes production- amylases, proteinases, cellulases.

• Amino acid production- glutamic acid and lysine productions, Oriental foods: mycoprotein, tempeh, soya sauce, idli, natto, poi.

UNIT IV

• Biotechnology for Improved Processing: Role of biotechnology in food industry, maintenance of nutritional quality.

• Application of enzymes in food processes like enzymes juice extraction, juice clarification, in bread manufacture, ice cream manufacture, etc.

• Newer concepts in food processing including organic foods, processing of organic raw material, Genetically modified foods.

• Applications of immobilized enzymes in food industry, enzymes for enhanced flavor and aroma compounds, enzymes in fat and oil industries, Genetically modified plants for high nutritional food.

UNIT V

• Importance and functions of quality assurance and control: Methods of quality, concept of rheology, Biochemistry of food products ,biochemical changes during processing of food

products and their storage strategies: fruits, vegetables, cereals, dairy products, meat and processed food products.
• Microbiological safety of food products, chemical safety of food products, contaminants by heavy metal, fungal toxins and pesticide residue.
•Food regulations, grades and standards (AgMark, and BIS Standards), USFDA/ ISO 9000 Series, Food Safety and Standard Act (FSSA), Food adulterations and safety.
• Status of food processing industry in India and abroad; prospectus and constraints in developments of Indian food industry.

TEXT /REFERENCE BOOKS:

1. Ahmed E.young, Food Microbiology: a lab manual (2003) (Wiley).
2. Dietrich knorr, Food Biotechnology (2005).
3. Doyle, Food Microbiology (2001).
4. Vangrade, Food Preservation & Safety: Principles & Practice.

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.

EBT-513	BIOSTATISTICS	3L:0T:0P	3CREDITS

COURSE OBJECTIVES

1. The students will learn statistical concepts and terminology and basic analytic techniques.
2. The students will understand the basic concepts and principles of test of hypothesis and probability and will learn to use them with respect to biological data.
3. The students will 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

Introduction to Bio-Statistics: Types of biological data (data on ratio scale, interval scale, ordinal scale, nominal scale, continuous and discrete data), frequency distribution and graphical representations (bar graph, histogram and frequency polygon),Measures of central tendency, Measures of dispersion –Skewness and Kurtosis – Correlation and Regression.

UNIT II

Probability and Theoretical Distributions: Probability concepts – conditional probability – Baye's theorem addition and multiplication theorem of probabilities ,Theoretical distributions : Binomial, Poisson, Normal (Problems only).

UNIT III

Testing of Hypothesis: Introduction – Large sample tests based on normal distribution - Test for single mean, difference between means, proportion, difference between proportion, standard deviation, difference between standard deviation. Chi-square test for goodness of fit, independence of attributes.

UNIT IV

Analysis of Variance :Small sample tests based on t and F distribution - Test for, single mean, difference between means, Paired t-test, test for equality of variances. ANOVA– one –way classification, Two-way classification.

UNIT V

Preparation of a successful clinical study, Study management, Project management Documentation, Monitoring, Audits and Inspections Pharmacovigilance, Importance of statistics in clinical research, Biostatistical considerations at the design, analysis and reporting stage, Experimental Designs: Principles of experimental designs, completely randomized, Randomized block and Latin square designs.

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. Use basic analytical techniques to generate results.
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-514	GENOMICS AND PROTEOMICS	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. To acquire the fundamentals and high throughput techniques in Genomics and Proteomics and their applications.
2. The course helps in developing a detailed understanding of eukaryotic genome complexity and organization.
3. Is to develop detailed understanding of techniques of gene diagnostics and DNA profile

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, Genetics to genomics to functional genomics, Forward genetics (Phenotype to gene structure) and Reverse genetics (Gene structure to phenotype).

UNIT II

Chromosome structure and Genome organization, Human Genome Project, Strategy of Genome sequencing, De novo sequencing, Next-generation sequencing: 454 Pyrosequencing, Illumina sequencing, Ion torrent, SOLiD sequencing, SMRT sequencing, Genome sequencing projects: Genome assembly: Velvet, ABySS, Assembly validation using short read aligners: BWA, Viewing the Genome assembly: Tablet, Genome Annotation Techniques: RAST, KAAS, Construction of circular map, current status of genome sequencing projects.

UNIT III

Phylogenetic analysis, MEGA (Molecular Evolutionary Genetic Analysis), COGS [Cluster of orthologues genes], paralogues and gene displacement, Metabolic Reconstruction, The Basic Principles and Methodology. ESTs, SAGE, cDNA Microarrays, Oligonucleotide Microarray Chips, Cancer and genomic microarrays, Application of Microarrays with examples, Microarray Data Analysis; Real Time PCR; Gene finding tools

UNIT IV

Introduction to Proteomics, Protein folding & misfolding, how to analyze a Proteome – 2D-gel electrophoresis, high-throughput proteome analysis with 2D-IEF, MALDI-TOF, Mass spectrometry, 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

Interactomics, Genomic browsers and databases, Proteomics applications, Challenges in proteomics, Study of Post translational Modifications: Methods of applications, Aspects of Clinical Proteomics; Protein micro arrays and MS Imaging, Protein-Protein Interaction Mapping: Experimental and Computational. Its application in health and disease. Microarray - the technique, Experimental design & mass spectrometric data analysis, Application of Microarray in proteome

analysis, Proteins Arrays and Protein Chips, Proteomics Tools and Databases, Pharmacogenomics: Ethical considerations of genetic testing; Genomics in drug discovery.

TEXT /REFERENCE BOOKS:

1. Genomes IV, T.A. Brown.
2. An Introduction to Biotechnology: A Genetic Manipulation Perspective by Rup Lal.
3. A Primer of Genome Science, Greg Gibson and Spencer V. Muse.
4. Database Annotation in Molecular Biology: Principles and Practice, Arthur M. Lesk.
5. Gene Cloning and DNA Analysis – An introduction (Seventh 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.
8. Advances in biotechnology: Indu Ravi, MamtaBaunthiyal and JyotiSaxena, Springer.

COURSE OUTCOMES

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

1. This course aims to provide with the knowledge and practical skills associated with genomics and proteomics.
2. Understand functional and structural genomics.
3. Identify and discuss the techniques used in functional genomics such as microarrays.
4. Understand tools for proteome analysis.
5. Interpret data obtained through high throughput expression studies.
6. Discuss the uses of functional genomics and proteomics in agriculture, ecotoxicology and human health.

ELECTIVE-II

EBT-515	BIOTECHNOLOGY FOR HUMAN HEALTH	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. To identify benefits of biotechnology for human health
2. To acquire knowledge of tools and techniques of biotechnology help in human life improvement
3. To deal with easily available diagnostic techniques for curing human ailments and disease

UNIT I

An introduction and scope of medical biotechnology, pharmaceutical applications of plants ,animal and microbes for human health, classification of genetic diseases and their possible cure through biotechnology, Chromosomaldisorders, mitochondrial disorders

UNIT II

Molecular basis of human disease-Pathogeneic mutations, oncogenes, Huntingtons diseseaes, Pittsburg variant of alpha1 antitrypsin, loss of function-Tumoursuppressor,Genomic dynamic mutations-Fragile –X syndrome,Myotonic dystrophy

UNIT III

Prenatal diagnosis-Invasive techniques-Amniocentesis, Fetoscopy, Chronic Villi Sampling(CVS),nNon –invasive techniques-Ultrasonography,X-ray,TIFA,maternal serum and fetal cells in maternal blood, Diagnosis using protein and enzyme markers,

UNIT IV

Mechanism action of antibiotics and drug resistance, Monoclonal antibodies, DNA/RNA based diagnosis,Microarray technology, Clinical management and Metabolic manipulation-PKU,FamilialHypercholestrolemia,Rickets,ADA, Congenital hypothyroidism

UNIT V

Strategies of Gene Therapy, vectors used in gene therapy, biological vectors-retrovirus,adenoviruses,Herpes Synthetic vectors-liposomes,receptor mediated gene transfer,Cell and tissue engineering,Stem cell potential use of stem cells-Cells based therapies.

