

**EVALUATION SCHEME
M. TECH. BIOTECHNOLOGY**

I-YEAR (I-SEMESTER)

S. No.	COURSE CODE	SUBJECT	PERIODS			EVALUATION SCHEME				
						SESSIONAL EXAM			ESE	Subject Total
			L	T	P	CT	TA	Total		
THEORY										
1.	TBT-511	Applied Biochemistry	3	1	0	30	20	50	100	150
2.	TBT-512	Molecular Genetics and Biotechnology	3	1	0	30	20	50	100	150
3.	TBT-513	Microbial Biotechnology	3	1	0	30	20	50	100	150
4.	TBT -514	IPR,Bioethics and Biosafety	4	0	0	30	20	50	100	150
5.	TBT-515	Research Methodology and Biostatistics	3	1	0	30	20	50	100	150
PRACTICAL										
6.	PBT -511	Biochemistry/Microbial Technology Lab	0	0	4	20	30	50	50	100
7.	PBT -512	Genetics and Molecular Biotechnology Lab	0	0	4	20	30	50	50	100
8.	GPP-511	General Proficiency	-	-	-	-	-	50	-	50
SEMESTER TOTAL			16	4	8	190	160	400	600	1000

TBT-511
APPLIED BIOCHEMISTRY

Unit I Fundamentals of biochemistry

- Recapitulation of the knowledge chemistry of biomolecules.
- Concept of Energy, Thermodynamics Principles.
- Recapitulation of cellular metabolism and major metabolic pathways.

Unit – II Protein engineering

- 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 Metabolic engineering

- Basic concepts of Metabolic Engineering.
- Different models for cellular reactions.
- Synthesis of primary and secondary metabolite.
- Metabolic pathway synthesis algorithm.
- Metabolic flux analysis and its applications.

Unit – IV Application of Biomolecules

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

Unit V Characterization of Biomolecules

- 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.

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, Mamta Baunthiyal, I. Ravi, Scientific Publication.
3. Biochemistry: Voet and Voet, John Wiley and Sons, Inc. USA.
4. Biophysical Chemistry Vol. I, II & III: Cantor and Schimmel, Freeman.
5. Biochemistry: Zubey, WCB.
6. Biochemistry: Stryer, W. H. Freeman.
7. Understanding Enzymes. Palmer, Horwood

TBT- 512
MOLECULAR GENETICS AND BIOTECHNOLOGY

Unit I

- Relationship between genes and traits.
- Reproduction as the basis of the heredity.
- Overview of Chromosomes, Cell Division, Gametogenesis.
- Mendelian principles of Genetics, Gene Interactions, Quantitative inheritance, inheritability.
- Extranuclear genomes and inheritance, Chromosomal basis of inheritance and linkage.

Unit II

- Construction of genetic and physical maps, Linkage and Crossing over.
- Chromosomal changes and gene mutations.
- Population Genetics, genetic disorders and genetic counseling. Application of genetics in Agriculture and medicine.
- Nucleic acids: DNA as genetic material, RNA – structure, stereochemistry and secondary structure.

Unit III

- Organization of eukaryotic and prokaryotic chromosomes, organelles, viruses and plasmids.
- Gene structure in eukaryotes and prokaryotes, Oncogenes.
- DNA replication – evidences to basic targets, DNA polymerases in prokaryotic RNA polymerases and protein factors. Mechanism of post transcriptional modifications in tRNA, mRNA, rRNA, hnRNA.
- Introduction to siRNA; si RNA technology; Micro RNA Construction of siRNA vectors; Principle and application of gene silencing; Gene knockouts
- Regulation and gene expression of sugar utilization models (Lac operon)

Unit IV

- RNA slicing, regulation and regulatory elements.
- Proteins: structural organization, conformation and biological functions.
- Translation: ribosomes genetic code, steps in protein synthesis and their mechanism, post translational modifications, protein targeting, Growth, development and differentiation.

