**1st Year B. Tech.**

**Introduction to Biotechnology** **BT-101 E**

**L T P/D** **Theory: 100 marks;** **Sessional: 50 marks;** **Total: 150 marks**

**3 1** **Time: 3 Hrs.**

**Note for paper setter:** Question paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting at least one from each unit.

**UNIT - I**

1. **Introduction to living world:** Concept and definition of Biology; Characteristic features of living organisms; Cell ultra structure and functions of cell organelles like nucleus, mitochondria, chloroplast, ribosomes and endoplasmic reticulum; Difference between prokaryotic and eukaryotic cell; Difference between animal and plant cell.
2. **Introduction to Biomolecules:** Definition, general classification and important functions of carbohydrates, lipids, proteins, nucleic acids (DNA & RNA: Structure and forms), vitamins, hormones and enzymes.

**UNIT-II**

3. **Genetics:** Cell division- Mitosis and its utility to living systems. Meiosis and its genetic significance; **Gene**: Concept, location, definition and structure; Introduction to replication, transcription, translation, Mutations, Genetic disorders; **Human traits**: Genetics of blood groups, diabetes type I & II.
4. **Role of immune system in health and disease**: Brief introduction to morphology and pathogenicity of bacteria, fungi, virus, protozoa beneficial and harmful for human beings.

**UNIT-III**

5. **Concepts of Genetic Engineering:** Definition; Tools used in recombinant DNA Technology: Plasmids as nature's interlopers, restriction enzymes as nature's pinking-shears, Vectors as gene transfer vehicles.
6. **Transgenesis:** Production and significance of transgenic plants and animals; Basic concept of genetically modified organisms.

**UNIT-IV**

7. **Applications of Biotechnology:** Definition of biotechnology; Applications of Biotechnology in Agriculture, Medicine, Environment, Industry and Forensic Science.
8. **Role of biology in allied fields:** Role of biology in Information Technology (Bioinformatics), Nanotechnology (Nanobiotechnology), Micro-electromechanical systems (Bio-MEMS) and Sensors (Biosensors). Ethical issues related to Biotechnology.

**Text/ Reference Books:**


1. Molecular Biology of cell, 4th ed. Alberts, Bruce *et al*. Garland Science Publishing, New York.
2. Microbiology. Pelczar Jr., M.J.; Chan, E.C.S. and Krieg, N.R. Tata McGraw Hill, New Delhi.
3. Lehninger: Principles of Biochemistry, 3rd edition, by David L. Nelson and M.M. Cox. Maxmillan/ Worth publishers.
4. Genetics by Snusted & Simmons.
5. Molecular Biotechnology: *Principles Application of Recombinant DNA.* Glick, B. R. and Pasternak, J. J. ASM press Washington DC.
6. Kuby's Immunology, Goldsby, R A,. Kindt, T.J, Osborne, B.A.(2003) W. H. Freeman and company, New York.
7. Recombinant DNA 2nd Edition. Watson, James D. and Gilman, M. (2001) W.H Freeman and Company, New York.
8. Essentials of Molecular Biology 4th ed, Malacinski, G. M. (2003) Jones & Bartlet Publishers, Boston

# Scheme of Courses/Examination 2nd YEAR B. Tech. (Bio-Technology)

**Bachelor of Technology ( Bio-Technology)**
**Scheme of Courses/examination**
**( 3rd Semester )**

| Sr. No. | Course No. | Subject | Teaching Schedule | | | | Examination Schedule | | | | Duration of Exam. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P/D | TOTAL | Th. | Sess. | P/VV | TOTAL | |
| 1 | BTT-201E | Cell Biology | 3 | 1 | - | 4 | 100 | 50 | - | 150 | 3 |
| 2 | BTT-203E | Microbiology | 3 | 1 | - | 4 | 100 | 50 | | 150 | 3 |
| 3 | BTT-205E | Biochemistry | 4 | 1 | - | 5 | 100 | 50 | | 150 | 3 |
| 4 | BTT-207E | Genetics | 3 | 1 | - | 4 | 100 | 50 | | 150 | 3 |
| 5 | BTT-209E | Organic Chemistry | 3 | 1 | - | 4 | 100 | 50 | | 150 | 3 |
| 6 | BTT-211E | Cell Biology and Genetics Lab | - | - | 4 | 4 | | 50 | 50 | 100 | 4 |
| 7 | BTT-213E | Microbiology Lab | - | - | 3 | 3 | - | 50 | 50 | 100 | 4 |
| 8 | BTT-215E | Biochemistry Lab | - | - | 4 | 4 | - | 50 | 50 | 100 | 4 |
| 9 | BTT-217E | Organic Chemistry Lab | - | - | 3 | 3 | - | 50 | 50 | 100 | 4 |
| | | **TOTAL** | **16** | **5** | **14** | **35** | **500** | **450** | **200** | **1150** | |

**Bachelor of Technology ( Bio-Technology)**
**Scheme of Courses/examination**
**( 4th Semester )**

| Sr.No. | Course No. | Subject | Teaching Schedule | | | | Examination Schedule | | | | Duration of Exam. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P/D | TOTAL | Th. | Sess. | P/VV | TOTAL | |
| 1 | BTT-202E | Molecular Biology | 4 | 1 | - | 5 | 100 | 50 | - | 150 | 3 |
| 2 | BTT-204E | Immunology | 3 | 1 | - | 4 | 100 | 50 | - | 150 | 3 |
| 3 | BTT-206E | Bio-analytical Techniques | 3 | 1 | - | 4 | 100 | 50 | - | 150 | 3 |
| 4 | BTT-208E | Industrial Microbiology & Enzyme Technology | 3 | 1 | - | 4 | 100 | 50 | - | 150 | 3 |
| 5 | BTT-210E | Thermodynamics of Bio-processes | 3 | 1 | - | 4 | 100 | 50 | - | 150 | 3 |
| 6 | BTT-212E | Molecular Biology Lab | - | - | 4 | 4 | - | 50 | 50 | 100 | 4 |
| 7 | BTT-214E | Immunology Lab | - | - | 3 | 3 | - | 50 | 50 | 100 | 4 |
| 8 | BTT-216E | Bio-analytical Tech-niques Lab | - | - | 3 | 3 | - | 50 | 50 | 100 | 4 |
| 9 | BTT-218E | Industrial Microbiology Lab | - | - | 4 | 4 | - | 50 | 50 | 100 | 4 |
| | | **TOTAL** | **16** | **5** | **14** | **35** | **500** | **450** | **200** | **1150** | |

**Students will undergo Practical Training of 6 weeks duration after the 4th Semester.**

## 3rd Semester B. Tech. ( Bio-Technology)

## CELL BIOLOGY

## BTT-201E

| L | T | |
|---|---|---|
| 3 | 1 | **Theory : 100 Marks** |
| | | **Sessional : 50 Marks** |
| | | **Total : 150 Marks** |
| | | **Time : 3Hrs.** |

**Note for paper setter :** Question paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting at least one from each unit.

### Unit I

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

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

### Unit II

**3. Cytoskeleton and cell motility**: Structure and functions of microtubules, microfilaments, intermediate filaments.

**4. Structure and Functions of Cellular Organelles:** Endoplasmic reticulum, golgi complex, lysosomes, vacuoles and microbodies, ribosomes, mitochondria, plastids **.**

### Unit III

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

### Unit IV

**7. Muscle contraction:** Different muscle types in the body, structural proteins of muscles, energetics and regulation of muscle contraction.
**8. Neurons and neurotransmission:** Resting potential, action potential, synaptic transmission, neurotransmitters and receptors, the generation of action potential by sensory stimuli and mechanism of nerve-impulses.

**Text/ References Books:**


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

**3rd Semester B. Tech. ( Bio-Technology)**

**MICROBIOLOGY**

**BTT-203E**

| L | T | | |
|---|---|---|---|
| 3 | 1 | **Theory** | **: 100 Marks** |
| | | **Sessional** | **: 50 Marks** |
| | | **Total** | **: 150 Marks** |
| | | **Time** | **: 3Hrs.** |

**Note for paper setter :** Question paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting at least one from each unit.

**UNIT - I**

**1. History and scope of Microbiology:** Development of Microbiology, various branches of microbiology and applications of microbiology.

**2. Classification of Microorganisms:** Microbial Taxonomy- criteria used including molecular approaches. Microbial phylogeny and current classification of bacteria.

**UNIT - II**

**3. Microbial Diversity:** Prokaryotes and Eukaryotes. Morphology and cell structure of major groups of microorganisms e.g. bacteria. fungi, algae, protozoa and viruses.

**4. Cultivation and Maintenance of Microorganism :** Methods of isolation, purification and preservation. Pure culture technique and sterilization methods.

**5. Principles of microbial nutrition:** Requirement for carbon, nitrogen, sulphur and growth factors. Nutritional categories of microorganisms.

**UNIT - III**

**6. Microbial Growth and Metabolism:** Growth curve (normal and biphasic) and generation time. Measurement of growth. Synchronous, batch and continuous cultures. Metabolic pathways- catabolic, anabolic and amphibolic. Microbial fermentation and its types.

**7. Microbial Reproduction:** Sexual and asexual reproduction (taking an example from each group). Bacterial recombination: transformation, transduction and conjugation. Formation of endospores and mechanism of sporulation.

**UNIT - IV**

**8. Environmental microbiology:** Normal and contaminating microflora of water, soil and air. Methods to study water, soil and air pollution. Major water, air and soil borne microbial diseases.

**9. Food Microbiology:** Definition, important fermented foods and beverages (curd, yogurt, cheese, bread, idli, pickles, beer, wine). Factors effecting spoilage of food and food preservation methods. Methods to study food quality.

**Text/References Books:**


1. Microbiology 5th Edition. Prescott, L.M.; Harley, J.P. and Klein, D.A.(2003) McGraw Hill, USA.
2. Microbiology. Pelczar Jr., M.J.; Chan, E.C.S. and Krieg, N.R. (1993) Tata McGraw Hill, New Delhi.
3. Food Microbiology 2nd ed, Adam, M. R. and Moss (2003) Panima Pub, New Delhi.
4. The Handbook of Water and Wastewater Microbiology Ed. Mara, D. and Horan, N. (2003) Academic Press.
5. Modern Food Microbiology. Jay, J.M. (1996) CBS Publishers and Distributors, New Delhi.
6. Food Microbiology: Fundamentals and Frontiers 2nd Edition. Doyle, M.P. Beuchat; L.R. and Montville, T.J. (2001) ASM Press Washington D.C.

# 3rd Semester B. Tech. ( Bio-Technology)

## BIOCHEMISTRY

### BTT-205E

| L | T | | |
|---|---|---|---|
| 4 | 1 | **Theory** | **: 100 Marks** |
| | | **Sessional** | **: 50 Marks** |
| | | **Total** | **: 150 Marks** |
| | | **Time** | **: 3Hrs.** |

**Note for paper setter :** Question paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting at least one from each unit.

### UNIT - I

1. **Introduction to Biochemistry : A Historical prospective**
2. **Amino acids & Proteins –**Structure and properties of amino acids. Essential and non-essential amino acids. Peptide bonds. Types of proteins and their classification. Forces stabilizing protein structure and shape. Different levels of structural organization of proteins.
3. **Carbohydrates-Structure and functions:** Structures and properties of monosaccharides, oligosaccharides and polysaccharides. Ring structure and mutarotation. Homo- and hetero-polysaccharides. Mucopolysaccharides .