TEXT /REFERENCE BOOKS:

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

COURSE OUTCOMES

Students will be able to:

1. Acquire the knowledge about common diseases which can easily be cured using biotechnological tools
2. Apply the knowledge of biotechnology for counseling and curing of complex genetic diseases/disorders
3. Develop the new strategies for biopharmaceutical industry

EBT-516	NATURAL RESOURCE MANAGEMENT	3L:0T:0P	3CREDITS

COURSE OBJECTIVES

1. To acquaint the students the knowledge of Natural resources and their importance
2. To acquire knowledge of different resource management strategies
3.To get knowledge about conservation of natural resources for sustainable development

UNIT I

Introduction to Natural Resources bases, concept of resource, classification of natural resources, factors influencing resource availability, distribution and uses, interrelationship among different types of natural resourcesVizAnimal ,Plant microbes etc, concern on productivity issues,ecological,social and economic dimension of resource management and their subsequent conservation

UNIT II

Forest resources, forest vegetation, status and distribution, major forest types, mining, dams and their effects on forest and tribal people, forest management, developing and developed world strategies for forestry, land resources, soil erosion, wet land ecology and management, use and over utilization of water resources, water ecology and management

UNIT III

Main energy resources, energy needs, renewable and non-renewable energy resources, use of alternate energy sources and their management , world food problems and importance of food resources, changes causes by agriculture and overgrazing, effects of modern agriculture, fertilizer pesticide problems, water logging,

UNIT IV

Fish and other marine resources, their production,status,unsustainable harvesting, issues and challenges for resource supply, new prospects in fish farming, use and exploitation of mineral resources, environmental effects of extracting and using mineral resources.

UNIT V

The evolution and history of resource management paradigms, resources conflicts, resource extraction, access and control system, ecological ,economic and ethnological approach of natural resource management and conservation, implications of different approaches, integrated resource management strategies, causes and link with resources scarcity and poverty. Biotechnological approaches, tools and techniques for natural resources management and conservation

TEXT /REFERENCE BOOKS:

1. Francois Ramade,1984.Ecology of Natural Resources.John Wiley & Sons Ltd
2. Odum,E.P.1971.Fundamentals of Eclogy.W.B.SaundersCo.USA
3. Global Change and Natural Resource Managemnt,Vitousek,P.M. 1994.Beyond global warming:Ecology and Global Change,Ecology 75,1861-1876
4. Agarwal,K.C.2001.EnvironmentalBiology,Nidhi Publications Ltd,Bikaner
5. Singh H.R.2014Environmental BiologyS.Chand& Company PVT LTD
6. Saha T.K.2007. Ecology and Environmental Biology. Books and Allied(P)Ltd.
7. Sharma P.D.2007.Ecology and Environment.Rastogi Publications (P)Ltd.

COURSE OUTCOMES

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

1. Apply the knowledge of natural resource management to live healthy life

2. Develop the new approaches with incorporation of new technologies for sustainable development of universe
3. Create awareness among masses to conserve all natural resources to save mother earth

EBT-517	PHARMACEUTICAL BIOTECHNOLOGY	3L:0T:0P	3CREDITS

COURSE OBJECTIVES

1. To acquire knowledge of steps of new drug discovery
2. To enrich minds with development and approval process regarding manufacturing drug
3. To develop skill of quality control in Pharmaceutical industry throght biotechnology tools

UNIT I

Development of drugs and pharmaceutical industry-organic therapeutic agents, uses and economics, biopharmaceuticals definitions and biotechnologically derived therapeutics,strategieis for new drug discovery using biotechnological tools

UNIT II

Production biotechnologically derived therapeutic proteins like humulin,humatrop and hormones,recombinantvaccines,DNA vaccines and monoclonal antibodies(hybridoma technology),gene therapy and toxicogenomics,

UNIT III

Role of proteomics in disease detection and diagnostic kit development,drug registration and regulatory affairs,GMP guidelines for Biopharmaceuticals

UNIT IV

Introduction to drug discovery, lead compound isolation and targeting,SAR and rational drug design,production of pharmaceuticals by genetically engineered cells,microbial transformation for the production of steroids and semi synthetic antibiotic

UNIT V

Drug formulation and their classification, oral solid dosage forms, coating of pharmaceutical dosage forms, parenteral preparations, ophthalmic preparations, novel drug delivery systems,GLP and good packaging techniqes, bioavalability and bioequivalence testing

TEXT /REFERENCE BOOKS:

1. Singh, K., Medicinal plants: applied biology of domestication & export (2004) (aavishkar pub).
2. Thrived, P. C., Medicinal plants: utilization & conservation (2004) (Aavishkar Pub).
3. Bhattacharjee, handbook of medicinal plants, 4th revised ed. (2004) (Aavishkar pub).
4. Bhattacharjee, Medicinal, herbs & flowers (2005) (Aavishkar pub).
5. G. Patrick, Medicinal Chemistry. (2002)
6. Shah and Seth, Text book of Pharmacognosy and phytochemistry (2010) Elsevier publications

COURSE OUTCOMES

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

1. Apply the concepts of biopharmaceuticals and pharmaceutical industry
2. Apply the knowledge of Pharmaceutical manufacturing in the production of biopharmaceuticals
3. Develop the strategies of new drug discovery

EBT-518	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

Introduction to Medicinal Plant of North Himalaya,Important Medicinal Plants of Garhwal Range & their medicinal value,Importance and relevance of herbal drugs in traditional Indian system of medicine(Ayurveda,Unani,Sidha,Homeopathyetc).

UNIT II

Pharmacognosy - Aim and scope; branches of Pharmacognosy and Phytochemicals - Reserve materials; Secretory materials; excretory materials, Principles and techniques in medicinal plant cell and tissue cultures, RFLP RAPD,AFLP mapping used for authentication of diversity in medicinal plants

UNIT III

Plant disease of medicinal plants like Blast, blight, tikka, smut, wilt, their control measures, and plant based herbicides, Use of biotechnology in crop improvement of medicinal ,Plant symbiont interaction, nitrogen fixation and disease, stress and salt resistance, Gene isolation, cloning and transfer in medicinal plants

UNIT IV

Herbal extraction methods, steps involved, solvents used, equipment required. Types of herbal extract preparations and storage methods, future prospects of herbal medicines in drug discovery

UNIT V

Isolation and quantification of secondary metabolite sused in drug production from medicnal plants (viz., alkaloids, terpenoids, steroids, essential oils, essential perfumes etc.),Parasitic diseases like Maleria, Filaria their herbal remedies and cure, Control of malarial parasite and vector thorugh medicinal plants,Herbs for human diseases like Diabetes(*Stevia spp*), Cancer(*Gingko biloba*) ,Diarrhea(*Cinnamomumzeylanicum*) etc as case studies.