Unit V

- Antisense and ribozymes, antisense molecules, types & structure of ribozymes, strategies for ribozymes designing, Application of antisense & ribozyme technologies.
- Genome sequencing: genome sizes, organelle genome, strategies for sequencing genome, methods of sequencing, DNA chips, Quantum Dots.
- Molecular biology applications: Cloning, cloning vectors, Type of Cloning vectors , Cloning strategies: Plants, microbes, Animals, Insertion of Foreign DNA into Host Cells: Transformation: Construction of libraries; Isolation of mRNA and total RNA; cDNA and genomic libraries; cDNA and genomic cloning; Expression cloning; Jumping and hopping libraries
- PCR, RT-PCR, Types of PCR- multiplex, nested reverse transcriptase, real time PCR touchdown, PCR hot start ,colony PCR, Primer designing, PCR based mutagenesis, Microarray technique.

Books:

1. Lodish et. al: Molecular Biology (4th edition) Freeman.
2. Alberts et.al. : Molecular Biology of the cell (3rd and 4th editions).
3. G. Karp: Cell and Molecular Biology.
4. Julio E Cells (Ed): Cell biology (Vol I, II and III).
5. Current Protocols in Cellular Biology : John Wiley Publishers (Vol I and II)

*** Practical Exercises: Based on theory papers.**

TBT- 513
MICROBIAL BIOTECHNOLOGY

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.

Books:

1. Alexander, N; Glazer & Hiroshi, Nikaido, W.H. Freeman & Co. 1995.
2. H.J. Rehm and g reed, Biotechnology, VCH Publ, New York, 1996.
3. C. Ratiedge and B. Kristiansen, Basic Biotechnology, Cambridge Univ. Press, UK, 2003.
4. W. Crueger and A. Crueger, Biotechnology; A Textbook of Industrial Microbiology, R. Oldenbourg Publ. FRG, 2000.
5. Rhodes A and D.L. Fletcher, Principals of Industrial Microbiology, Pergamon Press, Oxford, UK 1997.
6. A.M. Martin, Bioconversion of waste materials to industrial products, Blackie Acad & Prof. Publ, London, UK 1998.
7. James E Bailey, David Ollis, Biochemical Engg. Fundamentals, McGraw-Hill.
8. Shular & Kargi, Bioprocess Engg., P.H.L.

IPR, BIOETHICS AND BIOSAFETY

Unit I

- Introduction to Intellectual Property: Types of IP : Patents, trademarks, Copyrights & Related Rights, Industrial, Legislations covering IPRs in India, administration of IPRs in India,
- Design Traditional Knowledge, Geographical Indications, Protection of GMOs IP as a factor in R & D; IPs of relevance to Biotechnology and few Case Studies.
- General Patent Information: US patent laws, patentable subject matter.
- Requirements for patentability: Utility, Novelty, No obviousness, Sufficiency of disclosure.
- Rights of a patent, infringement of a patent, Procedures for obtaining patent protection.
- Types of patent applications: Provisional & regular, parts of patent applications.
- Types of inventions which are not patentable in India.

Unit II

- Patent prosecution, Appeals & interference proceedings, applying for foreign patent protection. Paris convention, Patent Cooperation Treaty (PCT).
- Unique aspects of Biotechnology patent laws & procedures: WTO with reference to biotechnological affairs, TRIPs. 'mail box' provision, Exclusive Marketing Right(EMR),Agreement and Treaties: History of GATT & TRIPS Agreement : Madrid Agreement; Hague Agreement :WIPO Treats : Budapest Treaty : PCT :Indian Patent Act 1970 & recent amendments.
- Technology transfer and other global biotech issues.

Unit III

- Special issues in Biotechnology Patents Disclosure requirements,
- Collaborative research, Competitive research, Indian patents and Foreign patents,
- Objectives of Protection of Plant Varieties and Farmers' Rights'(PPVFR) Act2001,
- Patent Litigation Substantive aspects of patent litigation, Procedural aspects of patent litigation, different Doctrines.
- Recent amendments in Indian patent Laws: Agriculture, Process and Product Patent
- Role of patent in pharmaceutical industry, computer related Innovations,
- Case studies: Rice, Haldi, Neem, etc. and challenges ahead

Unit IV

- Bioethics: Legality, morality and ethics, the principles of bioethics: autonomy, human rights, beneficence, privacy, justice, equity etc.,
- The expanding scope of ethics from biomedical practice to biotechnology.
- Ethical conflicts in biotechnology - interference with nature, fear of unknown, unequal distribution of risks and benefits of biotechnology, Animal bioethics Policy, bioethics vs. business ethics, ethical dimensions of IPR.