### UNIT - II

4. **Lipids- Structure and functions :** Classification of lipids and their general functions. Essential fatty acids. Hydrolysis of fats, Saponification value, Rancidity of fats, Iodine number and Acid value. Cholesterol- its structure and biological functions.
5. **Nucleic Acids- Structure and functions :** Structure and properties of purine and pyrimidine basis. Nucleosides and nucleotides. Biologically important nucleotides.
6. **Enzymes :** Nomenclature and classification of Enzymes. Basic concept of holoenzymes, apoenzymes, cofactors, coenzymes, prosthetic groups, metalloenzymes, monomeric and oligomeric enzymes. Definitions of enzyme activity, specific activity and enzyme specificity. Role of $NAD^+$/$NADP^+$, FMN/FAD, coenzymes A, thiamine pyrophosphate, pyridoxal phosphate, lipoic acid, biocytin, Vitamin $B_{12}$ coenzymes and tetrahydrofolate in enzyme catalysis.

### UNIT-III

7. **Carbohydrate Metabolism :** Glycolysis. Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance. Gluconeogenesis pathway. Biosynthesis of lactose, sucrose and starch. Glycogenolysis, glycogenesis and control of glycogen metabolism. Maintenance of blood glucose level. Energetics and regulation of carbohydrate metabolism. Glyoxylate cycle. Photosynthesis (light and dark reactions).
8. **Lipid Metabolism :** Beta -oxidation of saturated fatty acids, oxidation of unsaturated and odd carbon fatty acids. Alpha and omega oxidation of fatty acids. Formation and utilization of ketone bodies. Degradation of triacylglycerols by lipases. Biosynthesis, elongation and desaturation of saturated fatty acids. Biosynthesis of triacylglycerols, phospholipids and cholesterol.

### UNIT - IV

9. **Amino Acid Metabolism :** General reactions of amino acids metabolism- transamination, oxidative and non-oxidative deamination and decarboxylation. General pathways of amino acids degradation. Urea cycle and its regulations. Nitrogen cycle.
10. **Nucleic Acid Metabolism :** Catabolism, *de novo*-biosynthesis and regulation of purine and pyrimidine nucleotides. Formation of deoxyribonucleotides.
11. **Mitochondrial oxidative phosphorylation:** Mitochondrial electron transport chain. Hypotheses of mitochondrial oxidative phosphorylation. Inhibitors and uncouplers of oxidative phosphorylation.
12. **Integration of metabolisim** – Basic concepts.

**Text/ References Books:**


1. Biochemistry, 4th edition, by L. Stryer (1995). W.H. Freeman & Co. NY
2. Biochemistry, 4th edition, by G. Zubay (1998). Wm.C. Brown Publishers.
3. Biochemistry, 2nd edition, by Laurence A. Moran, K.G. Scrimgeour, H. R. Horton, R.S. Ochs and J. David Rawn (1994), Neil Patterson Publishers Prentice Hall.
4. Lehninger: Principles of Biochemistry, 3rd edition, by David L. Nelson and M.M. Cox (2000) Maxmillan/ Worth publishers.
5. Biochemistry, 2nd edition, by R.H. Garrett and C.M. Grisham (1999) . Saunders college Publishing, NY. Sons, NY.
6. Fundamentals of Biochemistry by Donald Voet and Judith G Voet (1999) , John Wiley & Sons, NY
7. Harper's Biochemistry, 25th edition, by R.K. Murray, P.A. Hayes, D.K. Granner, P.A. Mayes and V.W. Rodwell (2000). Prentice Hall International.

## 3rd Semester B. Tech (Bio-Technology)

## GENETICS

## BTT-207E

| L | T |
|---|---|
| 3 | 1 |

**Theory : 100 Marks**
**Sessional : 50 Marks**
**Total : 150 Marks**
**Time : 3Hrs.**

**Note for paper setter :** Question paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting at least one from each unit.

### UNIT -I

**1. Principles of Heredity and Variation:** Mendel and his experiments, monohybrid crosses, incomplete dominance and codominance, dihybrid crosses, multiple alleles( blood group systems), epistasis, lethal genes. Probability in prediction and analysis of genetic data. Pedigree analysis.

**2. 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- II

**3. Molecular organization of chromosomes:** Genome size and evolutionary complexity, supercoiling of DNA, structure of bacterial chromosome, structure of eukaryotic chromosome.

**4. Gene Mutation and DNA Repair:** Classification of mutations, spontaneous mutations, induced mutations, application of induced mutations, detection of mutations, site-directed mutagenesis, mechanisms of DNA repair.

### UNIT - III

**5. 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.

**6. Somatic Cell Genetics :** Somatic cell hybrids production and gene mapping.

### UNIT - IV

**7. 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).

**8. Quantitative Genetics :** Quantitative inheritance, causes of variation.

**Text/ Reference 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.

## 3rd Semester B. Tech (Bio-Technology)

## ORGANIC CHEMISTRY

**BTT-209E**

| L | T |
|---|---|
| 3 | 1 |

**Theory : 100 Marks**
**Sessional : 50 Marks**
**Total : 150 Marks**
**Time : 3Hrs.**

**Note for paper setter :** Question paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting at least one from each unit.

### UNIT-I

**1. Types of Organic Reactions:** Substitution, Addition, Elimination reactions. Wanger-Meerwin rearrangement reaction. Rearrangements of electron deficient nitrogen atom(Hoffmann, Beckmann and Curtius). Hyperconjugation : concept and consequences.

**2. IUPAC Nomenclature:** Systematic IUPAC nomenclature of alkenes, alkynes, cycloalkanes, aromatics, bicyclic and polyfunctional organic compounds. Bond line notation .

### UNIT-II

**3. Bonding**: Hydrogen bonding- Nature, type, stability and its importance in organic compounds. pπ - dπ bonding. Ylids (S& P) and Wittig reaction. Biological methylating reagents. Tautomerism-Concept, Ring-chain tautomerism, Ring-chain isomerism, properties and reactions of keto-enol tautomers.

**4. Stereo Chemistry***:* Classification of stereomers, diastereomers, separation of enantiomers, absolute configuration (R & S), projection formulae, stereochemistry of compounds containing two asymmetric C- atoms, stereochemistry of biphenyls. Geometrical isomerism-concept, E & Z nomenclature.

**5. Carbonyl Compounds:** Nature and structure of carbonyl group, Relative reactivities of carbonyl compounds, hydration and addition of alcohal to aldehydes and ketones. Addition of ammonia and ammonia derivatives to aldehydes and ketones. Wolf–Kishner reduction and its mechanism, Aldol condensation, Claisen condensation, Reformatsky and Perkin reactions.

### UNIT -III

**6. Acid Derivatives:** Acid catalyzed and base catalyzed hydrolysis of esters and acid amides, ammonolysis and alcoholysis of esters, acid halides and acid anhydrides**.**

**7. Polymers:** Classification of polymers. Tacticity and functionality, mechanism of chain growth and step growth polymerization, coordination polymerization. Preparation, properties and uses of epoxy resins, PMMA. Natural rubber and its vulcanization. Elastomers-GR-S, GR-M and GR-I.Biomedical polymers-silicone rubber, polyurethanes & their applications

### UNIT-IV

**8. Reducing Agents:** Their applications in Organic Chemistry with special emphasis on $LiAlH_4$, $NaBH_4$, $Pt/Ni/H_2$, $Metal/NH_3$ Solution, Hydroboration and Tri-n-butyl tin hydride.

**9. Peptide Bond Synthesis :** Protection of N-terminal and C-terminal of amino acids, formation of peptide bond, solid phase peptide synthesis.

**10. Epoxides:** properties and nucleophillic ring opening of epoxides. Crown ethers and their uses.

**Text/Reference Books:**


1. Organic Chemistry V1:6th ed. Finar,I L(2003) Pearson Education, Delhi
2. Organic Chemistry V2:5th ed. Finar,I L(2003) Pearson Education, Delhi.
3. Organic Chemistry 6th ed. Morrison,R & Boyd,T.(2003) Pearson Education, Delhi.
4. Organic Chemistry. Paula Yurkanis Bruice ; Pearson Education, Delhi.
5. Principle of Organic Synthesis. Richard Norman and James M Coxon.
6. Organic Chemistry :Reactions and Reagents,37th ed. O.P. Aggarwal (2003) Goel Publishing House, Meerut.
7. Organic Analytical Chemistry. Jagmohan (2003) Narosa pub. New Delhi.

**3rd Semester B. Tech. ( Bio-Technology)**
**CELL BIOLOGY& GENETICS LAB**
**BTT-211E**

| L | T | P | | |
|---|---|---|---|---|
| - | - | 4 | **Practical/V.V** | **: 50 Marks** |
| | | | **Sessional** | **: 50 Marks** |
| | | | **Total** | **: 100 Marks** |
| | | | **Time** | **: 4 Hrs.** |

**Note :** A college must offer 70% of the below listed experiments. The remaining 30% experiments may be modified by college according to facilities available .

1. Microscopy: Structure of Prokaryotic and eukaryotic cell,
   Fixation, Microtomy.
   Histology of various organ systems (Nervous, digestion, reproductive, respiratory and circulatory system).
   Mitochondrial staining and enzyme localization (Histochemistry and immunohistochemistry ).
2. Cell division in onion root tip.
3. Cell division in insect gonads/flower bud.
4. Fluorescence labeling of cellular organelles.
5. Isolation of DNA and study of its denaturation spectrophotometrically and viscometrically.

**Reference books:**

1. Principles and techniques of Practical Biochemistry: K. Wilson and J. Walker (1994), Cambridge University Press, Cambridge.
2. Introductory practical Biochemistry by S.K. Sawhney and Randhir Singh (2000), Narosa Publishing House, New Delhi.
3. An introduction to Practical Biochemistry by David T. Plummer (1988), McGraw- Hill, Book company, UK.

## 3rd Semester B. Tech. ( Bio-Technology)
## MICROBIOLOGY LAB

### BTT-213E

| L | T | P |
|---|---|---|
| - | - | 3 |

| | |
|---|---|
| **Practical/V.V** | **: 50 Marks** |
| **Sessional** | **: 50 Marks** |
| **Total** | **: 100 Marks** |
| **Time** | **: 4 Hrs.** |

**Note :** A college must offer 70% of the below listed experiments. The remaining 30% experiments may be modified by college according to facilities available.

1. **Microscopy**: Use of microscopes, microscopic examination of microorganisms.
2. **Micrometry:** Microscopic measurement of microorganisms.
3. **Staining methods.**
4. **Preparation of culture media.**
5. **Isolation and enumeration of microorganisms from different sources**.
6. **Pure culture techniques**- Streak plate, pour plate, spread plate.
7. **Measurements of growth and study of effect of various factors on growth of microorganisms**-temperature, pH, salt concentration, U.V and R.H.
8. **Biochemical tests useful in bacterial taxonomy**.
9. **Water Microbiology**- BOD, multiple-tube fermentation test.
10. **Milk Microbiology**- SPC, testing the quality of milk.

**References Books:**


1. Experiments in Microbiology, Plant Pathology and Biotechnology. 4th Edition. Aneja, K.R. (2003)New Age International Publishers, New Delhi**.**
2. Microbiology- a laboratory manual. 4th edition. Cappuccino J. and Sheeman N. (2000) Addison Wesley, California.
3. Environmental Microbiology – A Laboratory Manual Pepper. I.L.; Gerba, C.P. and Brendecke, J.W.(1995) Academic Press, New York.

**3rd Semester B. Tech. ( Bio-Technology)**
**BIOCHEMISTRY LAB**
**BTT 215E**

| L | T | P |
|---|---|---|
| - | - | 4 |

**Practical/V.V : 50 Marks**
**Sessional : 50 Marks**
**Total : 100 Marks**
**Time : 4 Hrs.**

**Note :** A college must offer 70%of the below listed experiments. The remaining 30% experiments may be modified by college according to facilities available..

