

**EVALUATION SCHEME
B. 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										
1.	TBT-231	Bioanalytical Techniques	3	1	0	30	20	50	100	150
2.	TBT -232	Biochemistry	3	1	0	30	20	50	100	150
3.	TBT-233	CellBiology	3	1	0	30	20	50	100	150
4.	TBT-234	Microbiology	3	1	0	30	20	50	100	150
5.	TBT-235	Biostatistics	3	1	0	30	20	50	100	150
PRACTICAL										
6.	PBT -231	Bioanalytical Lab	0	0	2	10	15	25	25	50
7.	PBT-232	Biochemistry Lab	0	0	2	10	15	25	25	50
8.	PBT -233	Cell Biology Lab	0	0	2	10	15	25	25	50
9.	PBT -234	Microbial Biotechnology Lab	0	0	2	10	15	25	25	50
10.	GPP-231	General Proficiency	-	-	-	-	-	50	0	50
SEMESTER TOTAL			15	5	8	190	160	400	600	1000

TBT-231
BIOANALYTICAL TECHNIQUES

Unit I

Types of analytical methods, Instrument for analysis, Uncertainties in Instrumental measurements-sensitivity and detection limit for, pH meter, dissolved oxygen, agitation, sensors and their operation.

Unit II

Bright field, Dark field, Fluorescent, Phase contrast, Confocal microscopy, SEM and TEM microscopy, Flow cytometry.

Unit III

General principles, Ultra Centrifugation, Velocity sedimentation and Measurements, equilibrium Ultracentrifugation -Density Gradient centrifugation.

Unit IV

General principles- Radiation, energy and atomic structure-types of spectra and their biochemical usefulness-basic laws of light absorption, Electromagnetic radiation and spectrum, Beer-lamberts law and Apparent deviations; UV-VIS spectrophotometer, Atomic absorption and Atomic absorption and emission spectroscopy, Circular Dichroism (CD)-principles, Instrumentation and applications, X-ray diffraction and crystallography: principle, mode of operation and application.

Unit V

Chromatography: HPLC, Gas Chromatography, Ion exchange chromatography, Gel Filtration Chromatography, Affinity Chromatography, Membrane separation, Ultrafiltration, Reverse Osmosis, Analytical techniques for nucleic acid analysis-electrophoresis, blotting techniques, PCR.

Books:

1. Lab Manual of Microbiology, Biochemistry and Mol. Biology-J. Saxena, Mamta Baunthiyal, I. Ravi, Scientific Publication.
2. A biologist Guide to principles and technique of practical biochemistry- By Keith Wilson, Kenneth H. Gouldind 3rd Edition, ELBS Series.
3. Skoog and West, Fundamentals of analytical chemistry, 1982.
4. Vogel, Text Book of quantitative Inorganic analysis, 1990.
5. Ewing, instrumental method of analysis, 1992.
6. Hobert, H. Willard, D. L. Merritt and J. R. J. A. Dean, Instrumental methods of analysis, CBS Publishers and Distributors, 1992.
7. F. Settle. Hand book of Instrumental Techniques for Analytical chemistry, Prentice Hall, 1997.

TBT- 232
BIOCHEMISTRY

Unit I

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

Unit II

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

Unit III

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

Unit IV

Metabolism and Bioenergetics: Basic concepts, Anabolism and catabolism, Carbohydrate Metabolism: Glycolysis, Fate of pyruvate under aerobic and anaerobic conditions, General mechanism of oxidative phosphorylation and ATP synthesis, Pentose phosphate pathway and its significance, Gluconeogenesis pathway, Maintenance of blood glucose level, Beta-oxidation of saturated fatty acids.

Unit V

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

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-233
CELL BIOLOGY

Unit I

Cell: An introduction, classification of organisms by cell structure, cytosol, compartmentalization of Eukaryotic cells, cell fractionation.

Unit II

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

Unit III

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

Unit IV

Cytoskeleton and cell motility: Structure and functions of microtubules, microfilaments, intermediate filaments, Structure and Functions of Cellular Organelles: Endoplasmic reticulum, Golgi complex, lysosome, vacuoles and micro bodies, ribosome, mitochondria, plastids.

Unit V

Nucleus: Structure, cell-cycle (interphase and M phases), regulation of cell cycle, Extra cellular matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extracellular matrix macromolecules, regulation of receptor expression and function.

Books:

1. Molecular Biology of cell, 4thed. Alberts, Bruce (*et.al*) (2002) Garland Science Publishing, New York.
2. Cell Biology-Smith and Wood by Chapman and Hall.
3. Cell Biology: Organelle structure and function, Sadava, DE. (2004) Panima pub., New Delhi.
4. Cell and Molecular Biology, 8thed. Robertis and Robertis (2002) Lippincot Williams and Wilkins Pvt. Ltd.,(International Student Edition) Philadelphia.
5. Molecular Cell Biology 4thed. Lodish, Harvey and Baltimore (2000) W.H. freeman & Co. New York.

TBT-234
MICROBIOLOGY

Unit I

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

Unit II

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

Unit III

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

Unit IV

Nutritional types of bacteria, culture media used, Growth kinetics, a synchronous and diauxic growth, Batch and continuous cultures, Measurement of growth, Factors affecting growth, Control of bacteria- physical and chemical agents, Pure culture isolation, Preservation methods, Sterilizing techniques, Cultivation of aerobic and anaerobic bacteria.

Unit V

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

Books:

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

TBT- 235
BIO-STATISTICS

Unit I

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

Unit II

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

Unit III

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

Unit IV

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

Unit V

Experimental Designs: Principles of experimental designs, completely randomized, Randomized block and Latin square designs, Simple factorial experiments of 2², 2³, 2⁴ and 2³² types, Analysis of variance (ANOVA) and its use in the analysis of RBD.