Unit V

- Biosafety concepts and issues: Rational vs. subjective perceptions of risks and benefits, relationship between risk, hazard, exposure and safeguards. Biosafety guidelines in India,
- Biotechnology and biosafety concerns at the level of individuals, institutions, society, region, country and the world.
- Issue regarding pathogenicity for biosafety hoods I, II III, radioactive handling methods, disposal and biosafety; Color marking.

Books:

1. The law and strategy of Biotechnological patents by Sibley. Butterworth publications.
2. Intellectual property rights – Ganguli – Tata McGrawhill.
3. Intellectual property right –Wattal –Oxford Publishing House.
4. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2000.
5. Patent Law, Narayana P Edison, Eastern Law House Pvt Ltd.
6. Gearing up for patents-The Indian scenario, Ganguli, P. Universities Press Hyderabad.

TBT- 515

RESEARCH METHODOLOGY & BIOSTATISTICS

Unit I

- Research: Meaning, Purpose, Types of research, significance of research in life sciences.
- Steps in Research: Identification, selection and formulation of research problem- Research questions- Research design, formulation of hypothesis.
- Review of literature.

Unit II

- Data for Research: Primary data-Meaning-Collection methods-Observation, Interview-Questionnaire-Schedule-Pretest-Pilot study, Experimental and case studies- Secondary data- Meaning: Relevance, limitations and cautions.
- Processing Data: Checking- Editing-Coding- transcriptions and Tabulation.
- Data analysis- Meaning and methods- Quantitative and Qualitative analysis.

Unit III

- Structuring the Report: Chapter format- Pagination- Identification.
- Using quotations- Presenting footnotes, abbreviations.
- Presentation of tables and figures- Referencing- Documentation-Use and format of appendices- Indexing.
- Research Report: Types of reports, Contents, Styles of reporting, Steps in drafting reports, Editing the final draft-Evaluating the final draft.

Unit IV

- Statistics in Research: Presentation of Data: Frequency distribution, graphical presentation of data by histogram, frequency curve and cumulative frequency curves, Specific applications of measures of Central tendency.
- Dispersion, Skewness and Kurtosis in research.
- Measures of Relationship: Correlation – Simple, Partial and multiple. Regression- Simple and multiple, applications in research.
- Hypothesis Testing and estimation.

Unit V

- Parametric and Non parametric tests

- Testing for significance of difference between means, proportions, variances and correlation coefficients.
- ANOVA and Chi-Square Tests: One-way and two-way ANOVA, Latin Square tests for association and goodness of fit.

Books:

1. Montgomery, Douglas C. (2007), 5/e, Design and Analysis of Experiments, (Wiley India)
2. Kothari C.K. (2004), 2/e, Research Methodology- Methods and Techniques (New Age International, New Delhi)
3. Krishnaswamy, K.N., Sivakumar, Appa Iyer and Mathiranjana M. (2006), Management Research Methodology; Integration of Principles, Methods and Techniques (Pearson Education, New Delhi)

* **Practical Exercises: Based on theory papers.**

**EVALUATION SCHEME
M. TECH. BIOTECHNOLOGY**

I-YEAR (II-SEMESTER)

S. No.	COURSE CODE	SUBJECT	PERIODS			EVALUATION SCHEME				
						SESSIONAL EXAM			ESE	Subject Total
			L	T	P	CT	TA	Total		
THEORY										
9.	TBT-521	Bioinformatics and System Biology	3	1	0	30	20	50	100	150
10.	TBT-522	Immunotechnology	3	1	0	30	20	50	100	150
11.	TBT-523	Principles and Applications of Genetic Engineering	3	1	0	30	20	50	100	150
12.	TBT-524	Bioprocess Engineering	3	1	0	30	20	50	100	150
13.	EBT-52X	Elective-I	4	0	0	30	20	50	100	150
PRACTICAL										
14.	PBT-521	Bioinformatics Lab	0	0	4	20	30	50	50	100
15.	PBT-522	Immunotechnology Lab	0	0	4	20	30	50	50	100
16.	GPP-521	General Proficiency	-	-	-	-	-	50	-	50
SEMESTER TOTAL			16	4	8	190	160	400	600	1000