1. Qualitative tests for amino acids, proteins, Lipids and carbohydrates.
2. Quantitative estimation of proteins, Lipids and carbohydrates.
3. Assay of any commonly occurring enzyme.
4. Effect of pH, temperature, enzyme concentration and protein denaturation on an enzyme activity.
5. Determination of $K_m$ and $V_{max}$ of any commonly occurring enzyme.
6. Biochemical analysis of urine and blood(pH, Uric acid, creatinine, proteins and carbohydrates).

**Reference Books:**

**1.** Principles and techniques of Practical Biochemistry: K. Wilson and J. Walker (1994), Cambridge University Press, Cambridge.
**2.** Introductory practical Biochemistry by S.K. Sawhney and Randhir Singh (2000), Narosa Publishing House, New Delhi.
**3.** An introduction to Practical Biochemistry by David T. Plummer (1988), McGraw- Hill, Book company, UK.

**3rd semester B. Tech. ( Bio-Technology)**

# ORGANIC CHEMISTRY LAB

**BTT-217E**

| L | T | P |
|---|---|---|
| - | - | 3 |

**Practical/V.V : 50 Marks**
**Sessional : 50 Marks**
**Total : 100 Marks**
**Time : 4 Hrs.**

**Note :** A college must offer 70% of the below listed experiments. The remaining 30% experiments may be modified by college according to facilities available

**1.** Derivitizations of poly sugars such as agarose with cynogen bromide for binding with proteins.

**2.** Derivitization of polystyrene to generate carboxyl groups.

**3.** Derivitization of polystyrene to generate amino groups.

**4.** Derivitization of polystyrene to generate aldehyde groups.

**5.** Derivitization of polysugars to generate aldehyde group and establish covalent linkage to protein through amino and carboxyl groups.

**6.** Sialinization of solid phases such as polyester, glass, polystyrene to provide amino groups.

**7.** Covalent linkage of proteins to solid phase through carbodiiamide reaction.

**8.** Estimation of reactive groups such as amino, aldehyde and carboxyl group on solid-phase/liquid phase.

**9.** Preparation of aspirin from salicyclic acid.

**10.** Preparation of anthranilic acid from phthalic anhydride.

**11.** Preparation of p-nitro acetanilide from aniline.

**12.** Preparation of phenacetin from p-aminophenol.

**4th Semester B. Tech. (Bio-Technology)**
**MOLECULAR BIOLOGY**
**BTT-202E**

| L | T |
|---|---|
| 4 | 1 |

Theory : 100 Marks
Sessional: 50Marks
Total : 150 Marks
Time : 3Hrs.

**Note for paper setter :** Question paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting at least one from each unit.

## Unit –I

**1. Genes :** DNA/RNA as the genetic material. Double helical structure of DNA. Types of DNA. Super coiling and periodicity of DNA. Linking number of DNA. Nature of multiple alleles, Cis- acting sites and Trans–acting molecules. Euchromatin and heterochromatin. Nucleosomes. Organelle DNA- Mitochondrial and chloroplast DNA.

**2. From Genes to Genomes :** Gene mapping, exons and introns, repetitive and non –repetitive DNA, C-value paradox.

**3. DNA Replication :** Origin of DNA replication. Bacterial and eukaryotic replicons. DNA polymerases. Mechanism and regulation of DNA replication in prokaryotes and eukaryotes.

## UNIT - II

**4. Transcription:** Various RNA species and their properties- tRNA as an adapter and turnover of mRNA.

a) **Transcription in Prokaryotes:** RNA polymerases. Mechanism of transcription- initiation, elongation and termination. Role of sigma factor in transcription.

b) **Transcription in Eukaryotes:** RNA Polymerases. Downstream and upstream promoters. Techniques to define promoters- foot printing experiment. Mechanism of transcription. Interaction of upstream factors with basal apparatus. Role of enhancers. Post-transcriptional modifications of various RNA species. Transcription in mitochondria and chloroplast.

c) **The Operon:** Positive and negative control of transcription, repressor-inducer complex, catabolite repression and attenuation.

d) **Regulation of Transcription:** DNA binding domains- zinc finger motif, helix loop helix, leucine zippers and homeodomains. Demethylation and gene regulation.

## UNIT - III

**5. Genetic Code:** Evidence for triplet code. Properties of genetic code, Wobble hypothesis. Mitochondrial genetic code. Suppressor tRNAs.

**6. Protein Synthesis :** Structure of prokaryotic and eukaryotic ribosomes and their role in protein synthesis. Mechanism of initiation, elongation and termination of protein synthesis. Regulation of translation in prokaryotes and eukaryotes. Post translational modifications of proteins.

**7. Protein folding :** Role of molecular chaperones.

## UNIT - IV

**8. Nuclear Splicing :** Lariat formation, Sn RNAs, cis-splicing and trans-splicing reactions. Catalytic RNA- Ribozymes- Ribonuclease P, small RNAs, group I &II introns.

**9. Transposons:** Transposition by replicative and non replicative mechanisms. Intermediates of transposition. Retroviruses and retroposons.

**10. Cell Cycle and Growth Regulation :** Different stages of cell cycle. Control of cell cycle by phosphorylation and dephosphorylation mechanisms. Basic concept of Apoptosis.

**Text/Reference Books :**


1. Genes VII, Lewin, Benjamin(2002)OUP, Oxford.
2. Genomes,2nd ed, Brown, T. A.(2002) John Wiley and sons ,Oxford
3. Molecular biology of cell 4thed Alberts, Bruce; Watson,J D(2002) Garland Science Publishing, New York.
4. Molecular cell biology 4th ed Lodish, Harvey and. Baltimore,D(2000) W.H. Freeman and Co., New York
5. Cell and Molecular Biology 8th ed, Robertis, EDP De & Robertis, EMF De(2002) lippincott Williams & Wilkins international student edition, Philadelphia.
6. Essentials of Molecular Biology 4th ed, Malacinski, G. M. (2003) Jones & Bartlet Publishers, Boston
7. Cell and Molecular Biology: concepts and experiments 3rd ed Karp, Gerald(2002) John Wiley and sons, New York.
8. The Cell-a molecular approach, 3rd ed Cooper, G M& Hausman, R E(2004) ASM Press, Washington D C

**4th Semester B. Tech. (Bio-Technology)**
**IMMUNOLOGY**
**BTT-204E**

| L | T |
|---|---|
| 3 | 1 |

**Theory : 100 Marks**
**Sessional : 50 Marks**
**Total : 150 Marks**
**Time : 3Hrs.**

**Note for paper setter :** Question paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting at least one from each unit.

**UNIT - I**

1. **Introduction to immune system:** Innate and acquired immunity, cells and organs of immune system- B-Lymphocytes and T-Lymphocytes, primary and secondary lymphoid organs, humoral and cell mediated immune response.

**2. Immune System:** Antigens. Immunoglobulins- structure and function, antigenic determinants(isotype, allotype, idiotype). Monoclonal antibodies. Hybridoma technology. Antibody engineering.

**UNIT - II**

3. **Antibody Diversity**: Organization and expression of immunoglobulin genes, generation of antibody diversity; class switching.

4. **Generation of B-Cell and T-Cell Responses :** Major histocompatibility complex. Antigen processing and presentation.

7. **Cell mediated immunity:** T-cell receptor, T-cell maturation, activation and differentiation.

**UNIT - III**

8. **Immunological techniques :** Immunoprecipitin reactions, agglutination reactions, complement tests, ELISA, RIA, Immunofluorescence.
9. **Immune effector responses :** Cytokines. Complement system.

**UNIT - IV**

8. **Immune System in Health and Disease :** Hypersensitive reactions. Auto immunity and immune response to infectious diseases. Tumor immunity. Immune response to transplants. Vaccines.

**Text / Reference Books:**


1. Kuby's Immunology, 5th ed. Goldsby, R A,. Kindt, T.J, Osborne, B.A.(2003) W. H. Freeman and company, New York.
2. Essential Immunology, 10th ed Roitt, Ivon; Delves, Peter(2001) Blackwell Scientific Publications Oxford.
3. Fundamentals of Immunology: Paul W.E. (Eds.) Raven Press, New York.
4. Immunology by Presscot.

**4th Semester B. Tech. ( Bio-Technology)**
**BIO-ANALYTICAL TECHNIQUES**
**BTT-206E**

| L | T | |
|---|---|---|
| 3 | 1 | **Theory : 100 Marks** |
| | | **Sessional : 50 Marks** |
| | | **Total : 150 Marks** |
| | | **Time : 3Hrs.** |

**Note for paper setter :** Question paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting at least one from each unit.

## UNIT- I

**1. Microscopy:** Light, electron (scanning and transmission), phase contrast, fluorescence microscopy, atomic force microscopy, freeze-fracture techniques, specific staining of organelles or marker enzymes.
**2. Centrifugation:** Techniques and their applications, differential centrifugation, zonal, density gradient and ultracentrifugation techniques.

## UNIT- II

**3. Electrophoresis**: Paper and gel electrophoresis, immunoelectrophoresis, isoelectric focussing, two-dimensional electrophoresis.
**4. Chromatography**: Paper, TLC, adsorption, partition, ion-exchange, reverse phase, gel filtration, affinity, gas chromatography, High Pressure Liquid Chromatography (HPLC).

## UNIT- III

**5. Spectrophotometry:** Basic concepts and brief description of applications of UV/visible, IR, NMR, ESR, fluorescence, Raman. Mass spectroscopy (LC-MS, MALDI-TOF, ES-MS) X-ray diffraction (diffraction by fibrous proteins, globular proteins and molecular crystals), CD and ORD.
**6. Calorimetry:** Differential scanning calorimetry, titration calorimetry.

## UNIT- IV

**7. Radioisotope Techniques**: Nature of radioactivity, properties of $\alpha$, $\beta$ and $\gamma$-rays, measurement of radioactivity, use of radioisotopes in research, *In vivo* and *in vitro* labelling techniques, double labelling, instruments for monitoring radioactivity, quenching, internal standard, channel ratio, external standard ratio, emulsion counting, radioactive decay, autoradiography, radio-immunoassay.

**Text/ References Books:**


1. Biological Spectroscopy: Campbell and Durek
2. Physical Biochemistry, 2nd edition, by D Friefelder (1983). W.H. Freeman & Co., U.S.A.
3. Introduction to instrumental analysis: Robert D. Braun (1987) Mc Graw Hill International Editions, Chemistry Series.
4. Analytical Chemistry for technicians : John Kenkel (1994), Lewis Publishers. Boca Raton.
5. Principles and techniques of Practical Biochemistry: K. Wilson and J. Walker (1994), Cambridge University Press, Cambridge.
6. Biophysical Chemistry: Principles and Techniques, 2nd edition by A. Upadhyay, K. Upadhyay and N. Nath. (1998). Himalaya Publishing House, Delhi.
7. Physical Biochemistry, 2nd edition, by K. E. VanHolde (1985), Prentice Hall Inc, New Jersey.

## 4th Semester B. Tech. ( Bio-Technology)
## INDUSTRIAL MICROBIOLOGY AND ENZYME TECHNOLOGY
## BTT-208E

| L | T |
|---|---|
| 3 | 1 |

**Theory : 100 Marks**
**Sessional : 50 Marks**
**Total : 150 Marks**
**Time : 3Hrs.**

**Note for paper setter :** Question paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting at least one from each unit.