Books:

1. Statistical methods in biology by Norman T.J. Bailey (3rd Edition), Cambridge University Press (1995).

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

S. No.	COURSE CODE	SUBJECT	PERIODS			EVALUATION SCHEME				
			L	T	P	SESSIONAL EXAM			ESE	Subject Total
						CT	TA	Total		
THEORY										
11.	TBT-241	Genetics	3	1	0	30	20	50	100	150
12.	TBT-242	Immunology	3	1	0	30	20	50	100	150
13.	TBT-243	Molecular Biology	3	1	0	30	20	50	100	150
14.	TBT-244	Programming Language	3	1	0	30	20	50	100	150
15.	TBT-245	Biophysics and Structural Biology	3	1	0	30	20	50	100	150
PRACTICAL										
16.	PBT-241	Genetics Lab	0	0	2	10	15	25	25	50
17.	PBT-242	Immunotechnology Lab	0	0	2	10	15	25	25	50
18.	PBT-243	Molecular Biology Lab	0	0	2	10	15	25	25	50
19.	PBT-244	Programming Language Lab	0	0	2	10	15	25	25	50
20.	GPP-241	General Proficiency	-	-	-	-	-	50	0	50
SEMESTER TOTAL			15	5	8	190	160	400	600	1000

TBT-241 GENETICS

Unit I

Definition-of genetics; Origin of life; spontaneous generation: Performation; Inheritance of acquired characters; Pangenesis; Germplasm theory; Early Ideas on reproduction; Molecular theory on origin of life, Early Hybridization experiments in plants Methods of genetic study, Problems Discovery of cell, Prokaryotes and eukaryotes, cell chemistry, Cell structure.

Unit II

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

Unit III

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

Unit IV

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

Unit V

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

Books:

1. Genetics: Analysis of Genes and Genomes. 5th edition (2001) Hartl, D.L. and Jones, E.W., Jones and Bartlet Publishers, Boston.
2. Genetics. 5th edition (1998) Russell, P.J., Addison Wesley Longman, Inc., California.
3. Genetics: Analysis and Principles. (1999) Brooker, R.J. McGraw Hill, New York.
4. Basic Genetics. (2000) Miglani, G.S., Narosa Publishing House, New Delhi.
5. A text Book of animal Genetics. P. Kanakraj, IBDC, New Delhi.
6. Genetics : B. D. Singh. Kalyani Publishers.
7. Genetics: Monroe W Strickberger. Prentice Hall of India, Pvt Limited.

TBT-242
IMMUNOLOGY

Unit I

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

Unit II

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

Unit III

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

Unit IV

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

Unit V

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

Books:

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

TBT-243
MOLECULAR BIOLOGY

Unit I

Structure and properties of Nucleic acid: Models of DNA structure; RNA structure, physical, chemical and Spectroscopic properties.

Unit II

Chromosome and gene organization: Histones, Non Histones, Nucleosome, chromatin, chromosome structure in prokaryotes and eukaryotes, Structure of genes in prokaryotes and eukaryotes, split genes, overlapping genes, Transposons and Retrotransposon, Gene cluster.

Unit III

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

Unit IV

Transcription, mRNA processing and Translation: Components of transcriptional machinery in prokaryotes and eukaryotes; Initiation, elongation and termination of transcription; Posttranslational modifications of transcript: capping, polyadenylation, splicing, mRNA stability, The genetic code and its properties, second genetic code, Translation process: initiation, elongation and termination of translation in prokaryotes and eukaryotes.

Unit V

Regulation of gene expression: General aspects of regulation of gene expression in prokaryotes and eukaryotes; Operon model, Lac and Trp operon; DNA methylation; Tissue specific and developmental stage specific expression of genes.

Books:

1. Gene IX by B. Lewin.
2. Essential of Molecular Biology, Malacinski and Freifelder. Jones and Bartlet Publisher.
3. Genomes. T.A.Brown, John Wiley and Sons PTE Ltd.
4. Cell and Molecular biology, Concepts and Experiment Gerald Karp, John Wiley and Sons.
5. The Cells- A molecular Approach, G M Cooper, ASM Pr.
6. Advances in biotechnology: Indu Ravi, Mamata Baunthiyal and Jyoti Saxena, Springer.

TBT-244
PROGRAMING LANGUAGE (PERL)

Unit I

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

Unit II

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

Unit III

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

Unit IV

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

Unit V

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

Books:

1. Andreas D. Baxevanis. Bioinformatics: A practical guide to the analysis of genes and proteins.

TBT-245
BIOPHYSICS AND STRUCTURAL BIOLOGY

Unit I

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

Unit II

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

Unit III

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

Unit IV

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

Unit V

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

Books:

1. Biophysics: An introduction Kluwer, Dordrecht.
2. Biophysics: Cantor -I, II & III vol.
3. Biophysics an introduction; Rodney Cotton II.
4. An introduction to Neural computing - Aleksander & Morten.
5. Biological membranes: architecture & function: Hand book of biological physics: Lipowsky & Sackmann all volumes techniques & methods.

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

S. N o.	COURSE CODE	SUBJECT	PERIODS			EVALUATION SCHEME				
			L	T	P	SESSIONAL EXAM			ESE	Subject Total
						CT	TA	Total		
THEORY										
21.	TBT-351	Bioinformatics I	3	1	0	30	20	50	100	150
22.	TBT-352	Bioprocess Engineering	3	1	0	30	20	50	100	150
23.	TBT-353	Cell and Tissue Culture Technology	3	1	0	30	20	50	100	150
24.	TBT-354	Enzymology	3	1	0	30	20	50	100	150
25.	TBT-355	Biodiversity and Conservation	4	0	0	30	20	50	100	150
PRACTICAL										
26.	PBT-351	Bioinformatics Lab	0	0	2	10	15	25	25	50
27.	PBT-352	Bioprocess Engineering Lab	0	0	2	10	15	25	25	50
28.	PBT-353	Cell and Tissue Culture Technology Lab	0	0	2	10	15	25	25	50
29.	PBT-354	Enzymology Lab	0	0	2	10	15	25	25	50
30.	GPP-351	General Proficiency	-	-	-	-	-	50	0	50
SEMESTER TOTAL			16	4	8	190	160	400	600	1000

TBT-351
BIOINFORMATICS-I

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

Protein structure prediction (Chou Fasman method): Secondary and tertiary structures, Homology Modelling, ORF prediction, Gene prediction, Micro array data analysis, Profiles and motifs.