Elective-I (EBT-52X, X: 1, 2, 3, 4)

1. EBT-521: Environmental Biotechnology
2. EBT-522: Food Process Biotechnology
3. EBT-523: Advances in Herbal Biotechnology
4. EBT-524: Nano Biotechnology

TBT-521
BIOINFORMATICS AND SYSTEM BIOLOGY

UNIT-1

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.

Books:

1. Attwood, Introduction to Bioinformatics (2001).
2. Baxevanis & Quellerie, 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 & Databases. (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.

IMMUNOTECHNOLOGY

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.

Books:

1. Hay, Practical immunology.
2. Kubey(Freeman), Immunology 5th ed. (2003).
3. Roitt, Essential immunology 10th ed. (2001).
4. Rose, Manual of clinical laboratory Immunology, 6th ed. (ASM 2002).
5. The elements of Immunology by Fahim Halim Khan (Pearson Education).

TBT-523

PRINCIPLES AND APPLICATIONS OF GENETIC ENGINEERING

Unit I

- Introduction and scope of genetic engineering.
- Enzymes used in manipulation of DNA and RNA.
- DNA and RNA markers. Nucleic acid purification, yield analysis.
- Restriction endonucleases, Modification enzymes DNAses, RNAses, alkaline phosphatase, ligases polynucleotide kinases.

Unit II

- Isolation of chromosomal and plasmid DNA, RNA.
- Plasmids, Phage derivatives, cosmid and phagemid vectors, Cloning and expression vectors.
- cDNA synthesis and cloning: mRNA enrichment, reverse transcription, DNA primers, linkers adaptors and their chemical synthesis, Transposons and gene targeting Library construction and screening.
- Restriction mapping of DNA fragments and map construction, DNA labeling, nucleic acid sequencing.
- Gene markers, taxonomic identification, Biodiversity Markers.

Unit III

- Principle and application of PCR, types of PCR.
- rDNA transfer methodologies, Cloning of genes in microbes, plants and animal systems.
- Southern, Northern and Western Blotting and hybridization techniques.
- Radioactive and non-radioactive labeling of probe.

Unit IV

- Expression of cloned genes in prokaryotes, eukaryotes.
- How to study gene regulation? DNA transections, northern blot, primer extension, SI mapping, Rnase protection assay, Reporter assays.
- 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.
- Transgenic and gene knockout technologies: Targeted gene replacement, chromosome engineering.

Unit V

- Site-directed mutagenesis and protein engineering.
- Gene targeting, Human genome project history and scope.
- T-DNA and Transposon tagging: Role of gene tagging in gene analysis, T-DNA and transposon tagging, identification and isolation of genes through T-DNA or transposon.
- Gene therapy: Strategies of gene delivery, gene replacement augmentation, gene correction, gene editing, gene regulation and silencing.

Books:

1. Molecular Cloning: A Laboratory Manual, J. Sambrook, E. F. Fritsch and T. Maniatis. Cold Spring Harbor Laboratory Press, New York, 2000.
2. DNA Cloning: A practical Approach, D. M. Glover and B. D. Hames, IRL Press Oxford, 1995.
3. Molecular and Cellular Methods in Biology and Medicine, P. B. Kaufman, W. Wu. O. 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.

*** Practical Exercises: Based on theory papers.**

TBT – 524
BIOPROCESS ENGINEERING

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, centrifugation, cell disruptions, liquid-liquid extraction and chromatography.
- Membrane separation process, drying and crystallization, effluent treatment: DOC and COD treatments and disposal of effluents.

Unit IV

- Diffusion and Mass Transfer in bioreactors: The oxygen requirement of industrial fermentation. Oxygen transfer phenomenon. Determination of $K_L a$, 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 bioprocessing.
- Utilizing genetic engineered organism in bioreactors.