### UNIT- I

**1. Industrial Microbiology:** Introduction, objectives and scope.
**2. Fermentation Technology:** Principle, range and component of fermentation processes. Types of fermentation. Purification of fermentation products.
**3. Industrially important microbes:** Sources, isolation, screening, preservation and maintenance of industrially important microorganisms. Improvement of industrially important microorganisms, selection of mutants, use of rDNA technology.

### UNIT - II

**4. Process technology for the Production of various Products:** Primary metabolites (ethanol, acetone, butanol, citric acid, vinegar). Production of alcoholic beverages (wine and beer).
**5. Microbial production of industrial enzymes**: Cellulase, amylase and protease.
**6. Production of secondary metabolites**: Antibiotics ( *e.g.* penicillin, streptomycin and tetracycline)

### UNIT - III

**7. Vaccines**: Types of vaccines and their production
**8. Biopesticides:** Characteristics of biopesticides. Important biopesticides- Bt-toxin, Kasugamycin, Beauverin, Devine and Collego
**9. Microbial protein:** Quorn
**10. Biofuels and biofertilizers**: Basic concepts and important types of biofuels and biofertilizers

### UNIT - IV

**11. Enzymes:** Nomenclature and Classification of enzymes. Mechanism of enzyme action, acid base catalysis, covalent catalysis proximity and orientation effects. Mechanism of action of selected enzymes- chymotrypsin, lysozyme and ribonuclease. Purification of enzymes. Immobilized enzymes. Stability of enzymes- enzyme stabilization by selection and protein engineering. Application of enzymes in industry, analytical purposes and medical therapy.

**Text/Reference Books:**


1. Industrial Microbiology. Casida Jr., L.E. (1968) New Age International (P)Ltd. New Delhi.
2. Prescott & Dunn's Industrial Microbiology. Ed. E.G. Reed (1987). CBS Publishers, New Delhi.
3. Biotechnology: A Textbook of Industrial Microbiology 2nd Edition. Crueger, W. and Crueger, A. (2000) Panima Publishing Corporation, New Delhi.
4. Enzymes: Biochemistry, Biotechnology, Clinical chemistry. Palmer, T. (2000) Horwood publishing Colphon.
5. Process engineering in biotechnology. Jackson, A.T. (1991) Prentice Hall.
6. Manual of Industrial Microbiology and Biotechnology 2nd Edition. Ed. Arnold L. Demain and Julian E. Davies (1999) ASM Press Washington D.C.

## 4th Semester B. Tech. (Bio-Technology)
## THERMODYNAMICS OF BIO-PROCESSES
## BTT-210E

| L | T |
|---|---|
| 3 | 1 |

**Theory : 75 Marks**
**Sessional : 25 Marks**
**Total : 100 Marks**
**Time : 3Hrs.**

**Note for paper setter :** Question paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting at least one from each unit.

### UNIT- I

1. Concept of Open, Closed, adiabatic and isolated systems with suitable examples. Biological System as open systems. Thermodynamic parameters –internal energy, enthalpy ; their relationship and their significance.
2. First law of thermodynamics. Kirchoff's Equation. Heat capacity at constant pressure and volume and their relationship.
3. Concepts of Free energy and Entropy, Second law of thermodynamics. Entropy changes for reversible and irreversible processes. Entropy of mixing.
4. Third Law of Thermodynamics. Entropy & life processes. Numerical problems on Laws of Thermodynamics.

### UNIT -II

1. Basic concept of Equilibrium and steady state conditions, Free energy and its relation with equilibrium constant, Chemical potential, Gibbs-Duhem equation and their application, Standard biochemical state and standard free energy changes. Thermodynamic basis of Biochemical reactions.
2. Phase Equilibrium and phase rule (thermodynamic derivation), Free energy of transfer between phases.
3. Structural transition in biological macromolecules and molecular processes.
4. Binding – independent and non-cooperative binding, Co-operative binding and its biological significance.

### UNIT -III

1. Biological application of thermodynamics. Concept of coupled reactions and group transfer potentials. Thermodynamic analysis of some important metabolic pathways.
2. Concept of flux and forces. Non-equilibrium thermodynamics and its biological applications.
3. Coupled flows and Onsager's phenomenological co-efficients and reciprocal relations.
4. Membrane-types and transport across biomembranes.

### UNIT- IV

1. Prigogine and Prigogine-Curie law. Thermo analysis of oxidative phosphorylation.
2. Stability of non equilibrium stationary state.
3. Ordering in time and space far from equilibrium.
4. Biological significance of the thermodynamic properties of water.
5. Biochemical oscillations and Biological clocks.

**Text/Reference Books :**


1. Kinetics and Thermodynamics in Biochemistry : Bray & White.
2. Biophysical chemistry Vol. I : Edsall and Wyman
3. Non Equilibrium Thermodynamics in Biophysics : Katchalasky and Curran; Harvard University Press.
4. Physical Biochemistry : Van Holde
5. Physical basis of biochemistry : Foundations of molecular biophysics, Bergethan, P.R.(2000) NY, Springer.
6. Introduction to the thermodynamics of biological processes : Jou D.& Llebot J.E., Prentice Hall, New Jersey.
7. Biochemical Engineering Fundamentals, 2nd ed., Bailey J.E.; Ollis D.F.(1986) MGH, New York.

**4th Semester B. Tech. (Bio-Technology)**
**MOLECULAR BIOLOGY LAB**
**BTT-212E**

| L | T | P |
|---|---|---|
| - | - | 4 |

**Practical/V.V : 50Marks**
**Sessional : 50Marks**
**Total : 100Marks**
**Time : 4Hrs**

**Note :** A college must offer 70% of the below listed experiments. The remaining 30% experiments may be modified by college according to facilities available .

1. Isolation of genomic DNA from eukaryotic cells.
2. Isolation of RNA from eukaryotic cells.
3. Isolation of proteins from eukaryotic cells.
4. Isolation of genomic DNA from prokaryotic cells.
5. Isolation of plasmid DNA from Prokaryotic cells.
6. Restriction mapping of plasmid DNA:This experiment involves single and double digestion of the plasmid with restriction enzymes.
7. Gel electrophoretic separation of DNA and molecular wt. determination.
8. Gel electrophoretic separation of RNA.
9. Gel electrophoretic separation of proteins.
10. Transblot analysis of DNA.
11. Gel Extraction of DNA.
12. PCR amplification of DNA: Visualization by gel electrophoresis.

**Reference Book:**

Molecular Cloning – A laboratory manual: 3rd Edition Vol. 1-3. Sambrook J and Russell D.W. (2001). Cold Spring Harbor laboratory Press, New York.

**4th Semester B. Tech. (Bio-Technology)**
**IMMUNOLOGY LAB**
**BTT-214E**

| L | T | P |
|---|---|---|
| - | - | 3 |

**Practical/V.V : 50Marks**
**Sessional : 50Marks**
**Total : 100Marks**
**Time : 4Hrs**

**Note :** A college must offer 70%of the below listed experiments. The remaining 30% experiments may be modified by college according to facilities available.

1. Routine techniques in handling laboratory animals: feeding, cleaning and bleeding procedure for mice and rabbit.
2. Surgical removal of lymphatic organs from mice.
3. Preparation and administration of antigens, following immunization protocols.
4. To bleed rabbits for the generation of antibodies.
5. Purification of immunoglobulins.
6. Isolation and purification of lymphocytes from mouse.
7. Immunoprecipitation techniques
8. Agglutination techniques
9. ELISA

**Reference Books:**

1. Using Antibodies: A Laboratory Manual. Harlow & Lane(1998) Cold Spring Harbor Lab Press.
2. Immunological Techniques Made Easy. Cochet, et al.(1998)Wiley Publishers,Canada.

**4th Semester B. Tech. ( Bio-Technology)**
**BIO-ANALYTICAL TECHNIQUES LAB**
**BTT-216E**

| L | T | P | |
|---|---|---|---|
| - | - | 3 | **Practical/V.V : 50Marks** |
| | | | **Sessional : 50Marks** |
| | | | **Total : 100Marks** |
| | | | **Time : 4Hrs** |

**Note :** A college must offer 70%of the below listed experiments. The remaining 30% experiments may be modified by college according to facilities available.

1. Verification of Beer-Lambert's law.
2. Separation of amino acids/ sugars by paper chromatography.
3. Extraction of lipids from tissues and their separation using TLC.
4. Partial purification of an enzyme by ammonium sulphate fractionation, Ion exchange and gel filtration chromatography of proteins.
5. Determination of molecular weight of an enzyme by gel filtration.
6. Separation of proteins by SDS-PAGE.
7. Cell fractionation

**Reference Books:**

1. Principles and techniques of Practical Biochemistry: K. Wilson and J. Walker (1994), Cambridge University Press, Cambridge.
2. Introductory practical Biochemistry by S.K. Sawhney and Randhir Singh (2000), Narosa Publishing House, New Delhi.
3. An introduction to Practical Biochemistry by David T. Plummer (1988), McGraw- Hill, Book company, UK.

**4th Semester B. Tech. ( Bio-Technology)**
**INDUSTRIAL MICROBIOLOGY LAB**
**BTT-218E**

| L | T | P | |
|---|---|---|---|
| - | - | 4 | **Practical/V.V : 50Marks** |
| | | | **Sessional : 50Marks** |
| | | | **Total : 100Marks** |
| | | | **Time : 4Hrs** |

**Note :** A college must offer 70%of the below listed experiments. The remaining 30% experiments may be modified by college according to facilities available.

1. Sterilization Techniques ( Media, air & water)
2. Construction of various fermenters (bioreactors)
3. Identification of industrially important microorganisms e.g. molds, yeasts and bacteria.
4. Production of various products in the lab. Alcohol, wine, cellulase, protease and bread.
5. Isolation of antibiotic producing microorganisms from the soil.
6. Penicillin production and testing of antimicrobial activity.
7. Isolation of streptomycin-resistant mutants by replica plating method.
8. Isolation of UV induced auxotrophic mutants.
9. Testing of microbial enzyme activity in the lab.
10. Determination of cell growth.

**Reference Books:**


1. **Experiments in Microbiology, Plant Pathology and Biotechnology.** Aneja, K.R.(2003) 4th Edition. New Age International Publishers, New Delhi.
2. **Fermentations & Biochemical Hand Book: Principles, Process Design and Equipment**. HC Vogel and Noyes(1983).
3. **Microbiology Labortary Manual.** Cappuccino, J. and Sheeman, N.(2000), 4th Edition, Addison Wesley, California.
4. **Manual of Industrial Microbiology and Biotechnology.** 2nd Edition. Ed. Arnold L. Demain and Julian E. Davies (1999) ASM Press Washington D.C.