UNIT-V

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

Books:

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

TBT- 352
BIOPROCESS ENGINEERING

Unit I

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

Unit II

Principle of microbial nutrition, formulation of culture media, selective media, factors influencing the choice of various carbon and nitrogen sources, vitamins, minerals, precursors and antifoam agents, fluid vs. solids, fluid static's mass and energy balance in fluid flow, Bernoulli's equation, flow past immersed bodies and drag coefficient, Microbial growth: growth, substrate utilization and production kinetics in Batch, Continuous and Fed-batch processes.

Unit III

Bioreactors: components and control of process parameters, Types of bioreactors: CSTR, Airlift, Fluidized bed, plug flow reactor, Sterilization of process fluids, Downstream processing: Introduction, removal of microbial cells and solid matter: Foam, Precipitation, filtration, centrifugation, Cell disruption, liquid liquid extraction and Chromatography, Integration of reaction and separation.

Unit IV

Diffusion and Mass Transfer: oxygen transfer in bioreactors, Measurement of $K_L a$, factors affecting oxygen transfer, Upscaling in bioprocess, Bioprocess consideration for animal and plant cell culture.

Unit V

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

Books:

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

TBT-353
CELL AND TISSUE CULTURE TECHNOLOGY

Unit I

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

Unit II

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

Unit III

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

Unit IV

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

Unit V

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

Books

1. Plant tissue culture: S.S. Bhojwani and M.K. Razdan, El sevier Science, The Netherlands.
2. Cell culture methods and cell biology procedure: A. Doyle.
3. Plant Tissue Culture – A practical Approach: R.A. Dixon, IRL press.
4. Cell and Tissue Culture: Lab procedures in biotechnology, Alan Doyal (Ed) J.Bryan Griffith (Ed.).
5. Plant biotechnology: HS Chawla.

TBT-354

ENZYMOLOGY

Unit I

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

Unit II

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

Unit III

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

Unit IV

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

Unit V

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

Books:

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

TBT-355
BIODIVERSITY AND CONSERVATION

Unit I

Definition, historical and geographical causes for diversity, Types of Biodiversity, Himalayan Biodiversity with emphasis on Uttarakhand specifically Garhwal and Kumaon region, Hill Agriculture.

Unit II

Germplasm, Gene pool, Genetic Erosion, Germplasm Collection, Germplasm Regeneration, Importance of germplasm in evolution.

Unit III

Components of biodiversity, Plant Genetic Resources, Animal Genetics Resources, Fish Genetic Resources, Molecular taxonomy, species and population biodiversity, quantifying biodiversity.

Unit IV

Maintenance of ecological biodiversity, Biodiversity and centers of origin, Biodiversity hot spots in India with emphasis to Uttarakhand, Loss of biodiversity, Biodiversity conservation of plant, animal, fish, microbial genetic resources, Holistic Concept of Bio conservation, Remote sensing and its applications in Biodiversity conservation.

Unit V

Assessing, analyzing and documenting biodiversity, morphological and molecular characterization of biodiversity, vulnerability and extinction of biodiversity, introduction to biodiversity data base, Endangered animals, endemism and Red Data books, Global biodiversity Information System, Convention on Biological Diversity(CBD).

Books:

1. Micheru, S.1885.Conservation of species and Genetic Resources. An NGO Action Guide.
2. Environment Liaison Center, Nairobi.
3. Sharma P.D.2007.Ecology and Environment. Rastogi Publications. Meerut BSI, 1996.Flora of India. Botanical Survey of India, Kolkata, India.
4. Palni, L.M.S., Miakhuri R.K., Rao K.S.1998.Conservation of the Himalaya Agroecosystem: Issues and Priorities. UNDP, New York, USA.
5. Anon.1996.The Wealth of India. Vol I-XI.CSIR, New Delhi, India.
6. Kandari, O. P. and Gusain,O .P.2001.Garhwal Himalaya-Nature Culture and Society. Transmedia Publication, Srinagar (Garhwal).
7. World Resources Institute Report,1993.
8. Mayers, N 1990.The biodiversity Challenge: expanded 'hot spots'analysis.-Envir 10(4):243-256.
9. Sinclair ARE, Ludwig D, Clark C W.2000.Conservation in the real world. Science 289:1875.
10. Saha T.K. 2007. Ecology and Environmental Biology.Books and Allied (P) Ltd.
11. Krattiger, F.Jeferey, Meneely,A 1996. Wandering Perspective on Biodiversity, Natraj Publishers, Dehradun.

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

S. No.	COURSE CODE	SUBJECT	PERIODS			EVALUATION SCHEME				
			L	T	P	SESSIONAL EXAM			ESE	Subject Total
						CT	TA	Total		
THEORY										
31.	TBT-361	Bioinformatics II	3	1	0	30	20	50	100	150
32.	TBT-362	Bioreactor Engineering	3	1	0	30	20	50	100	150
33.	TBT-363	Environmental Biotechnology	3	1	0	30	20	50	100	150
34.	TBT-364	Regulations in Biotechnology	4	0	0	30	20	50	100	150
35.	TBT-365	Recombinant DNA Technology	3	1	0	30	20	50	100	150
PRACTICAL										
36.	PBT-361	Bioinformatics II Lab	0	0	2	10	15	25	25	50
37.	PBT-362	Bioreactor Engineering Lab	0	0	2	10	15	25	25	50
38.	PBT-363	Environmental and Recombinant DNA Tech Lab	0	0	2	10	15	25	25	50
39.	PBT-366	Seminar	0	0	2	0	50	50	0	50
40.	GPP-361	General Proficiency	-	-	-	-	-	50	0	50
SEMESTER TOTAL			16	4	8	180	195	425	575	1000

TBT-361

BIOINFORMATICS-II

UNIT-I

Homology Identification, Genomic Sequence Annotation, Protein Structure Prediction, Protein Function Prediction, Micro Arrays Gene Expression Characterization, Intermolecular interactions and Biological pathways and Drug Discovery.

Unit II

Molecular phylo-genetics, Terminology, Gene Phylogeny Vs Species Phylogeny, forms of tree representation, phylo-genetic tree construction methods and programs, Distance based methods, Character Based methods, Tree evaluation methods, Bootstrap methods, Phylogenetic analysis softwares.