Books:

1. Biochemical Engineering, Aiba. S., Humphrey, A. E. and Millis, N. F., University of Tokyo Press, Tokyo.
2. Biochemical Reactors, Atkinson. B., Pion Ltd., London.
3. Biochemical Engineering Fundamentals, Baily. J.E. and Ollis. D. F., McGraw-Hill Book Co., New York.
4. Bioprocess Technology: Fundamentals and Applications, KTH, Stockholm.
5. Process Engineering in Biotechnology, Hack son. A. T., Practice Hall, Englewood Cliffs.
6. Bioprocess Engineering: Basic Concepts, Shuler. M.L. and Kargi. F., Prentice Hall, Englewood Cliffs.
7. Principles of Fermentation Technology, Stanbury. P. F. and Whitaker. A., Pergamon Press, Oxford.
8. Bioreaction Engineering Principal, Nielson. J. and Villadsen. J., Plenum Press.
9. Chemical Engineering Problems in Biotechnology, Schuler. M. L. (ed.), AICHE.
10. Biochemical Engineering, Lee J. M., Prentice hall Inc.

EBT-521

ENVIRONMENTAL BIOTECHNOLOGY

Unit I

- Management of waste: Biostimulation, Bioaugmentation, Phytoremediation, vermicomposting
- Waste water types, major contaminants in waste water, physical, chemical and biological methods of waste water treatment
- Aerobic: Activated sludge process including trickling filters, biological filters, rotating biological contractors, Fluidized bed reactors, oxidation ponds.

Unit II

- Anaerobic: contact digesters, packed bed reactors and anaerobic baffled digesters.
- Treatment methods for removal of suspended solids, nutrient, oil and grease, toxic compounds and dissolved inorganic substances from waste water.

Unit III

- Bio-mineralization: Microbial leaching and bio-mining, use of microbes in petroleum extraction.
- Biodegradation of chlorinated hydrocarbons and xenobiotic compounds, pesticides, soil spills, toxic and other industrial effluents.

Unit IV

Biomass as a source of energy, Biocomposting, vermiculture, Biofertilizers, Organic farming, Biofuels, Bioethanol, Biohydrogen, Bioelectricity through microbial fuel cells, Bioremediation its types, bioreactors for bioremediation.

Unit V

- Ozone depletion, UV radiation and their effects, Global warming, Control and remedial measures to prevent CO₂ emissions.
- Green house effect and acid rain – their impact and biotechnological approaches for Management.

Books:

1. Cockerham, Basic Environmental Toxicology (1994).
2. Evans, Environmental Biotechnology (Wiley 2003).
3. Hans-jochim 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.

FOOD PROCESS BIOTECHNOLOGY

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.

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.

EBT-523
ADVANCES IN HERBAL BIOTECHNOLOGY

Unit I

- Introduction to Medicinal Plant of North Himalaya.
- Important Medicinal Plants of Garhwal and Kumaon Range & their medicinal value.
- Role of Biotechnology in Agriculture of Medicinal Plants.
- Importance and relevance of herbal drugs in Indian system of medicine: Ayurveda, Unani, Sidha and Homeopathy.
- Pharmacognosy - Aim and scope; branches of Pharmacognosy and Phytochemicals - Reserve materials; Secretory materials; excretory materials.

Unit II

- Principles and techniques in plant cell and tissue cultures, protoplast fusion, somaclonal variation, genetic engineering and transgenic plants, RFLP mapping and use of biotechnology in crop improvement of medicinal plants.

Unit III

- Gene organization and regulation in plants, genetics and molecular basis of incompatibility in angiosperms. Plant symbiont interaction, nitrogen fixation and disease, stress and salt resistance.
- Gene isolation, cloning and transfer in plants, southern blot hybridization.

Unit IV

- Present and potential application of genetic engineering crop productivity, specific and random primers and probes, QT2s, marker assisted selection for agronomically important characters.
- Transgenic crops and their role in solving the recalcitrant problems in plant breeding.