# Scheme of Courses/Examination 3rd YEAR B. Tech. (Bio-Technology)

**Bachelor of Technology (Bio-Technology)**

**Scheme of Courses/Examination**

**(5th Semester)**

| Sr. No. | Course No. | Subject | Teaching Schedule L | T | P/D | TOTAL | Examination Schedule Th. | Sess. | P/VV | TOTAL | Duration of Exam. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | BTT-301 E | Recombinant DNA Technology | 3 | 1 | - | 4 | 100 | 50 | - | 150 | 3 |
| 2 | BTT-303 E | Bioreactor Analysis and Design | 3 | 1 | - | 4 | 100 | 50 | - | 150 | 3 |
| 3 | BTT-305 E | Bioprocess Engineering | 3 | 1 | - | 4 | 100 | 50 | - | 150 | 3 |
| 4 | BTT-307 E | Downstream Processing | 3 | 1 | - | 4 | 100 | 50 | - | 150 | 3 |
| 5 | BTT-309 E | Diagnostic Techniques | 3 | 1 | - | 4 | 100 | 50 | - | 150 | 3 |
| 6 | BTT-311 E | Biostatistics & Computer Applications | 3 | 1 | - | 4 | 100 | 50 | - | 150 | 3 |
| 7 | BTT-313 E | r-DNA Tech. Lab | - | - | 4 | 4 | - | 50 | 50 | 100 | 4 |
| 8 | BTT-315 E | Fermentation & Downstream Processing Lab | - | - | 4 | 4 | - | 50 | 50 | 100 | 4 |
| 9 | BTT-317 E | Diagnostic techniques & Biostatistical analysis Lab | - | - | 3 | 3 | - | 50 | 50 | 100 | 4 |
| 10 | BTT-319 E | Training Evaluation (viva-voce) | - | - | - | - | - | 50 | - | 50 | 4 |
| | | TOTAL | 18 | 6 | 11 | 35 | 600 | 500 | 150 | 1250 | |

**Bachelor of Technology (Bio-Technology.)**

**Scheme of Courses/Examination**

**(6th Semester)**

| Sr. No. | Course No. | Subject | Teaching Schedule L | T | P/D | TOTAL | Examination Schedule Th. | Sess. | P/VV | TOTAL | Duration of Exam. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | BTT-302 E | Microbial Biotechnology | 3 | 1 | - | 4 | 100 | 50 | - | 150 | 3 |
| 2 | BTT-304 E | Plant Biotechnology | 3 | 1 | - | 4 | 100 | 50 | - | 150 | 3 |
| 3 | BTT-306 E | Animal & Aquaculture Biotechnology | 3 | 1 | - | 4 | 100 | 50 | - | 150 | 3 |
| 4 | BTT-308 E | Healthcare Biotechnology | 3 | 1 | - | 4 | 100 | 50 | - | 150 | 3 |
| 5 | BTT-310 E | Environmental Biotechnology | 3 | 1 | - | 4 | 100 | 50 | - | 150 | 3 |
| 6 | BTT-312 E | Food Biotechnology | 3 | 1 | - | 4 | 100 | 50 | - | 150 | 3 |
| 7 | BTT-314 E | Cell & Tissue Culture Lab | - | - | 4 | 4 | - | 50 | 50 | 100 | 4 |
| 8 | BTT-316 E | Healthcare Biotechnology Lab | - | - | 4 | 4 | - | 50 | 50 | 100 | 4 |
| 9 | BTT-318 E | Microbial, Food & Environmental Biotechnology Lab | - | - | 3 | 3 | - | 50 | 50 | 100 | 4 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | BTT-320 E | Seminar | - | - | - | - | - | 50 | - | 50 | |
| | | TOTAL | 18 | 6 | 11 | 35 | 600 | 500 | 150 | 1250 | |

**Students will undergo Practical Training of 6 weeks duration after 6th semester.**

# 5th Semester B. Tech. (Bio - Technology)
# Recombinant DNA Technology

***BTT-301 E***

**L T**
**3 1**

**Theory : 100 Marks**
**Sessional : 50 Marks**
**Total : 150 Marks**
**Time : 3Hrs.**

**Note for paper setter :** Question paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting at least one from each unit.

## *UNIT I*

**Tools of Recombinant DNA:** Restriction endonucleases. Plasmid cloning vectors. Creating and screening a gene library. Genetic transformation of prokaryotes. Cloning DNA sequences encoding eukaryotic proteins. Vectors for cloning large pieces of DNA.

**Chemical synthesis, sequencing and amplification of DNA:** Chemical synthesis of DNA. DNA sequencing techniques. PCR. Analysis of eukaryotic DNA by chromosomal walking. Southern and Northern Blotting. *In situ* hybridization.

## *UNIT II*

**Isolation of cloned genes:** Basic strategies for cloning. Developing improved bacteria and vectors. Probes to locate clones and related genes. Identification and isolation of tissue specific cDNA. Procedures to analyze proteins encoded by cDNA clones.

**DNA markers**: RFLP. RAPD and DNA fingerprinting.

## *UNIT III*

**Study of gene functions:** Directed mutagenesis. Identification of mutant clones. Use of PCR to construct genes encoding chimeric proteins.
Mutagenesis-gateway to gene function and protein engineering.

## *UNIT IV*

**Application of recombinant DNA in biotechnology:**

**In medicine and Industry:** *Production of small biomolecules: vitamin-C, amino acids and indigo. Production of insulin, human growth hormone and its variants. Hepatitis-B virus vaccine. Tailoring antibodies for specific applications. Biopolymers production.*

## Marshalling recombinant DNA to fight AIDS.

**Text/ References Books:**


1. Recombinant DNA 2nd Edition. Watson, James D. and Gilman, M. (2001) W.H Freeman and Company, New York.
2. Molecular Biotechnology: *Principles Application of Recombinant DNA* 2nd Edition. Glick, B. R. and Pasternak, J. J. (1998) ASM press Washington DC.
3. Genetic Engineering. Ahluwalia, K. B. (2002) New Age International (P) Ltd.
4. An Introduction to Genetic Engineering 2nd edition Desmond Nicholl S.T. (2002) Cambridge University Press.
5. Genetic Engineering: *An introduction to Gene analysis and exploitation in eukaryotes*. Kingsman and Kingsman (1998) Blackwell Scientific Publication, Oxford.
6. DNA cloning: *A Practical Approach.* Glover and Hames (2001) Oxford Univ. Press.


### 5th Semester B. Tech. (Bio - Technology)

Bioreactor Analysis and Design

***BTT-303 E***

| L | T | |
|---|---|---|
| **3** | **1** | Theory : 100 Marks<br>**Sessional : 50 Marks**<br>**Total : 150 Marks**<br>**Time : 3Hrs.** |

**Note for paper setter :** Question paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting at least one from each unit.

***UNIT – I***

Types of reactor: **Batch, plug flow reactor (PFR), continuous stirred tank reactor (CSTR), Fluidized bed reactor, bubble column, air lift fermenter, mechanical design of bioreactors.**

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.

***UNIT - II***

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 above reactor systems.

***UNIT – III***

Unconventional bioreactors: **Gas liquid reactors, hollow fiber reactor, membrane reactor and perfusion reactor for animal and plant cell culture**

UNIT – IV

**High Performance Bio Reactors:** Sterile and non sterile operations - Reactors in series with and without recycle. Design of Reactors.

**Reactors for Solid state fermentation.**

**Text/Reference Books:**


1. Landfill Bioreactor Design & Operation. Reinhart Debra R, Townsend Timothy G. and Townsend Tim(1997) Lewis Publishers, Inc.
2. Multiphase Bioreactor Design. Edited by: Joaquim M.S. Cabral, Manuel Mota, Johannes Tramper (2001) CRC Press.
3. Bioreactor & Ex Situ Biological Treatment Technologies – 5. Allerman Bruce, Allerman Bruce C, Leeson Andrea, (1999). Battelle publisher.
4. Bioreaction Engineering: Modeling & Control. vol. I&II. Schugerl K, and Bellgardt K.H, (2000), Springer Verlag pub.


## 5th Semester B. Tech. (Bio - Technology)
## Bioprocess Engineering
**BTT-305 E**

| L | T | |
|---|---|---|
| 3 | 1 | **Theory : 100 Marks** |
| | | **Sessional : 50 Marks** |
| | | **Total : 150 Marks** |
| | | **Time : 3Hrs.** |

**Note for paper setter :** Question paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting at least one from each unit.

**UNIT– I**

**Introduction:** History and role of bioprocess engineering in biotechnology industries, Concept of unit operation unit processes.

**Introduction to Engineering calculation:** Variables, their dimensions and units, dimensionally homogeneous and non- homogeneous equations, standard conditions and ideal gases, physical and chemical property data, basics of materials and energy balances in a macroscopic view point.

## *UNIT – II*

**Fluid Mechanics:** 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, importance of pH, fluid vs. solids, fluid static's mass and energy balance in fluid flow, Bernoulli's equation, flow past immersed bodies and drag coefficient.
Sterilization of process fluids, recovering and purifying products, integration of reaction and separation.

## *UNIT – III*

**Heat Transfer:** Principles and design of processes involving biochemical reactions, including aerobic and anaerobic respiration and fermentation (involving pure and mixed cultures). Shake flask, batch and continuous operations. Solid state fermentations. Primary and secondary metabolites Energy balances and biochemical kinetics.

### *UNIT – IV*

**Diffusion and Mass Transfer:** Biological production consideration, large scale production, Enzyme kinetics, cell growth, energetics and mass transfer. Production of Penicillin, Streptomycin, Tetracycline and other Antibiotics.

**Text/ Reference Books:**


1. Bioprocess Engineering, Second Edition, Shuler ML; Kargi F (2002), Prentice Hall PTR, New Jersey.
2. Bioprocessing. Ward, O.P. (1991), New York,
3. Bioseparations- Downstream processing for biotechnology. Reinhold Van Nostrand, Belter P.A, Cussler E.L, Hu W.S. (1988), John Wiley and Sons. New York.
4. Process Engineering in Biotechnology. Jackson , A.T.
5. Bioprocess Engineering: Systems, equipments and facilities. Eds. Lydersen K.B., D'elia, N.A. and Nelson K.L. (1994), John Wiley & Sons, New York.
6. Chemical Engineering, Vol.1-6, Coulson J.M, and Richardson J.F (1999), Pergamon Press.


## 5th Semester B. Tech. (Bio - Technology)
## Downstream Processing

***BTT-307 E***

| **L** | **T** | **Theory : 100 Marks** |
|---|---|---|
| **3** | **1** | **Sessional : 50 Marks** |
| | | Total : 150 Marks |
| | | **Time : 3Hrs.** |

**Note for paper setter :** Question paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting at least one from each unit.

### *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, classes of bioproducts, physicochemical basis of bioseparation

***UNIT – II***

**Cell disintegration:** Separation of particulate by filtration, centrifugation, settling, sedimentation, decanting and micro filtration. Primary isolation methods including solvent extraction, sorption, precipitation, ultra filtration and reverse osmosis. Application of above methods in purification of antibiotics and enzymes.

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

chromatography.

***UNIT – III***

**Emerging separation techniques:** Dynamic immobilization, reverse osmosis, super critical fluid extraction evaporation, super liquid extraction and foam based separation.

Separation of intracellular, extracellular, heat and photosensitive materials. Product recovery trains - a few examples.

***UNIT – IV***

**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.

**Text/Reference Books:**


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


## 5th Semester B. Tech. (Bio - Technology)

## *Diagnostic Techniques*

***BTT-309 E***

| L | T |
|---|---|
| 3 | 1 |

**Theory : 100 Marks**
**Sessional : 50 Marks**
**Total : 150 Marks**
**Time : 3Hrs.**

**Note for paper setter :** Question paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting at least one from each unit.

**UNIT – I**

**Introduction:** Comparison of the methods to diagnose bacterial & parasitic infections.

**Immunological Diagnostic Procedures:**

**Basic considerations:** Antigen-antibody reactions. Signal amplification systems. Isolation and characterization of antibodies. Immuno assay systems. Assay development, evaluation and validation. Reagent formulation and their shelf life evaluation.

## *UNIT-II*

**Enzyme-Linked Immunosorbent Assay (ELISA) system**: Applications in clinical diagnosis and prognosis of various diseases. Membrane based Rapid Immuno assays.

**Monoclonal Antibodies**: Formation and selection of hybrid cells. Screening for specific antibodies producing hybrid cell lines.

**Applications of Monoclonal Antibodies:** Detection of polypeptide hormones, Tumor markers and cytokines. Diagnosis of infectious diseases and drug monitoring. Detection of miscellaneous targets e.g. Thyroxin, Vit. $B_{12}$, Ferritin degradation products, Tau protein etc.