UNIT-III

Proteomics and protein identification: MS for Protein Analysis, Data preprocessing, identification Characterization programs and tools, RNA prediction.

UNIT-IV

Machine learning: information theoretic decision tree induction, neural networks, the E/M algorithm (including K-means clustering and fitting hidden Markov models), management of large document collections and the biological literature: information retrieval, document clustering, and natural language information extraction.

UNIT-V

Genetic algorithms, simulated annealing, support vector machines, and the relation between statistics and machine learning, Evaluation of prediction methods: parametric tests cross validation and empirical significance testing.

Books:

1. Computational Methods in Biotechnology – Salzberg S. L. et al., Elsevier Science.
2. Statistical Methods in Bioinformatics-Evens & Grants, Springer-Verlag, NY.
3. Computational Molecular Biology- Setubal and Meidanis, PWS publishing Co., 1997.
4. Protein Structure Prediction-A Practical Approach, MJE Sternberg, Oxford University Press.
5. Purifying Protein for Proteomics, Richard J. Simpson, I.K. International Pvt. Ltd.

TBT-362
BIOREACTOR ENGINEERING

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, Sterile and nonsterile operation in bioreactor.

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, chemostat model with cell growth kinetics, Reactors in series with and without recycle.

Unit III

Plug flow reactor: For microbial processes, optimization of reactor systems, Multiphase bioreactors: Packed bed with immobilized enzymes or microbial cells, three phase fluidized bed, trickling bed reactor, Design and Analysis of experimental reactor data, evaluation of rate equations.

Unit IV

Unconventional bioreactors: Gas liquid reactors, hollow fiber reactor, membrane reactor and Perfusion reactor for animal and plant cell culture, High Performance Bio Reactors, Reactors for solid state fermentation.

Unit V

Basic concepts of process control in bioreactor, measurement and control system for various physical, chemical and biological processes in bioreactor.

Books:

1. Principle of Bioprocess engineering: Pauline M. Doran.
2. Biochemical Engineering: J.M. Lee, Prentice Hall.
3. Multiphase Bioreactor Design. Edited by: Joaquim M.S. Cabral, Manuel Mota, Johannes Tramper (2001) CRC Press.
4. Bioreactor & Ex Situ Biological Treatment Technologies – 5. Allerman Bruce, Allerman Bruce C, Leeson Andrea, (1999), Battelle publisher.
5. Bioreaction Engineering: Modeling & Control. Vol. I & II. Schugerl K and Bellgardt K.H, (2000), Springer Verlag pub.

TBT- 363

ENVIRONMENTAL BIOTECHNOLOGY

Unit I

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

Unit II

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

Unit III

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

Unit IV

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

Unit V

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

Books:

1. Environmental Biotechnology by Alan Scragg (1999); Longman.
2. An Introduction to Environmental Biotechnology by Milton Wainwright (1999): Kluwer Academic Press.
3. Advances in biotechnology: Indu Ravi, Mamta Baunthiyal and Jyoti Saxena, Springer.
4. Environmental biotechnology: Bhattacharya and Banerjee, oxford.

TBT- 364
REGULATIONS IN BIOTECHNOLOGY

Unit I

IPR definition and types, history & legislations covering IPRs in India, Patents: Introduction to patent law and conditions for patentability; Procedure for obtaining patents; Rights of a patentee; Patent infringements; grounds for opposition of patent, Biotechnology patents and patents on computer programs; Patents from an international perspective.

Unit II

Copyright: Registration procedure and copyright authorities; requirements for filing the copyright application in India, Assignment and transfer of copyright, Copyright infringement and exceptions to infringement; Rome Convention, Software copyright; Treaties associated with copyright protection on Internet, major provisions in the amended Copyright Act, 1999 with regards to computer programme, **Designs:** Introduction to the law on Industrial Designs; Registration and piracy; International perspective; Registration, commercial exploitation and infringement, essential requirements for the registration of design under the Designs Act, 2000.

Unit III

IPR laws: Rights/protection, infringement or violation, remedies against infringement: civil and criminal; Indian Patent Act 1970 and TRIPS; Major changes in Indian Patent system as post TRIPS effects; 'mail box' provision, Exclusive Marketing Rights (EMRs), Contents of patent specification and the procedure for patents; (a) Obtaining patents; (b) Geographical indication; (c) WTO; Detailed information on patenting biological products; Plant breeders' and farmers' rights; PPVFR Act, 2001, cost of registering a plant variety, Biodiversity; Budapest treaty; Appropriate case studies.

Unit IV

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

Unit V

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

Books:

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

TBT-365

RECOMBINANT DNA TECHNOLOGY

Unit I

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

Unit II

Vectors (Plasmids, Phage, cosmid, phagemid, BAC, YAC, HAC, PAC) and their properties: (Size, cloning capacity, copy Number, amplification, types, host range, selection marker, unique restriction sites) ,Types of vectors: Cloning vector, expression vector, shuttle vector, suicide vector, binary vector, Animal and Plant Viruses and their use as vectors.

Unit III

Basic cloning techniques, Screening and selection of recombinant clones, DNA sequencing methods: Maxam and Gilbert chemical degradation method, Sanger's chain termination method.

Unit IV

Construction of gene libraries (genomic and cDNA libraries), screening of libraries, Gene transfer techniques, PCR, RAPD, RFLP,

Unit V

Applications of recombinant DNA technology: Molecular mechanism of antisense technology, Site directed mutagenesis, Safety regulations in recombinant DNA, rDNA Technology in solving human problems, Ethical issue involving in rDNA Technology.