Unit V

- Introduction to bioprospecting and biomagnifications with reference to uttarakhand.
- Screening of Secondary metabolites in medicinal plants.
- Secondary metabolite production in Medicinal plants through cell suspension culture.
- Isolation and quantification of secondary metabolites (viz., alkaloids, terpenoids, steroids, essential oils, essential perfumes etc.)
- Extraction and purification of secondary metabolites from Medicinal Plants, Physiochemical Characterization and bioassay methods for studying their bioactivity, Assay methods for bioactivity in vitro, Bioactive principle production as medicines. i.e.
- Antimicrobial, antifungal, antiparasitic, anticancer, immunomodulators, antioxidants drugs of plant origin.

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. Chawla, H.S. laboratory manual for Plant Biotechnology.2004.Oxford &IBH Publishing Co. Pvt. Ltd. New Delhi.
8. Chawla, H. S Introduction to Plant Biotechnology.2005. Chawla, H.S.

EBT-524

NANOBIOTECHNOLOGY

Unit I

- Nanotechnology – Definitions, History of Nanotechnology.
- Motivation for Nanotechnology–Materials Devices, Systems, Issues of Miniaturization, Hazards of Nano biotechnology, Biological problems.
- Raw material of Nanotechnology – Nano Particle, Nano Fibers, Nano plates, Graphene based materials.
- Nanodimensional Materials 0D, 1D, 2D structures – Size Effects.
- General Methods available for the Synthesis of Nanostructures – precipitative – reactive – hydrothermal/ solvothermal methods.

Unit II

- Synthesis and characterization of nanoparticles.
- Biological Nanoparticles and their properties.
- Bio-nanomachines and their basics: Negligible gravity and inertia, atomic granularity, thermal motion, water environment and their importance in bionanomachines. The role of proteins- amino acids- nucleic acids- lipids and polysaccharides in modern biomaterials, Overview of natural Bionanomachines: ATP synthetase, Actin and myosin, Opsin.

Unit III

- Nano Devices- Electronics Devices, Photonic Devices, Mechanical Devices, Fluidic Devices, Biomedical Devices, Quantum Devices, Nanoelectronic Devices, Molecular Nanoelectronics.
- 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

- Use of nanoparticles as biosensors: Carbon nanotubes, Gold Nanoparticles, conducting polymers and electrode designing.
- Nanosensors: Temperature Sensors, Smoke Sensors, Pressure Sensor, Night Vision System, Nano tweezers, nano-cutting tools, Nano crystals in Biological Detection.

Unit V

- 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.

Books:

1. Introduction to Nanoscale science and technology. Ed. By Mosimilano Di ventra I Edition, Kluwer Academic – 2004.
2. Nanotechnology, Grejory Timp – I Edition, Springer International – 2005.
3. Nanotechnology. Michel Kohler – I Edition, Wiley VCH-2004.
4. Nanotechnology: Environmental implications & solutions by Lous Theodove & 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.

* Practical Exercises: Based on theory papers.

**EVALUATION SCHEME
M. TECH. BIOTECHNOLOGY**

II-YEAR (III-SEMESTER)

S. No.	COURSE CODE	SUBJECT	PERIODS			EVALUATION SCHEME				
						SESSIONAL EXAM			ESE	Subject Total
			L	T	P	CT	TA	Total		
THEORY										
17.	TBT-631	Enzyme Technology	3	1	0	30	20	50	100	150
18.	EBT-63X	Elective II	3	1	0	30	20	50	100	150
PRACTICAL										
19.	PBT-632	Seminar	0	0	4	0	100	100	0	100
20.	PBT-633	Special Problem	-	-	-	-	100	100	-	100
21.	PBT-634	Dissertation I	-	-	-	50	100	150	300	450
22.	GPP-631	General Proficiency	-	-	-	-	-	50	-	50
SEMESTER TOTAL			6	2	4	110	340	500	500	1000

Elective-II (EBT-63X; X: 1, 2, 3, 4)

- EBT-631: Advances in Animal Biotechnology
- EBT-632: Omics Science and Technology
- EBT-633: Molecular Modeling and Drug Designing
- EBT-634: Advances in Plant Biotechnology

TBT-631
ENZYME TECHNOLOGY

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 K_m and V_{max} 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, polygenic nature of multienzyme systems.
- Enzyme Purification: Isolation and purification of enzymes, criteria of homogeneity of enzymes and characterization of enzymes including determination of their molecular weight.