## *UNIT-III*

**DNA Diagnostics- a)Nucleic acid hybridization assay systems:** Basic considerations. Production of various types of hybridization probes. Diagnosis of *Plasmodium faliciparum, Mycobactrium tuberculosus, Trypanosoma cruzi* and Sickle cell by DNA hybridization. **b) Non - radioactive Hybridization procedures:** Use of chromogenic or chemiluminesent substrates and specific enzymes for detecting signal amplification. **DNA Fingerprinting and RAPD as Diagnostic tools.**

**UNIT-IV**

**Molecular diagnosis of Genetic Diseases:** Significance In prenatal diagnosis, diagnosis before onset of symptoms and identification of carriers of hereditary disorders.

**PCR/OLA Procedures:** Diagnosis of hereditary diseases caused by mutations not affecting restriction endonuclease sites.

**Genotyping with fluorescence labeled PCR primers**. **Detection of mutations at different sites within one gene.**

**Text/Reference Books:**


1. Essentials of Diagnostic Microbiology. Shimeld Lissa Anne and Rodgers Anne T. (1998) Delmes Learning.
2. Recombinant DNA. 2nd Edition. Watson James D and Gilman Michael, (2001). W.H Freeman and Company, New York.
3. Molecular Biotechnology: *Principles Application of Recombinant DNA.* 2nd Edition. Glick Bernard R. and Pasternak Jack J. (1998), ASM press Washington DC.
4. Methodology of immunochemical and immuno-logical research Kwapinski G and Bannatyne (1973) Willey inter science.
5. A handbook of practical and clinical immunology. Talwar G.P, and Gupta S.K (1992), Vikas Publishing house Pvt. Ltd. New Delhi.


# 5th Semester B. Tech. (Bio - Technology)

# BIOSTATISTICS & COMPUTER APPLICATIONS

**BTT-311 E**

| L | T | | |
|---|---|---|---|
| 3 | 1 | **Theory** | **: 100 Marks** |
| | | **Sessional** | **: 50 Marks** |
| | | **Total** | **: 150 Marks** |
| | | **Time** | **: 3Hrs.** |

**Note for paper setter :** Question paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting at least one from each unit.

## *UNIT I*

**Introduction**: Define statistics. Difference between statistics and mathematics.
**Data in Biology**: Samples and variables, frequency distributions, graphics.
**Basic quantitative methods**.

## *UNIT II*

**Estimation, hypothesis testing**: Confidence limits for means, t-distribution, chi-square distribution. Confidence limits for variances, t-tests, comparisons of variances.
**Comparisons of several means**: Analysis of Variance, A priori tests, A posteriori tests.
Two and three-way analyses of variance.

## *UNIT III*

**Regression and correlation:** Multiple Regression. Analysis of covariance. Nonlinear fitting. Correlation.
**Nonparametric statistics:** Goodness of Fit tests. Resampling methods.

## *UNIT IV*

**Probability distributions:** Normal, Binomial and Poisson.
**Applications of Statistical Methods in Biotechnology.**
**Role of Computer in solving biostatistical problems**.

**Text/Reference Books:**

1. Introduction to Biostatistics. Glover T. and Mitchell K. (2002). MacGraw Hill, New York.
2. Fundamentals of Biostatistics. Rosner Bernard. (1999), Duxbury Press.

## 5th Semester, B. Tech. (Bio - Technology)
## Recombinant DNA Technology Lab.

BTT- 313 E

| L | T | P |
|---|---|---|
| - | - | 4 |

Practical/V.V.: 50 Marks
Sessional: 50 Marks
Total : 100 Marks
Time : 4 Hrs

**Note**: A college should offer 70% of the below listed experiments. The remaining 30% experiments may be modified by college according to facilities available

### *Cloning and expression of proteins:*

1. Target selection
2. Strategy for cloning
3. Primer design
4. Isolation of genomic DNA
5. Gene amplification by PCR
6. Ligation of desired gene sequence
7. Transformation
8. Verification of cloned DNA
9. Induction of expression
10. Verification of protein expression

### References:

Molecular Cloning – A laboratory manual 3rd Edition Vol. 1-3. Sambrook J. and Russell D.W. (2001) Cold Spring Harbor laboratory Press, New York.

## 5th Semester, B. Tech. (Bio - Technology)
## Fermentation and Downstream Processing Lab.
## BTT- 315 E

| L | T | P |
|---|---|---|
| - | - | 4 |

Practical/V.V.: 50 Marks
Sessional: 50 Marks
Total : 100 Marks
Time : 4 Hrs

**Note**: A college should offer 70% of the below listed experiments. The remaining 30% experiments may be modified by college according to facilities available

1. **Study of factors affecting bioprocesses in submerged fermenters** (pH, $O_2$, Temperature, Foam, Ingredients)
2. **Purify a bacterial protein**
   a) Cell lysis by different methods.
   b) Cell debris separation by different methods.
   c) Column purification
      I Separation by Molecular weight.
      II By charge.
      III By metal affinity.
      IV By Receptor-Ligand affinity.
   d) Dialysis
   e) Ultrafiltration
   f) Crystallization
   g) Lyophilization
3. **Purification of O-PS**
   a) Cell lysis
   b) Harvesting of cells
   c) Purification of O-PS antigens

**References:**


1. Bioprocess Engineering: Systems, Equipment & facilities. Eds. Lydersen K.B.; D'elia N.A. and Nelson K.L. (1994) John Wiley & Sons, New York.
2. Bioprocess Technology-Kinetics and Reactors. Moser Anton (1988) *Springer-Verlag*, New York.
3. Bioseparations- Downstream processing for biotechnology. Belter, P.A.; Cussler, E.L. and Hu, W.S. (1988) John Wiley and Sons, New York.

4. Encyclopedia of Bioprocess Technology: Fermentation, biocatalysis and bioseparation Vol. 1-5. Eds. Flickinger M.C. and Drew S.W. (1999) John Wiley & Sons, New York.
5. **Physical Biochemistry: Principles & applications. Sheehan David (2000) John Wiley & Sons Ltd. New York.**
6. **Physical Biochemistry 2nd Edition. Friefelder D. (1983) W.H. Freeman & Co., USA.**
7. **Biophysical Chemistry: Principles & techniques 2nd Edition. Upadhyay, A.; Upadhyay, K. and Nath, N. (2002) Himalaya Publication House, New Delhi.**

## 5th Semester, B. Tech. (Bio - Technology)
## Diagnostic Techniques & Biostatistical Analysis Lab.
## BTT – 317 E

| L | T | P |
|---|---|---|
| - | - | 3 |

Practical/V.V.: 50 Marks
Sessional: 50 Marks
Total : 100 Marks
Time : 4 Hrs

**Note**: A college should offer 70% of the below listed experiments. The remaining 30% experiments may be modified by college according to facilities available

1. **Enzyme Immunoassay in Plates**
    a. Conjugation of antibody with enzyme.
    b. OD vs. Antigen conc. plot and its analysis.
2. **Point of Care –Membrane based assays**
    a. Dipstick based assays
    b. Immunofiltration
    c. Lateral flow assays
3. **Immunoblots**
4. **DNA primer probe selection**
    a. Design probes for diseases
    b. Use commercially available probes to amplify gene fragment in clinical samples.
    c. Detection of amplified product
        1. Gel electrophoresis
        2. Dot Blots
        3. Hybrid capture assays
5. **Genotyping HLA**
6. **DNA Fingerprinting**
7. **Biostatistical analysis of scientific data**

## References:

1. Antibodies: A laboratory manual. Harlow, Ed and Lane, David (1988) Cold Spring Harbor laboratory Press.

2. Introduction to Biostatistics: Glover, T. and Mitchell, K. (2002) McGraw-Hill, New York.

## 6th Semester B. Tech. (Bio - Technology)
## Microbial Biotechnology
**BTT-302 E**

| L | T | |
|---|---|---|
| 3 | 1 | **Theory : 100 Marks** |
| | | **Sessional : 50 Marks** |
| | | **Total : 150 Marks** |
| | | **Time : 3Hrs.** |

**Note for paper setter :** Question paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting at least one from each unit.

***UNIT I***

***Biocatalysis and Enzyme Biotechnology:*** *Biomimetic catalysis, industrial biocatalysis, extremozymes, modular enzymes, cofactor dependent enzymes and cofactor regeneration*

***Isolation and Purification of Enzymes:*** *Extraction of enzymes, preparation of crude enzymes, purification of enzymes, processing of enzymes.*

.

***UNIT II***

**Protein and Enzyme Engineering:** Basic principles, methods and their applications

***Metabolic Engineering:*** *Heterologous gene expression: complementing, transferring and engineering of metabolic pathways, redirecting metabolite flow.*

***UNIT III***

**Single Cell protein (SCP):** Introduction, conventional protein sources, substrates, microorganisms used, SCP from $CO_2$ , carbohydrates, hydrocarbons.
**Molecular Breeding of Biosynthetic pathways:** Metabolic engineering for carotenoid, polyhydroxy-alkanoates and alkaloid biosynthesis.
Pathway analysis, metabolic control analysis, metabolomics.

***UNIT IV***

***Microbes and Microbial Genomics for Industry:*** *Microbial transformations: transformation of steroids, sorbitol, sorbose and antibiotics. Microbes in paper industry, biohydrometallurgy and biomineralization.*

**Microbial Genomics in industry:** Analysis of microbial genomes and their use for designing vaccines and drugs.

**Text/Reference Books:**


1) Biotechnology and Genomics. Gupta, P.K. (2004) Rastogi Publications, Meerut, India.
2) Biotechnological Innovations in Chemical Synthesis. M.C.E Van Dam–mieras et al. (1997). Butterworth-Heinemann, Oxford.
3) Biotechnology. Smith, J. E. (1996) Cambridge University Press.
4) Methods for General and Molecular Bacteriology 2nd Edition. Gerhardt, P.; Murray, R.G.; Wood, W.A. & Kreig, N.R. (1994) Blackwell Publishing.

# 6th Semester B. Tech. (Bio - Technology)
## Plant Biotechnology
### BTT-304 E

| L | T | | |
|---|---|---|---|
| 3 | 1 | **Theory** | **: 100 Marks** |
| | | **Sessional** | **: 50 Marks** |
| | | Total | : 150 Marks |
| | | **Time** | **: 3Hrs.** |

**Note for paper setter :** Question paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The Students will be required to attempt five questions, selecting at least one from each unit.

### UNIT I

Introduction: **Cryo and organogenic differentiation. Types of culture: seed, embryo, callus, organ, cell and protoplast culture.**

***Micropropagation:*** *Axillary bud proliferation, meristem and shoot tip culture, bud culture, organogenesis, embryogenesis, advantages and disadvantages of micropropagation.*

***In Vitro haploid production:*** *Androgenic methods: anther culture, microspore culture, factors effecting and organogenesis. Significance and use of haploids, ploidy level and chromosome doubling, diplodization. Gynogenic haploids: factors effecting gynogenesis, chromosome elimination techniques for production of haploids in cereals.*

### UNIT II

***Protoplast Isolation and fusion:*** *Methods of protoplast isolation, protoplast development, somatic hybridization, identification and selection of hybrid cells, cybrids, potential of somatic hybridization, limitations.*

***Somaclonal variation:*** *Nomenclature, methods, applications basis and disadvantages. Gametoclonal variation.*

**Plant Growth Promoting bacteria:** Nitrogen fixation, nitrogenase, hydrogenase, nodulation, Growth promotion by free-living bacteria.