TEXT /REFERENCE BOOKS:

1. Singh, K., Medicinal plants: applied biology of domestication & export (2004) (aavishkar pub).
2. Thrived, P. C., Medicinal plants: utilization & conservation (2004) (Aavishkar Pub).
3. Bhattacharjee, handbook of medicinal plants, 4th revised ed. (2004) (Aavishkar pub).
4. Bhattacharjee, Medicinal, herbs & flowers (2005) (Aavishkar pub).
5. G. Patrick, Medicinal Chemistry. (2002)

6. Shah and Seth, Text book of Pharmacognosy and phytochemistry (2010) Elsevier publications
7. K.Janaradhan Reddy,2007.Advances in medicinal Plants,University Press
8. Sharma ,P.D Plant Pathology,Alpha Scientific International

COURSE OUTCOMES

On successful completion of the course 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

AUDIT COURSE-I

As per Institute's common syllabus for all branches.

EVALUATION SCHEME
M. TECH. BIOTECHNOLOGY
I-YEAR (II-SEMESTER)

S. No.	COURSE CODE	SUBJECT	PERIODS			EVALUATION SCHEME					CREDIT
						SESSIONAL EXAM			ESE		
			L	T	P	CT	TA	Total		Total	
THEORY											
1.	TBT-521	BIOINFORMATICS & SYSTEM BIOLOGY	3	0	0	30	20	50	100	150	3
2.	TBT-522	RDT	3	0	0	30	20	50	100	150	3
3.	EBT-52X	ELECTIVE-III	3	0	0	30	20	50	100	150	3
4.	EBT-52X	ELECTIVE-IV	3	0	0	30	20	50	100	150	3
5.	TAC-52X	AUDIT COURSE-II	2	0	0	15	10	25	50	75	0
PRACTICAL											
6.	PBT-521	BIOINFORMATICS & SYSTEM BIOLOGY	0	0	4	10	15	25	25	50	2
7.	PBT-522	IMMUNOTECHNOLOGY /BIOPROCESS ENGG. LAB	0	0	4	10	15	25	25	50	2
8.	PBT-523	MINI PROJECT			4	20	30	50	50	100	2
9.	GPP-521	GENERAL PROFICIENCY	-	-	-	-	50	50	-	50	0
SEMESTER TOTAL			**14**	**0**	**12**	**175**	**200**	**375**	**550**	**925**	**18**

ELECTIVE-III(EBT-52X, X: 1, 2, 3, 4)

1. **EBT-521:**IMMUNOTECHNOLOGY
2. **EBT-522**:VACCINE TECHNOLOGY
3. **EBT-523:**ANIMAL BIOTECHNOLOGY
4. **EBT-524:**BIOANALYTICAL TECHNIQUES

ELECTIVE-IV(EBT-52X, X: 5,6,7,8)

1. **EBT-525**: BIOPROCESS ENGINNERING
2. **EBT-526:** BIOREACTOR ENGINNERING
3. **EBT-527**: BIOSEPERATION TECHNOLOGY
4. **EBT-528**: BIOFUELS

AUDIT COURSE-II (As per Institute's common syllabus for all branches.)

1. **TAC-521**: DISASTER MANAGEMENT
2. **TAC-522** : PEDAGOGY STUDIES
3. **TAC-523 :** STRESS MANAGEMENT BY YOGA
4. **TAC-524**: PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS

TBT-521	BIOINFORMATICS & SYSTEM BIOLOGY	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. To acquire knowledge the interdisciplinary nature of advances in bioinformatics and system biology.
2. The basic understanding of how biological data is stored and retrieved from various biological databases.
3. To develop an understanding of algorithms of sequence alignment (pair-wise and multiple) and scoringalgorithms.
4. To solve problems through the understanding of various tools and softwares.
5. To develop an Insilco understanding of various systems in living organism.

UNIT I

Introduction, Evolution, History, Scope and Application of Bioinformatics.Biological databases; Introduction to sequence Alignment (Pairwise and multiple), Optimal Alignment Methods, and substitution Scores and Gap Penalties, Database Similarity Searching: FASTA, BLAST.

UNIT II

Protein structure, domains and motifs prediction method, visualization and model validation, RNA Prediction, Structure classification (SCOP, CATH): Visualization software (Pymol, Rasmol etc.)

UNIT III

Energy minimization; Molecular dynamics; Rosetta; Structure comparison (DALI, VAST etc.)CASP; Protein ligand docking; Computer aided drug design (pharmacophore identification) QSAR.

UNIT IV

Introduction to Systems Biology: Scope, Applications. Concepts, implementation and application. Databases for Systems Biology, Modeling and analysis tools: Cell-Designer, Cytoscape, Copasi, R and Bioconductor.

UNIT V

Biological Networks: Protein-protein interaction network, gene regulatory network, metabolic network, signal transduction network.

TEXT /REFERENCE BOOKS:

1. Attwood, Introduction to Bioinformatics (2001).
2. Baxevanis&Quellette, Bioinformatics: A practical guide to the Analysis of genes & proteins. 3rd ed. (2005) (Wiley)
3. Baldi, Bioinformatics, 2nd ed.
4. Hancock, Dictionary of Bioinformatics & computational biology. (2004) Wiley.
5. Higgins, Bioinformatics: Sequence, Structure 7 Databanks. (2001) (Oxford).
6. Mount, Bioinformatics 2nd Ed (Sequence & Genome Analysis) (2004).
7. Pevsner, Bioinformatics & functional genomics (2003) (Wiley).
8. Rastogi, Bioinformatics: Concepts, skills & application (CBS 2003) HB.

COURSE OUTCOMES

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

1. Explain the basic principles that underpin Bioinformatics analyses, and apply these principles when analyzing biological data;
2. Survey a selected field within Bioinformatics, synthesize information from primary literature, and coherently report your findings in a written document;
3. Analyze biological data using a variety of Bioinformatics tools; and
4. Interpret correctly the outputs from tools used to analyses biological data and make meaningful predictions from these outputs

PBT-521	BIOINFORMATICS & SYSTEM BIOLOGY	0L:0T:4P	2 CREDITS

List of experiments

1. Database searches
2. Database similarity searches
3. Pairwise sequence alignment
4. Multiple sequence alignment
5. Hidden markov model construction and searches
6. Protein motif searches
7. DNA motif searches
8. Phylogenetic analysis
9. Constructing a distance-based phylogenetic tree
10. Constructing a maximum parsimony tree
11. Constructing a quartet puzzling tree
12. Constructing a maximum likelihood tree using genetic algorithm
13. Constructing a phylogenetic tree using bayesian inference
14. Protein structure prediction
15. Protein homology modeling
16. Gene prediction
17. Operon prediction
18. Promoter prediction

TBT-522	RECOMBINANT DNA TECHNOLOGY	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. This course aims to expose students to Principles, methods and applications of recombinant DNA technology in biotechnological research.
2. To train students in strategizing research methodologies employing genetic engineering techniques.

UNIT I

Nucleic acids: DNA as genetic material, RNA – structure, stereochemistry and secondary structure. Gene structure in eukaryotes and prokaryotes. DNA replication. Transcription. Mechanism of post transcriptional modifications in RNAs. Translation, genetic code, post translational modifications, protein targeting. Genetic elements that control gene expression.