Books:

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

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

S. No.	COURSE CODE	SUBJECT	PERIODS			EVALUATION SCHEME				
			L	T	P	SESSIONAL EXAM			ESE	Subject Total
						CT	TA	Total		
THEORY										
41.	TBT-471	Plant Biotechnology	3	1	0	30	20	50	100	150
42.	TBT-472	Animal Biotechnology	3	1	0	30	20	50	100	150
43.	TBT-473	Downstream Processing	3	1	0	30	20	50	100	150
44.	EBT-47X	Elective-I	3	1	0	30	20	50	100	150
45.	EBT-47Y	Elective-II	3	1	0	30	20	50	100	150
PRACTICAL										
46.	PBT-471	Plant Biotechnology Lab	0	0	2	10	15	25	25	50
47.	PBT-474	Industrial Training	0	0	2	0	50	50	0	50
48.	PBT-475	Project I	0	0	4	25	25	50	50	100
49.	GPP-471	General Proficiency	-	-	-	-	-	50	0	50
SEMESTER TOTAL			15	5	8	185	190	425	575	1000

Elective-I: (EBT-47X; X=1, 2, 3, 4)

1. EBT-471: Genomics and Proteomics
2. EBT-472: Herbal biotechnology
3. EBT-473: Medical Biotechnology
4. EBT-474: Vaccine Biotechnology

Elective-II: (EBT-47Y; Y= 5, 6, 7, 8)

1. EBT-475: Bioenergetics
2. EBT-476: Biosensors
3. EBT-477: Industrial safety & hazard management
4. EBT-478: Metabolic Engineering

TBT-471
PLANT BIOTECHNOLOGY

Unit I

Introduction Definition, Classical versus modern approach, Production of disease free plants explants, shoot tip culture, shoot tip grafting, Micropropagation: Basic technique, Automation in the area scope as a commercial venture.

Unit II

Tissue Culture as some of Genetic Variability, Somaclonal and gametoclonal variation, Selection, Sources and causes of variation, Application in crop improvement.

Unit III

Protoplast Related Techniques Protoplast, Isolation, Culture and fusion, Selection of hybrid cells, regeneration of hybrid plants, somatic hybridization and cybridization, Applications in crop improvement, Plant as Biofactories Concept, Production of Chemicals, Pigments, Perfume, Flavours, Insecticides, anticancer agents and other important compounds.

Unit IV

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

Unit V

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

Books:

1. Plant Tissue Culture: Applications and Limitations. S.S. Bhojwani (1990), Elsevier, Amsterdam.
2. Micropropagation: P.C. Debergh and R.H. Zimmerman (1990), Kluwer Academic Publ. Dordrecht.
3. Transgenic plants – Lindsey and Jones.
4. Plants, genes & crop improvement, Crispeels – ASPB, 2002.
5. Agricultural Biotechnology – A. Altman.

TBT-472

ANIMAL BIOTECHNOLOGY

Unit I

Introduction to Animal Tissue Culture: History and scope of animal cell and tissue culture, Background, Advantages and disadvantage, Limitations, Application, Culture Environment, Cell Adhesion, Cell Proliferation, Differentiation Structure and organization of animal cell, Laboratory facilities for animal tissue culture, Substrate for animal cell culture technology.

Unit II

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

Unit III

Primary Culture: Isolation of Tissue, Steps involved in primary cell culture, Cell Lines and its type, Nomenclature, Subculture and Propagation, Immortalization of cell lines, Cell line designations (physical and enzymatic), Establishment of cell culture, Routine maintenance, Source of contamination, Type of microbial contamination, Monitoring, Eradication of Contamination, Cross-Contamination, Large scale cell culture in biotechnology, Somatic cell fusion, invitro fertilization and embryo transfer in human , Hybridoma technology.

Unit IV

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

Unit V

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

Books:

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

TBT-473
DOWNSTREAM PROCESSING

Unit I

Introduction: History and scope of downstream processing in biotechnology, problems, requirement of purification, Overview of a bioprocess including upstream and downstream processing, Characteristics of biotechnology products and fermentation broth, classes of bioproducts, physicochemical basis of bioseparation.

Unit II

Cell disintegration, solid liquid separation: Separation of particulate by filtration, centrifugation, settling, sedimentation, decanting and micro filtration, Primary isolation methods including solvent extraction, adsorption, precipitation, ultrafiltration and reverse osmosis.

Unit III

Purification methods: Fractional precipitation, electrophoresis, electro dialysis and various kinds of chromatography.

Unit IV

Final product formulation and finishing operation: crystallization, drying and lyophilization, Emerging separation techniques: Dynamic immobilization, super critical fluid extraction and foam based separation, Separation of heat and photosensitive materials, Product recovery trains - a few examples.

Unit V

Downstream processes and effluent treatment: applications of Unit Operations in Downstream with special reference to membrane separations & extractive fermentation, anaerobic and aerobic treatment of effluents, Typical examples for downstream Processing and effluent disposal in process industries.

Books:

1. Biochemical Engineering fundamentals 2nd ed. Bailey J. E. and Ollis D. F. (1986) MacGraw Hill, New York.
2. Principles of fermentation technology, Stanbury, P. F. and Whitaker, A. (1984), Pergamon press.
3. Unit Operation of Chemical Engineering 6th ed. McCabe, W. L; Smith J. C and Harriott P. (2000). MacGraw Hill, New York.
4. Separation Process Principles, Seader, J.D. & Henley, E.J. (1998) John Wiley & Sons, Oxford.
5. Bioseparation: Downstream Processing for Biotechnology, Belter, P. A.; Cussler E. L. and Hu W. S. (2003) John Wiley & Sons. OXFORD.
6. Bioseparations Science and Engineering, Harrison R.G.; Todd P.; Rudge S.R. and Petrides D.P. (2003), Oxford Press.
7. Wastewater Engineering 4th ed. Metcalf and Eddy (2002). MacGraw Hill, New York.

EBT-471
GENOMICS AND PROTEOMICS

Unit I

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

Unit II

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

Unit III

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

Unit IV

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

Unit V

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

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. Essential of Genomics and Bioinformatics, C.W. Sensen, John Wiley and Sons Inc.
8. Advances in biotechnology: Indu Ravi, Mamta Baunthiyal and Jyoti Saxena, Springer.

EBT-472

HERBAL BIOTECHNOLOGY

Unit-I

History, definition and scope of herbal medicine, the great contributors of Herbal Medicine, Traditional and alternative system of medicine Viz Ayurveda, Unani, Sidha and Homeopathy, Medicinal plants biodiversity of Uttarakhand.