### *UNIT III*

***Plant Molecular Biology:*** *Plant gene structure as a discontinuous gene, control sequences*

**Gene transfer in plants:** Transient and stable gene expression, marker genes, selectable markers, chimeric gene vectors.

**Gene transfer methods:** Agrobacterium, viruses and transposable elements. Vectorless or direct DNA transfer: Physical, chemical and imbibation methods of gene transfer.

***UNIT IV***

***Transgenics in crop improvement:*** *Resistance to biotic stresses-insect, virus and disease (fungus and bacterium) resistance, herbicide resistance. Development of stress and senescence-tolerance – Oxidative stress, salt stress and fruit ripening. Transgenics for : improved quality, longer life, flower color and shapes, for male sterility, for terminator seed. Trangenic plants as bioreactors: production of carbohydrates, lipids, vitamins and minerals, biodegradable plastics, peptides, proteins and edible vaccines. Commercial transgenic crops.*

**Text/Reference Books:**


1. Introduction to Plant Biotechnology 2nd edition. Chawla, H.S. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi
2. Molecular Biotechnology: Principles and Applications of recombinant DNA. Glick, B. R. and Pasternak J. J. (1998) ASM press, Washington DC.
3. Plant Tissue culture: Theory and Practice. Bhojwani, S.S. and. Razdan M.K (1996) Elsevier Science, Netherlands.
4. Improving Plant draught, salt and freezing tolerance by gene transfer of a single stress-inducible transcription factor. (1999) *Nature Biotechnology 17(3):* 287-291. Kasuga, M., Q. Liu, et al.
5. Heterologous expression of *Arabidopsis* phytochrome B in transgenic potato influences photosynthetic performance and tuber development.(1999) *Physiology***120,** (1):73-81. Thiele, A., Herold M., et al.
6. Building better trees with antisense. (1999) *Nature Biotechnology* **17** (8): 750-751. Sederoff R.
7. Exploiting the full potential of disease-resistance genes for agricultural use. Curr Opin Biotechnol. 2000 Apr;11(2):120-5. Review Rommens CM, Kishiore GM
8. Directed molecular evolution in plant improvement. Curr Opin Plant Biol. 2001 Apr;4(2):152-6. Review. Lassner M, Bedbrook J.

## 6th Semester B. Tech. (Bio -Technology)

Animal & Aquaculture Biotechnology

***BTT-306 E***

| L | T |
|---|---|
| 3 | 1 |

**Theory : 100 Marks**
**Sessional : 50 Marks**
**Total : 150 Marks**
**Time : 3Hrs.**

**Note for paper setter :** Question paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting at least one from each unit.

## *UNIT I*

**Introduction:** History and scope of animal biotechnology.
Basic techniques of animal cell culture & their applications. Balanced salt solutions and simple growth media. Serum quality and cell culture.
**Preservation and maintenance of animal cell lines:** Cryopreservation and transport of animal germplasm (i.e. semen, ovum and embryos).

### *UNIT II*

**Transgenic animals Methodology**: Retroviral vector method, DNA microinjection method and engineered embryonic stem cell method. Cloning by nuclear transfer. Yeast artificial chromosome transgenesis.

*In Vitro* fertilization and embryo transfer.

### *UNIT III*

**Molecular biological techniques for rapid diagnosis of genetic diseases and gene therapy. Molecular maps of animal genomes. Chemical carcinogenesis. Transfection. Oncogenes and antioncogenes.**

**Gene cloning techniques for mammalian cells, establishment of immortal cell lines, cloning in mammalian cells, expression of mammalian genes in prokaryotic and eukaryotic systems. Extinction of gene function by antisense RNA and DNA.**

### *UNIT IV*

**Aquaculture**: Introduction. Water resources and types of culture systems (Fish & Prawn). General principles of nutrition. Engineering considerations. Food, bait and ornamental marine species. Transgenic fishes.

**Text/Reference Books:**

1. Principles of Gene Manipulations 6th edition. Primrose S.B.; Twyman, R. and Old B. (2002) Blackwell Publishing.

2. Molecular Biotechnology: Principles and Applications of recombinant DNA 2nd Edition. Glick, B. R. and Pasternak J. J. (1998) ASM press, Washington DC.
3. Animal Cell biotechnology : Spier, R.E. and Griffiths J.B. (1988) Academic press.
4. Living resources for Biotechnology, Animal cells. Doyle, A.; Hay, R. and Kirsop, B.E. (1990) Cambridge University Press, Cambridge.
5. Animal Biotechnology. Murray Moo-Young (1989) Pergamon Press, Oxford.
6. Introduction of Aquaculture Landau Matthew (1991) John Wiley & Sons, New York.

## 6th Semester B. Tech. (Bio - Technology)

## *Healthcare Biotechnology*

***BTT-308 E***

| L | T |
|---|---|
| 3 | 1 |

**Theory : 100 Marks**
**Sessional : 50 Marks**
**Total : 150 Marks**
**Time : 3Hrs.**

**Note for paper setter :** Question paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting at least one from each unit.

## *UNIT I*

***Simple proteins and therapeutic agents:*** *Proteins as therapeutic agents, choice of expression systems and optimizing gene expression. Applications, delivery and targeting of therapeutic proteins. Engineering human interferons and human growth hormones. Regulatory aspects of therapeutic proteins.*

***Enzymes as therapeutic agents:*** *Use of genetically engineered DNase I and alginate lyase for treatment of Cystic Fibrosis*

### UNIT II

**Monoclonal Antibodies as Therapeutic agents:** Production of Monoclonal antibodies. Human Monoclonal antibodies – its scope and limitations. Hybrid human - mouse antibodies.
Production of antibodies in *E. coli.*
Approaches for producing HIV therapeutic agents.

**UNIT III**

**Human Diseases and Vaccines:** Viral & bacterial diseases. Diseases caused by protozoan and parasitic worms (helminths). Emerging infectious diseases. Active and passive immunity. Autoimmunity. Rational of immunization. Diseases controllable by vaccination.

**Vaccines:** Designing vaccines adjuvants. Whole organisms vaccines-attenuated viruses and bacteria. Inactivation of pathogenic organisms by heat and chemical treatment.

***UNIT IV***

**Purified macromolecules as vaccines:** Bacterial polysaccharides , proteins and toxins as vaccines.
**Recombinant vaccines**: Subunit, attenuated and vector vaccines.
**Multivalent vaccines**
**Vaccine development against AIDS.**
**Commercial and regulatory aspects of vaccine production and its distribution.**

**Text/Reference Books:**


1. Molecular Biotechnology: Principles Application of Recombinant DNA. 2nd Edition Glick, B. R. and Pasternak, J. J. (1998) ASM press, Washington DC.
2. Basic Biotechnology 2nd Ed. Ratledge, C. and Kristiansen, B. (2001) Cambridge University press.
3. New generation vaccines. Woodsaw, G.C. & Leine, H. M. Marcel Dekker Inc., New York.
4. Recombinant DNA vaccines: Rationale & Strategies. Richard, E.I. (1992) Marcel Dekker Inc., New York.


## 6th Semester B. Tech. (Bio - Technology)
## Environmental Biotechnology
## BTT-310 E

| L | T | |
|---|---|---|
| 3 | 1 | **Theory : 100 Marks** |
| | | **Sessional : 50 Marks** |
| | | **Total : 150 Marks** |
| | | **Time : 3Hrs.** |

**Note for paper setter :** Question paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting at least one from each unit.

***UNIT I***

**Role of Biotechnology in Environment Protection:** Introduction and current status of biotechnology in environment protection and its future prospects.

**Microbiology and Biochemistry of Waste Water Treatment:** Biological treatment, impact of pollutatnts on biotreatment, cell physiology and important microorganisms, plasmid borne metabolic activities, bioaugmentation, packaged microorganisms, use of genetically engineered organisms.

***UNIT II***

**Bioreactors for Waste Water Treatment:** Biological processes for industrial effluent treatment, aerobic biological treatment, anaerobic biological treatment, periodic biological reactors, membrane bioreactors, use of immobilized enzymes and microbial cells.

**Removal of Specific Pollutants:** Sources of heavy metal pollution, microbial systems for heavy metal accumulation, biosorption, bioleaching.

### *UNIT III*

**Bioremediation :** What is bioremediation? Types of bioremediation, bioaugmentation for bioremediation. Bioreactors for remediation processes. Applications of bioremediation.

**Biotechnology for Hazardous Waste Management :** Xenobiotic compounds, recalcitrance, hazardous wastes, biodegradation of xenobiotics, biological detoxification, biotechnological management of hazardous wastes.

### *UNIT IV*

**Restoration of degraded lands :** Restoration through microorganisms, Casuarinas for tropical reforestation on adverse sites, development of stress tolerant plants, use of mycorrhizae in reforestation. Organic farming and use of microbes for improving soil fertility, reforestation of lands contaminated with heavy metals.

**Biotechnology for Waste Treatment of Food and Allied Industries:** Biological treatment, methods, SCP and biomass from waste and distillery industry.

**Novel Methods for Pollution Control :** Vermitechnology, waste water treatment using aquatic plants, root zone treatment. Aiming for biodegradable and ecofriendly products.

**Text/Reference Books:**


1. Waste water Engineering Treatment, Disposal and Reuse. Metcalf & Eddy (1991) McGraw Hill.
2. Environmental Biotechnology. Forster, C. F and. Wase, D. A. J. (1987) Ellis Horwood Halsted Press.
3. New Processes of Waste water treatment and recovery. G. Mattock E.D. (1978) Ellis Horwood.
4. Biochemical Engineering Fundamentals 2nd ed. Bailey, J. E. and Ollis, D. F. (1986) MacGraw Hill. New York.
5. Environmental Biotechnology. Jogdand, S.N. (1995) Himalaya Publishing House, New Delhi.
6. Comprehensive Biotechnology (Vol. 1-4) Young Murray Moo (Ed.) (1985) Elsever Sciences.
7. Standard Method for Examination of water & waste water 14th Ed. (1985) American Public Health Ass.


## 6th Semester B. Tech. (Bio - Technology)
## Food Biotechnology
## BTT-312 E

| L | T |
|---|---|
| 3 | 1 |

**Theory : 100 Marks**
**Sessional : 50 Marks**
**Total : 150 Marks**
**Time : 3Hrs.**

**Note for paper setter :** Question paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting at least one from each unit.

### UNIT I

**Introduction:** Microorganisms in food – historical developments.

**Food Fermentation Technology:** Origin, scope and development of fermented products, primary feed stock, raw materials and conversions, fermented food and microbial starters, commercial potential, food fermentation industries, their magnitude, R&D innovations.

*UNIT II*

**Development of Novel Food and food Ingredients:** Single cell protein, polysaccharides, low calorie sweeteners, naturally produced flavor modifiers, amino acids, vitamins, food supplements, food coloring, neutraceuticals, water binding agents.

**Bioreactors in Food Fermentations:** Cultivation of microorganisms, instrumentation regulation and process control, laboratory scale submerged and solid state fermentation, pilot scale submerged and solid state fermentation.

*UNIT III*

**Food Spoilage and Preservation:** General principle of spoilage, microbial toxins (endotoxins and exotoxins), contamination and preservation, factors affecting spoilage. Methods of food preservation (thermal processing, cold preservation, chemical preservatives & food dehydration).

**Radiation and Food Preservation:** Role of radiation in food preservation, characteristics of radiation of interest in food preservation. Principles underlying the destruction of microorganisms by irradiation. Effect of irradiation on food constituents. Legal status of food irradiation.