UNIT II

Introduction and scope of genetic engineering. Enzymes used in manipulation of DNA and RNA. Types, biology and salient features of vectors of recombinant DNA Technology.
Cloning strategies: Plants, microbes, Animals, Insertion of Foreign DNA into Host Cells. Transformation.

UNIT III

Expression of cloned genes in prokaryotes, eukaryotes.Gene regulation study.
Expression strategies for heterologous genes: Vector engineering and codon optimization, host engineering, in vitro transcription and translation, expression in bacteria, expression in yeast, expression in insects and insect cells, expression in mammalian cells, expression in plants.

UNIT IV

Restriction mapping of DNA fragments and map construction, DNA labeling. Nucleic acid sequencing. Genetic markers.
Gene therapy: Strategies of gene delivery, gene correction, gene editing, gene regulation and silencing.
Safety guidelines for recombinant DNA research.

UNIT V

Application of RDT; Principle and application of PCR, types of PCR.
Antisense molecules, Introduction to siRNA; si RNA technology; Micro RNA Construction of siRNA vectors; Principle and application of gene silencing; Gene knockouts.
Ribozymes, types & structure of ribozymes, strategies for ribozymes designing, Application of antisense & ribozyme technologies.Terminator Technology
Microarray technique. DNA chips, Quantum Dots.DNAfootprintings
Site-directed mutagenesis and protein engineering.

T-DNA and Transposon tagging. Identification and isolation of genes through T-DNA or transposon.

TEXT /REFERENCE BOOKS:

1. Alberts et.al. : Molecular Biology of the cell (3rd and 4th editions).
2. G. Karp: Cell and Molecular Biology.
3. Molecular and Cellular Methods in Biology and Medicine, P. B. Kaufman, W. Wu. 0. Kim and L.J. Cseke, CRC Press, Florida, 1995.
4. DNA Science: A First Course in Recombinant Technology, D. A. Mickloss and G_A. Freyer, Cold Spring Harbor Laboratory Press, New York, 1990.
5. Molecular Biotechnology, 2nd edition, S.B. Primrose, Blackwell Scientific Publishers. Oxford, 1994.
6. Molecular Cloning: A Laboratory Manual, J. Sambrook, E. F. Fritsch and T. Maniatis. Cold Spring Harbor Laboratory Press, New York, 2000.

COURSE OUTCOMES

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

1. Summarize the basics of molecular biology.
2. Demonstrate Cloning methods.
3. Identify suitable vectors for RDT experiments.
4. Select suitable Expression vectors and expression strategies of foreign genes in host.
5. Assimilate knowledge of restriction mapping, gene therapy.
6. Handle RDT experiments according to safety guidelines.
7. Demonstrate and apply various advance techniques of RDT including, PCR, antisense, microarray etc.
8. Use RDT for welfare of living organism and protection of environment.

PBT-522	IMMUNOTECHNOLOGY & BIOPROCESS ENGG. LAB	0L:0T:4P	2 CREDITS

List of experiments

1. Determination of Blood group
2. To isolate serum and plasma of given blood sample
3. To perform Haemoglobin test
4. To determine total leucocyte count (TLC) of the given blood sample
5. To determine the differential leucocyte count (DLC) of the given blood sample.
6. To perform separation of Lymphocytes from given blood sample
7. To Perform Widal test by slide agglutination
8. To perform Immune chromatographic test for detection of Hepatitis B surface Ag in Human
9. To perform ASO latex agglutination test for Arthritis
10. To perform single radial immunodiffusion by Mancini's technique.
11. To perform double immunodiffusion (DID) by Ouchterlony's method
12. To perform Immuno electrophoresis
13. To perform Rocket Immuno electrophoresis
14. To perform western blotting
15. To perform enzyme-linked immunosorbent assay (ELISA) by direct method
16. To perform Immunoprecipitation Techniques
17. Isolation of Pure culture
18. Maintenance and Preservation of Industrial important microorganism by different method.
19. Monod Kinetics in batch culture.
20. Carbohydrate fermentation test.
21. Antibiotic production by Fungi
22. Ethanol production and its estimation.
23. Media Sterilization in the Bioreactor
24. Study of Thermal deactivation kinetics
25. KLa determination in the Bioreactor
26. Study of parts of bioreactor.

EBT-521	IMMUNOTECHNOLOGY	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES:

1. To learn about immune systems and their components at the cellular and humoral levels.
2. To acquire knowledge about Immunodiagnostic Techniques and its role in disease diagnosis
3. To enrich knowledge about vaccine technology and its role in human health
4. To know about monoclonal and polyclonal antibodies -their production, characterization and its application in immunodiagnosis in clinical purpose.
5. To know the concept of cancer biology

UNIT I

Basic Concept of Immunotechnology: antigens for raising antibodies: peptide antigens and their preparation; handling of animals; Adjuvants, viral coat proteins as recombinant, adjuvants and their mode of action.

Unit II

Immunodiagnostic Techniques-agglutination, Precipitation, immunofluorescence, immunoelectrophoresis, ELISA (Indirect, Sandwich, Competitive) ELISPOT assay, radioimmunoassay, western blotting, flow cytometry, immunofluorescence, Immunoprecipitin reactions, Complement system – components and functions of complement, Neutralisation test.

UNIT III

Vaccine technology : Active and passive immunization; Live, killed, attenuated, sub unit vaccines; recombinant DNA and protein based vaccines, plant-based , vaccines, reverse vaccinology; Peptide vaccines, conjugate, Immunotoxin: mechanism of immunotoxin and their role in medical science, Immunization, types of immunization, Rationale of immunization, role of adjuvant in immunization.

UNIT IV

Antibody engineering, Hybridoma technology, Production of monoclonal antibodies and their applications- in biomedical research, in clinical diagnosis and treatment, Human recombinant antibodies–antibody humanisation and applications of humanized antibodies, Application of human recombinant antibodies and antibody fragments in medicine and industry.

UNIT V

Transplantation Immunology, Cancer biology, MTT assay, Immunomodulators Autoimmunity and auto immune disease, Immunotherapy.

TEXT /REFERENCE BOOKS:

1. Practical immunology by Hay
2. Immunology by Kubey(Freeman)
3. Essential immunology byRoitt,
4. Manual of clinical laboratory Immunology by Rose
5. The elements of Immunology by Fahim Halim Khan (Pearson Education)

COURSE OUTCOMES

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

1. Explain the antigen and immunogen, properties and its preparation for raising the antibodies
2. understand immune responses, composition, and function of cells involved in immune system, mechanism of T, B cell and macrophage activation
3. understand the action mechanism of vaccine and methods of preparation of vaccines
4. Perform techniqueslike immunodiagnostic tests western blot analysis, immuno electrophoresis, ELISA-principle and applications, radio immuno assay and chemilluminescence assay
5. Apply concepts of hypersenstivity, autoimmunity, cancer biology to assess and handle health problems

EBT-522	VACCINE TECHNOLOGY	3L:0T:0P	3 CREDITS

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

Fundamental concepts and anatomy of the immune system, Components of innate and acquired immunity, Humoral and Cell mediated immunity, Antigens, Major Histocompatibility Complex - MHC genes, MHC and immune responsivenessand disease susceptibility, Age of commencement of immunization, Dosage and Dosage spacing, Vaccine schedule, Hazard of immunization.