Unit II

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

Unit III

Introduction to parts of medicinal plant cell organelles of plant cell, plant tissue, microscopy of plant, leaves, stems, flowers, fruits, seeds, barks, woods, underground drugs, Herbarium preparation for identification of plants.

Unit IV

Cultivation propagation methods, methods of disease control, types of plant protection measures used in cultivation and part harvest operations of herbal plants, Plant growth regulators used during cultivation of medicinal and aromatic plants, Storage of raw material.

Unit V

Optimum utilization of medicinal and aromatic plant's extract in India, Genetic and plant breeding techniques for improvement of medicinal herbs, modern genetic engineering, recombinant DNA technology and Plant tissue culture techniques for enhancing potential of medicinal plants.

Books:

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

EBT-473
MEDICAL BIOTECHNOLOGY

Unit I

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

Unit II

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

Unit III

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

Unit IV

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

Unit V

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

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.

EBT-474

VACCINE BIOTECHNOLOGY

Unit I

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

Unit II

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

Unit III

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

Unit IV

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

Unit V

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

Books:

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

EBT-475
BIOENERGETICS

Unit I

Energy, energy flow cycle, energy conversion; Structure and properties of ATP; High energy compounds, Thermodynamic considerations, Coupling reactions of ATP and NDP (nucleotide di phosphate); photosynthesis.

Unit II

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

Unit III

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

Unit IV

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

Unit-V

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

Books:

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

EBT-476 BIOSENSORS

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 / amperometric conductometric/resistometric.

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.

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 Clin Biochem* 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, Mamata Baunthiyal and Jyoti Saxena*, Springer.

EBT-477
INDUSTRIAL SAFETY & HAZARD MANAGEMENT

Unit I

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

Unit II

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

Unit III

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

Unit IV

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

Unit V

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

Books:

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

EBT-478
METABOLIC ENGINEERING

Unit I

Basic concepts of Metabolic Engineering- Overview of cellular metabolism, Introduction to various pathways, Primary and Secondary metabolites, Medical and agricultural importance of secondary metabolites.

Unit II

Different models for cellular reactions, Flexible and rigid in metabolic pathways, Metabolic regulation network at enzyme level and whole cell level- Examples of metabolic pathway manipulations.

Unit III

Metabolic pathway synthesis algorithms, Metabolic flux analysis and its applications, Mathematical calculation for the flow of carbon and nitrogen fluxes.

Unit IV

Methods for experimental determination of metabolic fluxes by isotope labelling, Stereochemistry of regulatory molecules, Concepts of regulatory analogs.

Unit V

Genetic regulation of metabolic fluxes, Gene expression in response to environmental stimuli, Regulation of gene expression, Analysis of metabolic control and the structure metabolic networks.

Books:

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

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

S. No.	COURSE CODE	SUBJECT	PERIODS			EVALUATION SCHEME				
						SESSIONAL EXAM			ESE	Subject Total
			L	T	P	CT	TA	Total		
THEORY										
51.	TBT-481	Food Biotechnology	3	1	0	30	20	50	100	150
50.	TBT-482	Biotechnology and Entrepreneurships Development	4	0	0	30	20	50	100	150
52.	EBT48X	Elective-III	3	1	0	30	20	50	100	150
53.	EBT-48Y	Elective-IV	3	1	0	30	20	50	100	150
PRACTICAL										
54.	PBT-481	Food Biotechnology Lab	0	0	2	10	15	25	25	50
55.	PBT-483	Project-II	0	0	6	50	50	100	200	300
56.	GPP-481	General Proficiency	-	-	-	-	-	50	0	50
SEMESTER TOTAL			13	5	8	180	145	375	625	1000

Elective-III

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

1. EBT-481: Biofuel and alcohol technology
2. EBT-482: Biotechnology in Health care
3. EBT-483: Cancer Biology
4. EBT-484: Industrial Biotechnology

Elective-IV

(EBT-48Y; Y=5, 6, 7, 8)

1. EBT-485: Bio-separation Technology
2. EBT-486: Drug Delivery and Drug Designing
3. EBT-487: Enzyme and Protein Engineering
4. EBT-488: Nano-Biotechnology

TBT-481
FOOD BIOTECHNOLOGY

Unit I

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

Unit II

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

Unit III

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

Unit IV

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

Unit V

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

Books:

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

TBT-482
BIOTECHNOLOGY AND ENTREPRENURSHIPS DEVELOPMENT

Unit I

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

Unit II

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

Unit III

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

Unit IV

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

Unit V

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

Books:

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

EBT- 481
BIOFUELS & ALCOHOL TECHNOLOGY

Unit -I

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

Unit II

Introduction to Alcohol Technology, Raw Material of Alcohol Industry, Storage & handling of Raw material in detail, Study of different yeast strains used in alcohol industries, Biochemistry of alcohol production.

Unit III

Study of different alcoholic fermentation techniques, Batch fermentation, Continuous fermentation, Modern techniques of Continuous fermentation, Bio still fermentation, Encillium process Wet milling of grain for alcohol production, Grain dry milling cooking for alcohol production, Use of cellulosic feed stocks for alcohol production.

Unit IV

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

Unit V

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

Text books and References:

1. Chemical Process Principles – Part I, Material and Energy Balances by Olaf A Hougen, Kwenneth M. Watson, and Roland A Ragatz, CBS Publishers and Distributors (1995).
2. Text books of alcohol tech by T. P. Lyons.
3. Product Recovery in Bioprocess Technology ",BIOTOL Series, VCH, 1990.
4. Shreve's Chemical Process Industries, 5th Ed. Reference.
5. Outlines of Chemical Technology by Chmles E.
6. Chemical Process Industries, 4th Ed. By Shieve, McGraw.

EBT-482
BIOTECHNOLOGY IN HEALTH CARE

Unit I

Therapeutic Aspects of Biomacromolecules: Introduction, Endogenous peptides and proteins, Modification of endogenous peptides and proteins, Immune System: Overview, Antibody-mediated response, Cell-mediated immune response, Vaccine, Cancer immunotherapy.