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.

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 Inhiro Chibata, Halsted Press Book.
7. Enzyme structure and function by S. Blackburn (1976) Marcel Dekker, Inc., NY. Introduction to Protein Structure, C. Branden and J. Tooze, Garland Publishing, New York.

8. Understanding Enzymes: T. Palmer, Horwood

EBT-631

ADVANCES IN ANIMAL BIOTECHNOLOGY

Unit I

- Introduction to Animal Biotechnology, History, Scope and Importance.
- Structure and organization of animal cell.
- Laboratory facilities for animal tissue culture.

Unit II

- Initiation of animal cell cultures, Primary culture, secondary culture, sub-culturing, Cell lines, cloning and selection, Cell culture products, Culture media, Serum free media (advantage & disadvantages).
- Preparation and sterilization of substrate and medium, isolation of explants, sub culturing, evolution Cryo preservation 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.

Unit IV

- *In vitro* fertilization and embryo culture in human and farm animals.
- Requirement and Application of embryo transfer technology.
- Somatic cell fusion .
- Hybridoma technology, monoclonal antibody and its application.

Unit V

- Stem cell culture, their application, cell culture based vaccines, 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 & ethical issues, Tissue and organ transplant, vaccines & peptide vaccines, Engineering human interferons and human growth hormones. Enzymes as therapeutic agents : Use of genetically engineered DNase I.

Books:

1. Culture of Animals Cells 3rd Edition, R Ian Freshney, Wiley-Liss.
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.

* **Practical Exercises: Based on theory papers.**

EBT-632
OMICS SCIENCE AND TECHNOLOGY

Unit I

- Structural organization of genome in Prokaryotes and Eukaryotes.
- DNA microarray: printing of oligonucleotides and PCR products in glass slides, nitrocellulose paper.
- Analysis of microarray data.
- Genome analysis for global patterns of gene expression using fluorescent – labeled cDNA or endo – labeled RNA probes.
- Analysis of single nucleotide polymorphism using DNA chips.
- Molecular markers in genome analysis: RFLP, RAPD and AFLP analysis.

Unit II

- Mapping of genome: Genetic and physical maps, Physical mapping and map – based cloning, choice of mapping population, Simple sequence repeat loci.
- Genome sequencing projects: Microbes, plants and animals, Accessing and retrieving genome project information from web ,Comparative genomics, Identification and classification using molecular markers - 16SrRNA typing/ sequencing, EST's and SNP's.
- Southern and Fluorescence in situ hybridization for genome analysis.

Unit III

- Gene replacement and correction gene therapy, Somatic and germline therapies, various methods for transport of recombinant genes to target cells.
- High throughput screening in genome for drug-discovery –identification of gene targets.
- Pharmacogenetics and drug development.
- Antisense therapies, limitations and application of gene therapies.

Unit IV

- Proteomics: Measurement of concentration, amino acid composition, N-terminal sequencing.
- Introduction. Proteomics and proteome protein databases.
- Tools of proteomics: Analytical protein and peptide separations, 2-D gel electrophoresis, high throughput proteome analysis with 2D – IEF, protein digestion techniques, Mass spectrometry.
- Microscale solution isoelectrofocusing, Peptide fingerprinting, LC/MS-MS for identification of proteins and modified proteins, MALDI-TOF; SAGE and Differential display proteomics, Protein-protein interactions.

Unit V

- Peptide sequencing analysis by tandem mass spectrometry data.
- Mass finger- printing, Protein- Protein interactions.

- Application of genomics and proteomics: mining genome proteomes, protein expression profiles, mapping protein modifications, new directions.
- Protein and peptide microarray based technology; protein in *situ* arrays; Structural Proteomics.
- Metabolomics- Bioinformatics for reconstruction of metabolic networks- Systems biology frameworks for metabolic engineering.