UNIT II

Vaccines, Live, killed, attenuated, sub unit vaccines; Vaccine technology- Roleand properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines,reverse vaccinology; Peptide vaccines, conjugate vaccines,Rationale vaccine design based on clinical requirements

UNIT III

A short history of vaccination, Active and passive immunization, General immunization practices,Vaccination of immunocompromised hosts, Vaccination of human immunodeficiency virusinfectedpersons, Autoimmunity, Transplantation, Tumor immunology, immunodeficiency,Stem cell therapy, Transfusion of immune competent cells.

UNIT IV

Licensed vaccines, Viral Vaccine (Poliovirus vaccine-inactivated & Live, Rabies vaccinesHepatitis A & B vaccines), Bacterial Vaccine (Anthrax vaccines, Cholera vaccines, Diphtheriatoxoid), Parasitic vaccine (Malaria Vaccine).

UNIT V

The vaccine industry, Vaccine manufacturing, Evolution of adjuvants across the centuries,Vaccine additives and manufacturing residuals, Regulation and testing of vaccines, Regulation of vaccines in developing countries, Vaccine safety and Legal issues.

TEXT /REFERENCE BOOKS:

1. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman,2002.
2. Brostoff J, Seaddin JK, Male D, Roitt IM., Clinical Immunology, 6th Edition, Gower Medical
Publishing, 2002.
3. Janeway et al., Immunobiology, 4th Edition, Current Biology publications., 1999.
4. Stanley A. Plotkin& Walter Orenstein & Paul A. Offit, Vaccines, 6th Edition 2013 BMA Medical Book Awards Highly Commended in Public Health! Elsevier Publication.
5. Roitt's Essential Immunology. 11th ed. P. Delves, et al., ed., Blackwell Publishing, 2006.

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.
6. Demonstrate an understanding of the nature and variability of bacterial and virus antigens relevant to vaccine development

EBT-523	ANIMAL BIOTECHNOLOGY	3L :0T: 0P	3 CREDITS

COURSE OBJECTIVES

1. To understand importance and types of different kinds of media and cell cultures that are commonly used in Animal Biotechnology.
2. To understand the latest techniques and methods that are used for betterment of animal biotechnology.

UNIT I

Introduction to Animal Biotechnology, Historical perspectives, Scope and Importance, Structure and organization of animal cell, Laboratory facilities for animal tissue culture, Bioethical issues related to animal biotechnology.

UNIT II

Initiation of animal cell cultures, Primary culture, secondary culture, sub-culturing, Established cell lines, Cultural media, Nutrient requirements of mammalian cells, natural and artificial media, Serum free media (advantage & disadvantages), Preparation and sterilization of substrate and medium, Trypsinization, Cryopreservation of cell lines, revival and maintenance of animal cell lines.

UNIT III

Large scale culturing in biotechnology, Monolayer (in Roux Bottle, Roller bottle, Plastic film, Optical culture system, Bread Bed reactors, Heterogenous reactors), Suspensions (stirred bioreactors, continuous flow cultures, air lift fermenter) and immobilized cell cultures, Methods of scaling up of animal cell culture, Hybridoma technology, monoclonal antibody and their application in animal health and production.

UNIT IV

Induction of superovulation, *In vitro* fertilization and embryo culture in human and farm animals, Requirement and Application of embryo transfer technology, Somatic cell fusion, Embryo collection and evaluation. Embryo splitting. Embryo sexing. Embryo transfer. Embryo cloning. Nuclear transplantation. Identification and transfer of gene influencing production and disease resistance,

UNIT V

Application of animal cell culture for in vitro testing of drugs, Testing of toxicity of environmental pollutants in cell culture, Application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins, Stem cell culture, their application, Cell death, measurement of cell death, Development of transgenic animal, transfection methods, Embryonic stem cell transfer, targeted gene transfer, detection of transgenic and transgene function, Animal cloning, Tissue and organ transplant, Engineering human interferons and human growth hormones.

TEXT /REFERENCE BOOKS:

1. Culture of Animals Cells 7th Edition, R Ian Freshney, Wiley-Blackwell.
2. Cell Growth and Division: A Practical Approach, ed., R Basega, IRL Press.
3. Animal Cell Culture – Practical approach, ed., John RW. Masters, Oxford.
4. Cell Culture Lab Fax, eds., M. Butler and M. Dawson, Bios Scientific Publications Ltd., Oxford.
5. Animal Cell Culture Techniques, eds., Martin elynes, Springer.
6. Methods in Cell Biology, vol. 57, Animal Cell Culture Methods, eds., Jenni P. Mather and David Barnes, Academic Press.

COURSE OUTCOMES

On completion of this course, students shall be able to:

1. To acquire knowledge to the basic understanding and application of appropriate husbandry best practices to animals of economic value.

2. This course is beneficial to work productively in the emerging fields of animal biotechnology.

3. Understand the advanced techniques and methods used in Animal Biotechnology and will learn their application in Biotechnology for example: Animal Cloning, transplantation methods, Transgenic animals, Vaccines etc.

EBT-524	BIOANALYTICAL TECHNIQUES	3L :0T: 0P	3 CREDITS

COURSE OBJECTIVES

1. To understand protein crystallization techniques and its applications

2. To understand chromatographic techniques for protein purification

3. To understand advanced imaging techniques, electrophoretic techniques and other advanced techniques for analysis of biological samples

UNIT I

Protein Crystallography: Biological macromolecules, Principle and method of protein crystallization, Influence of heterogeneity on crystallization, Progress in structural genomics, Micro crystallization, Utility of micro fluidics for crystallization, Cryotechniques.

UNIT-II

Chromatographic methods for protein and peptide purification: Gas chromatography with mass spectrometric detection (GC-MS), liquid chromatography with mass spectrometric detection (LC-MS), inductively coupled plasma with mass spectrometric detection (ICP-MS). Metal analysis by ICP-MS; Analysis of data: HPLC chromatograms, including trouble shooting – how to achieve good separation on HPLC; GC-MS data; LC-MS spectra.

UNIT III

Advanced imaging techniques in microscopy: Live cell imaging, Confocal microscopy and sample preparation for fluorescence microscopy, High content/throughput screening: Basics of SEM and Specimen preparation for SEM , Basics of TEM and Specimen preparation for TEM. Advanced EM techniques: CryoEM, Methods to study interactions: FRET, FCCS and BiFC, Atomic Force Microscopy.

UNIT IV

Electrophoretic Techniques: Strategies, Separation of proteins using 2D gel electrophoresis, Electrophoresis method for purifying proteins, in situ enzyme detection, Staining method,Separation of peptide mixture, Pulse field gel electrophoresis, Denaturing gradient gel electrophoresis.

UNIT V

Flow Cytometer: Introduction to flowcytometry, Fluorochromes and fluorescence, Experimental design and fluorescence quantitation. Readings on flow cytometry, data analysis.High-Throughput Next generation sequencing (HT-NGS) platforms. Comparative genomics in HT-NGS platform - RNA-seq and transcriptome analysis - ChIP- sequencing and epigenomics - Challenges in next generation sequencing and bioinformatics.

TEXT /REFERENCE BOOKS:

1. Williams, D. and Fleming, I. "Spectroscopic Methods in Organic Chemistry", McGraw-Hill Higher Education, Maidenhead, UK.