Unit II

Oligonucleotides: Overview, Gene therapy, Antisense therapy, Ribozymes Oligosaccharides: Overview, Oligosaccharide synthesis, Heparin, Glycoproteins, Polysaccharide bacterial vaccines, Approaches to carbohydrate-based cancer vaccines.

Unit III

Therapeutic index, Radiological Agents: Radiosensitizers and Radioprotective agents, Endogenous vasoactive peptides, Cardiovascular Drugs: Myocardial infarction agents, Anticoagulants, Antithrombotics, Hemostatics, Hematopoietic agents.

Unit IV

Chemotherapeutic Agents: Synthetic antibacterial agents, Lactam antibiotics, Anthelmintic agents, Antiamebic agents, Antiviral agents, Endocrine Drugs: Female sex hormones and analogs, Agents affecting the immune Response.

Unit V

Drug Targeting Organ-Specific Strategies: Basic concepts and novel advances, Brain-specific drug targeting strategies, Pulmonary drug delivery, Cell specific drug delivery.

Text books and References:

1. Pharmaceutical Chemistry by Christine M. Bladon. John Wiley & Sons, Ltd.(2002).
2. Burger's Medicinal Chemistry and Drug Discovery (5th edition) by Manfred E. Wolff. A Wiley & Sons, Inc. (2000).
3. Drug Targeting Organ-Specific Strategies by Grietje Molema and Dirk K. F. Meijer, Wiley-VCH. (2002).

EBT-483
CANCER BIOLOGY

Unit I

Fundamentals of Cancer Biology Regulation of Cell cycle, mutations that cause changes in signal molecules, effects on receptor, signal switches, Tumor Suppression tumour suppressor genes, modulation of cell cycle in cancer, Different forms of cancers, Diet and cancer.

Unit II

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

Unit III

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

Unit IV

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

Unit V

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

Books:

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

EBT-484
INDUSTRIAL BIOTECHNOLOGY

Unit I

Introduction, public awareness of genetic engineering, Regulatory requirements-safety of genetically modified food, policy making, area of significant public concern, Process economics-cost estimates, process design, design exercise, capital cost estimates, operating cost estimates.

Unit II

Introduction to bioprocess technology, Isolation, preservation and improvement of industrially important organisms, Substrates for fermentation processes, Medium optimization, Elements of biochemical engineering: Bioreactor design: Laboratory, pilot and large scale reactors, Plug flow reactors, enzyme reactors, Sterilization of media and air Mass transfer of oxygen: Agitation and aeration, Determination of K_La , factors affecting K_La , fluid rheology, Inoculum development, aseptic inoculation and sampling, Bioprocess kinetics: Kinetics of growth and substrate utilization in batch, fed batch and continuous systems.

Unit III

Biological wastewater treatment- Waste water characterization: COD, BOD, Inorganic constituents, solids, biological components, Principles and aim of biological waste water treatment processes, biochemistry and microbiology of inorganic phosphorus and nitrogen removal, Suspended growth technologies: Activated sludge, oxidation ditches, lagoons, waste stabilization ponds, Fixed film technologies: Trickling filters, rotating biological contactors, activated biofilters, fluidized bed etc, Anaerobic waste water treatment systems: RBC, UASB, Anaerobic filters, etc, Environmental problems and treatment of industrial waste waters: distillery, tannery, paper pulp etc, Toxicity testing in waste water treatment plants using microorganisms, Solid waste management: Anaerobic digestion and composting.

Unit IV

Classification: IUB enzyme classification, techniques used in enzyme characterization, Principle and techniques of enzymatic analysis, factors affecting enzyme activity, Extraction and purification of enzyme, separation techniques, test of purity, substrate kinetics: Equilibrium and Steady state kinetics, significance of K_m , A_{max} & K_{cat} , Pre-steady state and Relaxation kinetics, Enzyme activators, co-enzymes and co-factors in enzyme catalysis, Experimental approaches to determine enzyme mechanisms, Enzyme mechanisms: Lysozyme, Chymotrypsin, Carboxypeptidase, Restriction endonuclease, Aspartate transcarbamoylase, Allosteric enzymes and sigmoidal kinetics: Protein ligand binding, Co-operativity, MWC & KNF models, Regulation of enzyme activity, Control of metabolic pathways, Isoenzymes and its physiological significance, Ribozymes and Abzymes Enzyme engineering: Chemical modification of enzymes: methods of modification of primary structure, catalytic and allosteric properties, use of group specific reagents, Enzymes in non conventional media; Enzymes sensors, Enzymes as analytical reagents.

Unit V

General concept of Microbial biotechnology, Fermentation economics, Microbial production of: Antibiotics: Penicillin, streptomycin, Enzymes: proteases, amylases, Organic acids: Citric acid, acetic acid, Vitamins: Vit B12, B2, Amino acids: Glutamic acid, Lysine, Ergot Alkaloids, Industrial Alcohol, Beer, wine, Microbial Exo Polysaccharides, Single cell protein, Single cell oil, Microbial

Flavours, Food and dairy products: Cheese, bread and yogurt., Mushroom cultivation, Plant cell culture, animal cell culture, Steroid transformation, Biopolymers and Bioplastics.

Books:

1. Plant design and economics for chemical engineers, Peters M.S. and Timmerhaus K.D. McGraw-Hill international editions.
2. Economic analysis of fermentation process. Resiman, H. B., C R C press, Boca Raton, Florida.
3. Waste water treatment for pollution control, 2nd edition. Arceivala.
4. Environmental Microbiology. R. M. Maier, I. L. Pepper & G. P. Gerba.
5. Fundamentals of Enzymology: Nicholes C. Price and Lewis Stevens, Oxford Univ. Press.
6. Enzyme Structure and mechanism: Alan Fersht, Reading, USA.
7. Understanding Enzymes: Trevor Palmer.
8. The chemical kinetics of enzyme action: K. J. Laidler and P. S. Bunting, Oxford University Press, London.
9. Enzymes : M. Dixon, E. C. Webb, C.J.R Thorne and K. F. Tipton, Longmans, London.
10. Proteins: Thomas Creighton.
11. Biochemistry: Lubert Stryer.
12. Biotechnology: Rehm and Reid.
13. Comprehensive biotechnology: Murray Moo Young. Microbial Technology: Pepler.