Books:

1. Genomes II, T.A. Brown
2. Biotechnology and Genomics by P.K.Gupta
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 (Fourth Edition), T.A. Brown
6. Genes & Genomes, Maxine Singer and Paul Berg
7. Discovering genomics, Proteins and Bioformatics ECampell AM &Heyer LJ 2nd Edition Benjamin Cummings 2007.
8. Principles of Gene Manipulation and Genomics, Primrose S &Twyman R 7th Edition Blackell 2006,
9. Molecular Biotechnology Glick BR & Pasternak JJ, 3rd Edition, ASM Press,

*** Practical Exercises: Based on theory papers.**

EBT-633
MOLECULAR MODELING AND DRUG DESIGNING

Unit I

- Introduction to Molecular Modeling: Areas of application – Single molecule calculation, assemblies of molecules.
- Reaction of the molecules, Drawbacks of mechanical models as compared to graphical models, Co-ordinate systems two – matrix, potential energy surface.
- Postulates of quantum mechanics, electronic structure calculations, ab initio, semi-empirical and density functional theory calculations, molecular size versus accuracy, Approximate molecular orbital theories.

Unit II

- Molecular Mechanisms, energy calculations, Bond stretch, angle bending, torsional term.
- Electrostatic interaction- Van der waals interactions, Miscellaneous interaction.
- Introduction to Molecular Dynamics using simple models, Dynamics with continuous potentials, Constant temperature and constant dynamics.
- Conformation searching, Systematic search, Applications to protein folding.

Unit III

- Modeling by Homology-the alignment, Construction of frame work, selecting variable regions, side chain placement and refinement.
- Validation of protein models –Ramchandran plot.

Unit IV

- Drug target classification: DNA, RNA, posttranslational processing enzymes, metabolic enzymes involved in nucleic acid synthesis.
- G-protein coupled receptors, small molecule receptors, transporters.
- Target discovery and validation strategies: genomics, natural products, combinatorial chemistry.
- General overview of modeling methodologies, structure, based drug design, protein structure determination and alternative techniques.
- Targeted drug delivery

Unit V

- Structure based design: ‘de novo’ Design methodologies, receptor mapping.
- 3 D-database searching techniques, Design and development of combinatorial libraries for new lead generation: the molecular diversity problem, characterization.
- Chemometrics in drug design.
- QSAR: Statistical techniques behind QSAR, drug metabolism, toxicity and pharmacokinetics.

Books:

1. Principles and applications of modeling by Leach.
2. Molecular Modeling by Hans Pieter, Heltje & Gerd Folkens, VCH.

3. Chemical Applications of Molecular Modeling by Jonathan Goodman.

4. Computational Chemistry by Guy H. Grant & W. Graham Richards, Oxford University Press.

* **Practical Exercises: Based on theory papers.**

EBT-634
ADVANCES IN PLANT BIOTECHNOLOGY

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 nutraceuticals, 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.

Books:

1. S.S. Bhojwani and M.K. Razdan, Plant tissue culture: Elsevier Science, The Netherlands.
2. R.A. Dixon Plant Tissue Culture – A practical Approach, IRL press.
3. Doods. J.H. & Roberts L.W. (1985). Experiments in plant tissue culture Cambridge Univ. Press.
4. Alan Doxal(ed) J. Bryan scritch ed. Cell & Tissue Culture: Lab procedure in

biotechnology.

5. A. Altman Agricultural Biotechnology.
6. Satyanarayana. U, 2008, Biotechnology, Books and Allied (p) Ltd.
7. Reinert J and Bajajy.P.S, 1997, Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture, Narosa Publishing House.
8. Singh, B. D (2004).Biotechnology, Kalyani Publishers, New

**EVALUATION SCHEME
M. TECH. BIOTECHNOLOGY**

II-YEAR (IV-SEMESTER)

S. No.	COURSE CODE	SUBJECT	PERIODS			EVALUATION SCHEME				
						SESSIONAL EXAM			ESE	Subject Total
			L	T	P	CT	TA	Total		
THEORY										
23.	PBT-641	Dissertation II	-	-	-	150	300	450	500	950
24.	GPP-641	General Proficiency	-	-	-	-	-	50	-	50
SEMESTER TOTAL						150	300	500	500	1000