2. Babine, R.E. and Abdel-Meguid, S.S., "Protein Crystallography in Drug Discovery", WillyVCHVerlag GmbH& Co.

3. Keith Wilson and John Walker, "Principles and Techniques of Practical Biochemistry", Cambridge University Press.

4. Kwon, Young Min, Ricke, Steven C. (Eds), "High-Throughput Next Generation Sequencing Methods and Applications" Humana Press.

5. Bhowmik, G. and Bose, S., "Analytical Techniques in Biotechnology", Tata McGraw-Hill Publishers.

6. Chandler, D. and Roberso, R.W., "Bioimaging: Current Techniques in Light & Electron Microscopy", Jones and Bartlett publishers.

COURSE OUTCOMES

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

1. Apply crystallography for protein samples.

2. Illustrate chromatography and electrophoretic techniques for protein purification.

3. Analyze biological samples using different microscopy and mass spectroscopy techniques.

4. Demonstrate flow cytometry and understand data generated.

5. Study nucleotide sequencs through next generation sequencing methods

ELECTIVE-IV

EBT-525	BIOPROCESS ENGINEERING	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. To introduce the engineering principles of bioprocesses including kinetics of microbial cells in different type of fermentation process, medium requirement and optimization.
2. To study different types of bioreactor, control of bioreactors and concept of sterilization.
3. To learn the techniques used in product recovery, basic concept of scale up and role of mass transfer in bioreactor.
4. To identify good manufacturing and lab practices in bioprocess industries

UNIT I

- Introduction to bioprocess engineering.
- Isolation, Preservation and maintenance of industrial microorganisms.
- Medium formulation and optimization.
- Kinetic of microbial growth and Types of fermentation process: analysis of batch, fed-batch and continuous culture.

UNIT II

- Bioreactor: components and control of process parameters.
- Different types of bioreactor: CSTR, airlift, fluidized, plug flow, packed bed, specialized bioreactor: photo bioreactor, pulse column.
- Sterilization of reactor and medium: concept and method.

UNIT III

- Downstream processing: introduction, removal of microbial cells and solid matter: Foam separation, precipitation, filtration, and centrifugation.
- Cell disruption techniques, liquid-liquid extraction and chromatography.
- Membrane separation process, drying and crystallization.
- Effluent treatment of bioprocess waste.

UNIT IV

- Diffusion and Mass Transfer in bioreactors: The oxygen requirement of industrial fermentation. Oxgen transfer phenomenon. Determination of Kla , factors affecting oxygen transfer rate.
- Concept of scale up: scale up criteria for bioreactors based on oxygen transfer, power consumption and impeller tip speed.

UNIT V

- Safety practices in bioprocess.
- Quality control of bioproducts.
- Concept of GMP and GLP in bioproceesing.
- Utilizing genetic engineered organism in bioreactors.

TEXT /REFERENCE BOOKS:

1. Biochemical Engineering Fundamentals, Baily. J.E. and Ollis. D. F., McGraw-Hill Book Co., New York.
2. Bioprocess Technology: Fundamentals and Applications, KTH, Stockholm.
3. Bioprocess Engineering: Basic Concepts, Shuler. M.L. and Kargi. F., Prentice Hall, Englewood Cliffs.
4. Principles of Fermentation Technology, Stanbury. P. F. and Whitaker. A., Pergamon Press, Oxford.
5. Chemical Engineering Problems in Biotechnology, Schuler. M. L. (ed.), AICHE.
6. Biochemical Engineering, Lee J. M., Prentice hall Inc.

COURSE OUTCOMES

On successful completion of this course

1. The students will acquire skill to perform lab experiments.
2. Students will be able to solve problems related to microbial growth kinetics and mass transfers in bioreactor
3. The student will be capable to apply the acquired knowledge to design of fermenters and various process in any bioprocess industries.
4. The students can decide and select appropriate techniques for biospertaion of product.
5. Students will be aware of the rules of safety practice in bioprocess industries.

EBT-526	BIOREACTOR ENGINEERING	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. To introduce the concept of bioreactor design and different types of bioreactors.
2. To learn about the concept of ideal, non ideal reactors their models,
3. To study bioreactor consideration in enzyme system and multiphase bioreactor system
4. To know about unconventional bioreactors and their application
5. To learn various bioreactor operation.

UNIT I

Bioreactor: Mechanical design of bioreactors. Types of reactor**:** Batch, plug flow reactor (PFR), continuous stirred tank reactor (CSTR), Fluidized bed reactor, bubble column, air lift fermenter. Design criteria for airlift, bubble column, and chemostat bioreactors

UNIT II

Concept of ideal and non-ideal reactors, residence time distribution, models of non ideal reactors– plug flow with axial dispersion, tanks-in-series model, chemo stat model with cell growth kinetics.

UNIT III

Bioreactor consideration in enzyme system: Analysis of film and pore diffusion effects on kinetics of immobilized enzyme reactions; formulation of dimensionless groups and calculation of effectiveness factor. Design of immobilized reactors: Packed bed, fluidized bed and membrane reactors.

UNIT IV

Unconventional bioreactors**:** Gas liquid reactors, hollow fiber reactor, and perfusion reactor for animal and plant cell culture, bioreactor design consideration for animal/mammalian and plant cell culture, Reactors for Solid state fermentation.

UNIT V

Bioreactor operations: Sterilization of bioreactor, mixing and aeration, process monitoring and control, Heat and mass transfer in bioreactor

TEXT /REFERENCE BOOKS:

1. Landfill Bioreactor Design & Operation. Reinhart Debra R, Townsend Timothy G. and Townsend Tim(1997) Lewis Publishers, Inc.
2. Multiphase Bioreactor Design. Edited by: Joaquim M.S. Cabral, Manuel Mota, Johannes Tramper (2001) CRC Press.

3. Bioreactor & Ex Situ Biological Treatment Technologies – 5. Allerman Bruce, Allerman Bruce C, Leeson Andrea, (1999). Battelle publisher.
4. Bioreaction Engineering: Modeling& Control. vol. I&II. Schugerl K and Bellgardt K.H, (2000), Springer Verlag pub.

COURSE OUTCOMES

On successful completion of this course

1. The student will be able to perform different laboratory experiments related to the subject.
2. Students will have understanding of how to fully specify bioreactor design characteristics for free and immobilized system.
3. Students will be able to evaluate and solve problems related to reactor data.
4. Students will have understanding of how to relate the fundamental knowledge of bioreactor engineering to industrial practice.

EBT-527	BIOSEPERATION TECHNOLOGY	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. To provides an opportunity to understand the importance of the Bio separation process.
2. To learn various separation techniques related to primary cell disruption, primary isolation, purification and final polishing.
3. How to deal with problems associated with product recovery through case studies.

UNIT I

Role and importance of Bio separation process in biotechnological processes. Problems and requirements of bioproduct purification. Characteristics of biological mixtures, Classification of bioproducts, Process economics-Capital and operating cost analysis.

UNIT II

Cell disruption methods for intracellular products, removal of insoluble, biomass (and particulate debris) separation techniques-flocculation and sedimentation, centrifugation and filtration methods- theory and equipment.

UNIT III

Extraction – theory and practice: Aqueous two phase extraction, supercritical fluid extraction Precipitation techniques: salts, solvents, polymers (PEG). Membrane based separations techniques: micro, ultra filtration , RO and Dialysis- theory, design and configuration of membrane separation equipment, applications.