EBT-485
BIOSEPARATION TECHNOLOGY

Unit- I

Introduction, Scope and limitation of bioseparation methods Isolation and Identification of small molecules, Factors affecting isolation and purification methods and GMP Practice in biotechnology.

Unit – II

Identification methods of small molecules: NMR, X ray Crystallography Isolation methods: Bioassay directed separations, Methods of Purification of Novel molecules.

Unit – III

Purification and characterization of Proteins, Introduction, Preparation of sources, Protein properties, Assay, Initial isolation: Concentration, Cell lyses methods (Enzymatic, Mechanical) Refolding.

Unit – IV

High resolution Purification: Column chromatography, HPLC, Various modes of operations in column chromatography: Ion exchange chromatography, Reverse and normal phase chromatography, Affinity chromatography, Size exclusion chromatography.

Unit- V

Characterization: Electrophoresis, Peptide sequencing, Tryptic mapping, Analytical ultracentrifugation, Biosensors, Analysis of glycosylation, Mass spectroscopy, Emerging trends.

Books and References:

1. T.Atkison B.J.Capel and R.F.Sherwood, in “Safety in industrial Microbiology”, ed. C.H.Collins, (1992) Pearson.
2. B.C.Buckland, W.Richmond, P.Dunnill, and M.D.Lilly, in industrial Aspects of Biochemistry. Ed. B.Spencer, North Holland Publishing Company.
3. Asenjo, J.A and J.Hong (1986). Acs Symposium series, vol. 314. Separation, Recovery and Purification in Biotechnology.

EBT-486

DRUG DELIVERY AND DRUG DESIGNING

Unit I

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

Unit II

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

Unit III

Drug Design Strategies: Structure-based design-Docking and de novo methods, Design and development of combinatorial libraries for new lead generation, The molecular diversity problem, drug characterization – principles of equilibria, diffusion and kinetics, pre formulation: pKa, partition coefficient, solubility, dissolution, chemical stability, and permeability, optimization of ADME characteristics, physico-chemical properties calculation, chemometrics in drug design, QSAR: Statistical techniques behind QSAR, classical QSAR, molecular descriptors 3D QSAR and COMFA, drug design to discovery and development, drug metabolism, toxicity and pharmacokinetics, toxicology considerations, problems and drawbacks on drug discovery and development.

Unit IV

Drug toxicity, tolerance, dependence, addiction, Dose Response curves.

Unit V

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

Books:

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

EBT-487
ENZYME & PROTEIN ENGINEERING

Unit –I

Introduction - scope, mechanism, Nomenclature, classification of enzyme, Industrial & analytical application of enzyme, Enzyme kinetics, Single substrate steady state kinetics, Michaelis Menten equation, Inhibitors and activators, Multisubstrate systems, Types of Inhibition- kinetic models, Substrate and Product Inhibition, Allosteric enzyme.

Unit II

Stability of enzymes: Enzyme stabilization by selection and genetic engineering, protein engineering, Reaction environment rebuilding, chemical modification, intra-molecular Crosslinking and immobilization, Molecular structure and function of enzymes, Folding and active site formation in enzymes, Phenomena of allosterism and allosteric kinetics.

Unit III

Various techniques used for the immobilization of enzymes, chemical modifications, Applications of immobilized enzyme in Biotechnology, Kinetics of immobilized enzymes, Kinetics of inhibition of immobilized enzymes, mass transfer effects on enzyme kinetics both in free and immobilized enzyme system, Different types of enzyme reactors, Heterogeneous reaction systems, transient analysis of enzyme reactors, Process design and operational strategies of immobilized enzyme reactors.

Unit IV

Biosynthesis of proteins, Conformation studies of different proteins, Specific conformation of enzymes considering position of active sites, Effect of amino acids on structure of proteins, Energy status of a protein molecule, structure, function relation of enzymes.

Unit V

Physical methods such as X-ray crystallography for determination of protein structure, Site directed mutagenesis for specific protein function, Basic concept for designing a new protein/enzyme molecule, Specific examples of enzyme engineering, Tryesyl t RNA synthetase, Dihydrofolate reductase, Subtilisin.

Books:

1. Enzymes-Dixon and Webb.
 2. Biochemistry- A. L. Lehninger.
 3. Biochemical Engg. Aiba, Humphrey & Miller, Academic Press.
 4. Fermentation & Enzyme Technology- Wangs & Humphrey, Wiley International.
 5. Microbial Enzymes & Bioconversions- A. H. Rose, Academic Press.
 6. Heat & Mass Transfer- Srivastava& Murthy S., TMH publication.
 7. Protein Biotechnology and Biochemistry, 2nd ed.- Walsh, Wiley Publications.
- Novel Therapeutic Proteins-Klaus Dembowsky, Wiley Publications.

EBT-488
NANO-BIOTECHNOLOGY

Unit I

Introduction, Legal considerations for nanotechnology , Environmental risk assessment, Health risk assessment, and Hazards risk assessment, Motivation for Nanotechnology – Materials Devises, Systems, Issues of Miniaturization, Raw material of Nanotechnology – Nano Particle, Nano Fibers, Nano plates, Graphene based materials.

Unit II

Prime Materials: Metals, Iron, Aluminum, Nickel, Silver, Gold, Copper and their oxides, Silica products, Nanomaterial Types: Nanowires, Nanotubes and their synthesis, properties, applications.

Unit III

Fullerenes, quantum dots, Dendrimers, Properties, Method of preparation: Top down, bottom up, plasma forcing, chemical vapor deposition, sol – gel methods.

Unit IV

Self assembled monolayers, Bio molecular motors and their functions, Proteins and applications, Drug delivery systems - Nanofluidic, fluids at micro and nanometer scale, fabrication of nanoporous and nanofluidic devices, applications.

Unit V

Current and future market applications: Semiconductor manufacturing, Advanced composites, Advanced ceramics, Catalytic and photocatalytic applications, Gas sensors & other analytical devices, consumer products, drug delivery mechanisms & medical therapeutics, Micro Electronics applications.

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.