UNIT IV

Theory, practice and selection of media for – gel-filtration chromatography, Ion exchange chromatography, Hydrophobic interaction chromatography, reverse phase chromatography, Affinity chromatography – Metal affinity chromatography, dye affinity chromatography, immunosorbent affinity chromatography & Expanded bed chromatography. Scale-up criteria for chromatography, calculation of no. of theoretical plates and design, all electrophoresis techniques including capillary electrophoresis, hybrid separation technologies-membrane chromatography, electro chromatography.

UNIT V

Drying and crystallization- Theory and equipment. Case studies on purification of: cephalosporin, aspartic acid, Recombinant Streptokinase, Monoclonal antibodies, Tissue plasminogen activator, Taq polymerase, Insulin. Case studies of product recovery economics.

COURSE OUTCOME

On successful completion of this course

1. The students will be able to perform different laboratory procedures related to the subject.
2. The knowledge derive from this course will give the skill sets to the students for the Research, chemical, pharmaceutical, biotech and Food Industry.
3. Students will be able to analyze and select the appropriate scheme and separation method for recovery of any bio product.
4. Students will be able to demonstrate critical thinking, problem solving and decision making abilities.

EBT-528	BIOFUELS	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. Acquire knowledge about theory and process used to make different types of biofuels such as bioethanol, biodiesel, bio hydrogen and biogas.
2. Know about the social and environmental impact on use of biofuels.
3. Recapitulate various geochemical cycles and factors causing global warming

UNIT I

Overview of Energy Sources & Utilization, Climate Change & the Impact of Carbon Dioxide, Fossil fuels versus renewable energy resources. Introduction of biofuels: history of biofuels, Different generations of biofuels.

UNIT II

Bioethanol production from sugar, starch and lignocellulosic feedstock, biomass pretreatment and fermentation process. Bio Butanol: Butanol and its properties, butanol as fuel, method of its production, industrial application.

UNIT III

Bio hydrogen production: types of substrates, different production process for biohydrogen, photo biological hydrogen production using algae. Biodiesel production**:** Chemistry of biodiesel production, Sources and production by plants and other sources, methods of biodiesel production

UNIT IV

Microbiology of methane production, biomass sources for methane production, biogas composition and use, biogas design. Fuel cell: concept, working and principle, Biochemical basis of fuel cell design

UNIT V

Future trends of biofuel development, challenges and hurdles in biofuel production, Role of genetic and metabolic engineering in biofuel production. Economic and environmental impact of biofuels.

TEXT /REFERENCE BOOKS:

1. Introduction to Biofuels : Book by David M. Mousdale
2. Biofuels Production ByVikashBabu, AshishThapliyal, Girijesh Kumar Patel, Wiley publication.
3. Biofuel**s:** Securing the Planet's Future Energy Needs by AyhanDemirbas, Springer Science & Business Media

COURSE OUTCOMES

On successful completion of this course

1. To use the theoretical concepts of biofuel production technology at commercial level.
2. Create an awareness on use of biofuel as cleaner fuel.
3. Recognize the major potential substrates for biofuel production.
4. Appreciate the application of genetic Engineering and metabolic engineering in biofuel production.

EVALUATION SCHEME
M. 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.	EBT-63X	Elective –V	3	0	0	30	20	50	100	150	3
2.	T0E-63X	Open Elective	3	0	0	30	20	50	100	150	3
PRACTICAL											
3.	PBT-631	Dissertation –I	-	-	20	50	100	150	300	450	10
4.	GPP-631	General Proficiency	-	-	-	-	50	50	-	50	0
SEMESTER TOTAL			**6**	**0**	**20**	**110**	**190**	**300**	**500**	**800**	**16**

ELECTIVE-V (EBT-63X; X: 1, 2, 3, 4)

1. **EBT-631**: ENZYME TECHNOLOGY
2. **EBT-632:** ENVIRONMENT BIOTECHNOLOGY
3. **EBT-633**: PLANT BIOTECHNOLOGY
4. **EBT-634**: BIOSENSOR

OPEN ELECTIVES (As per Institute's common syllabus for all branches).

1. BUISNESS ANALYTICS
2. INDUSTRIAL SAFETY
3. OPERATION RESEARCH
4. COST MANGEMENT OF ENGINEERING PROJECTS
5. COMPOSITE MATERIALS
6. WASTE TO ENERGY

EBT-631	ENZYME TECHNOLOGY	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. This course aims to provide a deeper insight into the fundamentals of enzyme structure,function and kinetics of soluble and immobilized enzymes.
2. To acquire knowledge about isolation and purification of enzymes.
3. To deal with current applications and future potential of enzymes.

UNIT I

- History and scope of enzyme and enzyme technology,
- Enzyme classification, enzyme nomenclature, activity units.
- Energetics of enzyme catalyzed reactions, transition state, Factors affecting enzyme activity

UNIT II

- Enzyme cofactors: Structure and biological functions, concepts of active sites and enzyme substrate complex, active site mapping.
- Factors associated with catalytic efficiency, proximity orientation and strain.
- Mechanism of enzyme action.

UNIT III

- Enzyme kinetics: Michaelis-Menton equation, secondary plots, methods to determine Km and Vmax with their merits and demerits.
- Arrhenius equation, determination of energy of activation.
- Bisubstrate reaction kinetics including Random, ordered and Ping-Pong mechanism.
- Regulation of enzyme activity.

UNIT IV

- Isoenzymes, Ribozymes and Catalytic antibodies.
- Multienzyme systems: Occurrence, polygemic nature of multienzyme systems.
- Enzyme Purification: Isolation and purification of enzymes, criteria of homogeneity ofenzymes and characterization of enzymes including determination of their molecularweight.

UNIT V

- Methods of immobilization of enzymes, physical adsorption, covalent binding, entrapment and microencapsulation
- Kinetics of immobilized enzymes, effect of solute partition and diffusion on the kinetics of immobilized enzymes.
- Use of enzymes in analysis, biosensors-calorimetric, potentiometric, optical piezoelectric biosensors and immunosensors.

TEXT /REFERENCE BOOKS:

1. Fundamentals of Enzymology: Nicoles C Price and Lewis Stevens. Oxford Univ. Press. 2005..
2. The chemical kinetics of enzyme action by K.J. Laidler and P.S. Bunting, Oxford University Press, London.
3. Enzymes by M. Dixon, E.C. Webb, CJR Thorne and K.F. Tipton, Longmans, London.
4. Enzyme structure and mechanism (1977) by Alan Fersht, Reading, USA.
5. Enzymatic reaction mechanism (1979) by christopher Walsh, Freeman Publishers, San
   Francisco.
6. Immobilized enzymes(1978) by InhiroChibata, Halsted Press Book
7. . Introduction to Protein Structure, C. Branden and J. Tooze, Garland Publishing, New York.
8. Understanding Enzymes:T. Palmer, Horwood

COURSE OUTCOMES

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

1. Describe structure, functions and the mechanisms of action of enzymes.
2. Summarize various cofactors and their role..
3. Calculate the catalytic efficiency of enzymes.
4. Demonstrate kinetics of enzyme catalyzed reactions, enzyme inhibition and enzyme regulation.
5. Use isozymes, multienzyme complex for different reaction systems.
6. Perform purification and immobilization of enzymes.
7. Apply and use enzymes for different industries.

EBT-632	ENVIRONMENTAL BIOTECHNOLOGY	3L:0T:0P	3 CREDITS

COURSE OBJECTIVE

To introduce the application of biotechnology in biological treatment and management of waste and energy management by learning

1. Conventional and advanced biological waste water treatment techniques.
2. Different techniques of waste management.
3. Modern tools of bioremediation.
4. Application of biotechnology in energy management
5. Use of biotechnological processes for solving global environmental problems.

UNIT I

- Role of biotechnology in environment protection.
- Waste water types, major contaminants in waste water, waste water treatment methods.
- Aerobic waste water treatment methods: Activated sludge process including trickling filters, biological filters, rotating biological contractors, Fluidized bed reactors, oxidation ponds.
- Anaerobic waste water treatment methods: contact digesters, packed bed reactors and anaerobic baffled digesters.
- Advanced waste water treatment methods.

UNIT II

- Biodegradation, Microbiology of degradation and its mechanism, Biodegradation of xenobiotic compounds- general mechanism for simple hydrocarbon, substituted hydrocarbon, aromatic and polyromantic hydrocarbons, pesticides, oil spills and surfectants.
- Solid waste management: Landfills, composting, vermiculture.

UNIT III

- Bioremediation and its type
- Bioaugmentation, Biosorption, Bio-mineralization: Microbial leaching and bio-mining, use of microbes in petroleum extraction.
- Phytoremediation for heavy metal pollution.
- Molecular biology tools for Environmental management, genetically modified organisms in Waste management.

UNIT IV

- Alternate Source of Energy; Biomass as a source of energy, Biofuels: Bioethanol and Biohydrogen
- Agriculture biotechnology: Biofertilizers, Organic farming,
- Bio-electricity through microbial fuel cell.
- Energy management and safety.

UNIT V:

- Global environmental problems – Ozone depletion, Green house effect, Acid rain and Global warming, their impact and biotechnological approaches for management.

- Effect of release of GMOs on environment.
- Biosensors development to monitor pollution
- Nanoscience in Environmental management.

TEXT /REFERENCE BOOKS:

1. Cockerham, Basic Environmental Toxicology (1994).
2. Evans, Environmental Biotechnology (Wiley 2003).
3.Hans-joachim jordening, Josef winter, Environmental Biotechnology-concepts & application, (2005).
4. Environmental biotechnology by Alan scragg (1999); Longman.
5. Waste water engineering treatment, Disposal and reuse .Metcalf& Eddy (1991) Mcgraw hill.

COURSE OUTCOMES

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

1. Demonstrate an awareness of emerging concerns such as global warming, waste management or reductions in fossil fuels.
2. Appreciate the use of biotechnology and other new technologies in combating the environmental problems.
3. Appreciate the scientific, ethical and/or social issues associated with certain applications of biotechnology for alleviating the environmental concerns.

EBT-633	PLANT BIOTECHNOLOGY	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. The course aims to give students new knowledge and widening of the knowledge of classical and modern plant biotechnology processes.

2. To introduce biotechnology methods in plants.

3. The course also deals with the knowledge of plants with improved characteristics and plants for biomolecule production.

UNIT I

- Principles of Micropropagation: Direct and indirect morphogenesis, somatic embryogenesis, caulogenesis, rhizogenesis, acclimatization.
- Synthetic seed production. Protoplast Culture-Isolation, regeneration and viability test,
- Somatic hybridization, methods of protoplast fusion-Chemical and electro fusion, practical application of somatic hybridization, cybrids,

UNIT II

- Role of DNA markers with special emphasis on RFLPs, RAPD markers, SSCP (single strand conformational polymorphism), AFLP,
- Map based cloning.

UNIT III

- Symbiotic nitrogen fixation in legumes by rhizobia - biochemistry and molecular biology.
- Technique of Gene transfer in plant- Agrobacterium and crown gall tumours - mechanism of T-DNA transfer to plants - Ti plasmid vectors for plant transformation - Agroinfection - molecular biology of plant stress response (stress genes).
- Vector less gene transfer – electroporation and gene gun method

UNIT IV

- Application of DNA technology - transgenic plants with reference to virus and pest resistances - herbicidal resistance, insect resistance, Disease resistance, stress tolerance (heat and salt).
- Cytoplasmic male sterility, resistance to fungi and bacteria, delay of fruit ripening.
- Modifying the expression resistant gene by antisense RNA technique.

UNIT V

- Molecular farming, Use of plants for production of neutraceuticals, immuno-protective drugs,

- Edible vaccines and other desired products,
- Biotransformation and immobilization of plant cells.
- Production of secondary metabolic compounds using cell and tissue culture.

TEXT /REFERENCE BOOKS:

1. S.S. BhojwaniandM.K.Razdan, Plant tissue culture: Elsevier Science, The Netherlands.
2. R.A.Dixon Plant TissueCulture– Apractical Approach, IRLpress.
3. Doods.J.H.&RobertsL.W.(1985).ExperimentsinplanttissueCultureCambridge Univ. Press.
4. Satyanarayana. U, 2008, Biotechnology, Books and Allied (p) Ltd.
5. Reinert J and Bajajy.P.S, 1997, Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture, Narosa Publishing House.

COURSE OUTCOMES

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

1. Select explants and performmicropopagation from different explants.

2. Apply knowledge of genetic markers for investigation of plants.

3. Understand process and role of nitrogen fixation in plants.

4. Perform techniques of Gene transfer in plants.

5. Perform application of DNA technology in plant modifications- transgenic plants.

6. Apply Plant Biotechnology for humanand environment well-ness.

EBT-634	BIOSENSOR	3L:0T:0P	3 CREDITS

COURSE OBJECTIVES

1. To explain the fundamental concepts behind the operation of the most important classes of biosensors.
2. To demonstrate how biosensors are characterized, compared to each other, and designed to suit particular applications.
3. To explain how biochemical functionality is coupled to a biosensor transducer.
4. To describe the major applications of biosensor technology in diagnostic tests, life science research, and environmental testing.
5. To expose students to several of the most important emerging biosensor technologies.

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

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

UNIT IV

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 V

Potential advantages & Developments towards a biomolecular computer, development of molecular arrays as memory stores; molecular wires and switches; mechanisms of unit assembly.

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. Roger, K.R. and Gerlach, C.L. 1~99. Update on environmental for biosensors. Env. Sci. Techno! 33: 500A - 506A.
4. Bilitewski, U. Turner, A.P.F. 2000 Biosensors for environmental monitoring Harwood, Amsterdam.
5. Moses, V and Cape, R.E. 1991, Biotechnology the science and business, Harwood, Academic Publisher London.
6. Rogers, K.R. and Mascini, M. 2001, Biosensors for analytical monitoring EPA biosensors group.
7. Advances in biotechnology: Indu Ravi, MamtaBaunthiyal and JyotiSaxena, Springer.

COURSE OUTCOMES

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

1. Understand the concept of transduction and methods of extracting information from biosensors
2. Be able to analyze sensor outputs through the use of signal processing and analogue circuit concepts
3. Gain knowledge in the state of the art of biological and medical sensors both in research and commercial products
4. Be familiar with a wide range of sensors and instrumentation.
5. To deal with control systems combining sensing and actuation.

EVALUATION SCHEME
M. 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.	PBT-641	Dissertation II	-	-	28	150	300	450	500	950	16
2.	GPP-641	General Proficiency	-	-	-	-	50	50	-	50	0
SEMESTER TOTAL			**-**	**-**	**28**	**150**	**350**	**500**	**500**	**1000**	**16**