*UNIT IV*

**Biological controls and Monitoring of food quality.**

**Packaging of Food:** Need for packaging, requirements for packaging, containers for packaging (glass, metal, plastics, molded pulp and aluminium foil), dispensing devices.

**Text/Reference Books:**


1. Modern Food Microbiology 6th Ed. Jay, J.M. (2000). Kluwer Academic/Plenum Pub.
2. Food Microbiology: Fundamentals and Frontier 2nd Eds. Ed. Beuchat, Doyle & Montville. (2001). Blackwell Synergy.
3. Food Microbiology. Frazier, W.C. and Westhoff, D.C. (1988) Tata Mc-Graw Hill, New Delhi.
4. Biotechnology. Gupta, P.K. (1998) Rastogi Publication, Meerut. India
5. Biotechnology: Food Fermentation Vol. I & II. Eds. Joshi, V.K. & Pandey, A. (1999) Educational Publishers and Distributers, Kerala.
6. Biotechnological Strategies in Agroprocessing Eds. Marwaha S.S & Arora, J.K. (2003) Asiatech Publishers, New Delhi.


## 6th Semester, B. Tech. (Bio - Technology)
## Cell and Tissue Culture Lab

***BTT- 314 E***

| L | T | P |
|---|---|---|
| - | - | 4 |

Practical/V.V.: 50 Marks
Sessional: 50 Marks
Total : 100 Marks

Time : 4 Hrs

**Note**: A college should offer 70% of the below listed experiments. The remaining 30% experiments may be modified by college according to facilities available.

**A) Animal Cell Culture**

1) Primary cell culture from 12-14 days mouse embryos.
2) Culture of fibroblast and epithelial cells.
3) Visualization of proteins by immunofluorescence.
4) Induction of interferon in cell culture.
5) Culture of human lymphocytes
   - PHA stimulation-estimation by amount of DNA.
   - Karyotyping.

**B) Plant Tissue Culture**

1) Plant cell culture from different types of explants.
2) Isolation of DNA/RNA from cultured cells and compare with seeds.
3) Callus development for somatic embryogenesis.
4) *Agrobacterium* mediated transformation.

## References:

1. Culture of Animal Cells – a manual of basic techniques 4th Edition. Freshney, R. I. (2000) John Wiley & Sons, New York.
2. Animal Cell Biotechnology. Spier, R. E. and Griffiths, J. B. (1988) Academic Press.
3. Living resources for biotechnology: Animal Cells. Doyle, A.; Hay, R. and Kirsop, B. E. (1990) Cambridge University Press.
4. Plant Tissue Culture: Theory & Practice. Bhojwani, S. S. and Rajdan, M. K. (1996). Elsevier Amsterdam.
5. Experiments in Plant Tissue Culture. Dodde, J. H. and Robert, L. W. (1998).

## 6th Semester, B. Tech. (Bio - Technology)
## Healthcare Biotechnology Lab.
**BTT- 316 E**

| L | T | P |
|---|---|---|
| - | - | 4 |

Practical/V.V.: 50 Marks

Sessional: 50 Marks
Total : 100 Marks
Time : 4 Hrs

**Note**: A college should offer 70% of the below listed experiments. The remaining 30% experiments may be modified by college according to facilities available.

1. Normal microflora of mouth and determination of its susceptibility to dental caries.
2. Preliminary identification of enteric bacteria by TSI agar.
3. Estimation of ketone bodies in the urine of normal persons.
4. Fasting and post-prandial determination of blood glucose.
5. Lipid profile (Total cholesterol, TG, VLDL, LDL and HDL) of human blood samples.
6. Determination of Rh factor.
7. VDRL test for syphilis.
8. WIDAL test for Salmonella/Typhoid.
9. Pregnancy test.
10. Cultural sensitivity of pathogens against various antibiotics.

# 6th Semester, B. Tech. (Bio - Technology)
## Microbial, Food and Environmental Biotechnology Lab.
**BTT- 318 E**

| L | T | P |
|---|---|---|
| - | - | 3 |

Practical/V.V.: 50 Marks
Sessional: 50 Marks
Total : 100 Marks
Time : 4 Hrs

Note**: A college should offer 70% of the below listed experiments. The remaining 30% experiments may be modified by college according to facilities available.**

**A. Microbial Biotechnology:**

1. Production of organic acids (Citric and lactic) by microorganisms.
2. Production of antibiotics by microorganisms.
3. Production of industrially important enzymes (protease, amylase, cellulose, xylase or lipase) by microorganisms.
4. Demonstration of bacterial lysis by bactriophages.

**B. Food Biotechnology:**

1. Microbiological analysis (bacterial count ) of food products.
2. Isolation of bacteriocin producing microorganisms from fermented foods and determination of the antimicrobial spectrum of bacteriocin producing isolates.
3. Cultivation of white button mushroom (*Agaricus biosporus*).
4. Determination of food toxins.

**C. Environmental Biotechnology:**

1. Qualitative analysis of water/waste water:
   a. Bacterial analysis
   b. Determination of hardness, alkalinity, conductivity, chlorides, temperature and pH.
   c. Determination of soluble phosphates.
   d. Determination of BOD, COD and DO contents.
2. Biobleaching/ Decolourization of industrial effluents/industrially important dyes by microbes.
3. Microbial degradation of organic wastes eg: Lignocelluloses/ pesticides/ hydrocarbons.
4. Vermicomposting.

## Bachelor of Technology (Biotechnology)

### Scheme of Courses/ Examination

### 7th Semester

| S No. | Course No. | Subject | Teaching Schedule | | | | Examination Schedule | | | | Duration of Exam. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P/D | Tota | Th | Sess. | P/VV | Total | |
| 1 | BTT-401E | Bioinformatics | 4 | 1 | - | 5 | 100 | 50 | - | 150 | 3 |
| 2 | BTT-403 E | Stem Cell in Health Care | 4 | 1 | - | 5 | 100 | 50 | - | 150 | 3 |
| 3 | BTT-405 E | Essentials of Virology | 3 | 1 | - | 4 | 100 | 50 | - | 150 | 3 |
| 4. | BTT-407E | Intellectual Property Right in Biotechnology | 4 | - | - | 4 | 100 | 50 | - | 150 | 3 |
| 4 | * | Deptt. Elective-I | 3 | 1 | - | 4 | 100 | 50 | - | 150 | 3 |
| 5 | BTT-409 E | Bioinformatics Lab | - | - | 3 | 3 | - | 50 | 50 | 100 | 3 |
| 6 | BTT-411 E | Training Report | - | - | - | - | - | 100 | - | 100 | - |
| 8 | BTT-413 E | Minor Project | - | - | 10 | 10 | - | 150 | 150 | 300 | - |
| **TOTAL** | | | **18** | **4** | **13** | **35** | **500** | **550** | **300** | **1250** | |

LIST OF DEPARTMENTAL ELECTIVES FOR B.TECH. BIOTECHNOLOGY FOR 7TH SEMESTER

| * DEPARTMENTAL ELECTIVE –I, 7th Semester | | |
|---|---|---|
| **Sr. No.** | **Subject Name** | **Subject Code** |
| 1 | Biosensors and Bioinstrumentation | BTT-415E |
| 2 | Biochips & Microarray Technology | BTT-417E |
| 3 | Nanobiotechnology | BTT-419E |
| 4 | Pharmaceutical Biotechnology | BTT-421E |

**7th Semester B. Tech (Bio-Technology)**
**BIOINFORMATICS**
**BTT-401E**

| L | T | | |
|---|---|---|---|
| 4 | 1 | Theory | : 100 Marks |
| | | Sessional | : 50 Marks |
| | | Total | : 150 Marks |
| | | Time | : 3 Hrs. |

**Note for paper setter :** Question paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting at least one from each unit.

## UNIT I

**1. Information Theory And Biology :**
Entropy and information- Shannon's formula-divergence from equiprobability and independence, elementary ideas about Mark off Chains and Ergodic process, redundancy concepts - applications to DNA and protein sequences.

**2. Databases**
**a.)** Sequence Databases: the nucleotide and protein sequence databases: introduction, primary and secondary databases, Format vs Content, the database, the gene bank flat file- a dissection.

**b)** Structure Databases: Introduction to structures, PDB (Protein Data Bank) Molecular Modeling database at NCBI, structure file formats, visualizing structural information, database structure viewers

## UNIT – II

3.**Sequence Analysis Using Software Resources** :
Introduction, The Wisconsin package, databases that accompany the Wisconsin package, the Seq Lab environment, analyzing sequences with operations and Wisconsin package programmes, viewing output, monitoring programme progress and troubleshooting problems, annotating sequences and graphically displaying annotations in the Seqlab Editor, saving sequences in the Seq Lab Editor, example of analysis that can be undertaken in Seqlab, extending Seqlab by including programmes that are not part of the Wiscosin package. Information retrieval from biological database, retrieving database entries, the retrieve server, integrated information retrieval, The Entrez system, Integrated information axis: the query/server, sequence database beyond NCBI, medical databases**.**

**4. Phylogenetic Analysis:**
Elements of phylogenetic models, phylogenetic data analysis: alignment, substitution model building, tree building and tree evaluation, building the data model (alignment), determining the substitution model, tree-building methods, searching for trees, rooting trees, evaluation trees and data, phylogenic software (PHYLIP), phylogenetics on the web, some simple practical considerations.

## UNIT III

**5. Sequence Alignment And Database Searches**
Introduction, the evolutionary basis of sequence alignment, the modular nature of proteins, optional alignment methods, substitution scores and gap penalties, statistical significance of alignment, database similarity searching, FASTA, BLAST, low-complexity regions, repetitive elements, practical aspects of multiple, sequence alignment- progressive alignment methods, motifs and patterns, presentation methods, Hidden Markov Models (HMMs) and threading methods.

**6. Predictive Methods:**
Predictive methods using nucleotide sequences: frame work, masking repetitive DNA, Database searches, Codon bias detection, detecting functional sites in the DNA, integrated gene parsing, finding RNA genes, future prospects. Predictive methods using gene sequences: protein identity based on composition, physical properties based on sequence, secondary structure and folding classes,

specialized structures or features, tertiary structure. Related software.

**UNIT –IV**

**7. Plasmid Mapping And Primer Design**

Restriction mapping, DNA strider, Mac Vector and OMIGA, Gene construction kit, Vector NTI, primer design for PCR Sequencing, primer design programs and software.

**8. Genome Bioinformatics:**

Genome sequencing, raw genome sequence data, expressed sequence tags, polymorphism, DNA chips, comparative genomics, genome annotation problem, Genomics and research: pharmaceutical and agricultural, types of physical maps. Genome- wide maps from large community databases. Genome- wide maps from individual sources. Chromosome – specific human maps.

**9. Informatics And Automation in Genome Mapping:**

Finding genes sequence and codes, fundamentals of bio molecular cryptology, prediction of protein secondary and tertiary structures, prediction of antigenic sites and metabolic pathways. Related software.

**REFERENCES:**


1. Bioinformatics by Andreas D.Boxevanis. Wiley Interscience, 1998.
2. Bioinformatics: Sequence and genome analysis by David W.Mount, Cold Spring Harbor, 2001.
3. Biocomputing Informatics And The Genome Projects by Smith D.W., Academic Press, 1993.
4. Bioinformatics: A Biologists Guide to Computing and the Internet. by Stuart M. Brown, NKU Medical Center, NY USA, 2000.
5. Molecular Evolution Computer Analysis of Protein And Nucleic Acid Sequences, Methods in Enzymology, Vol. 183, Academic Press, 1990.
6. Biological Sequence Analysis by Durbin, Eddy, Krogh, And Mitchison. Allied Publishers Ltd. 1998.
7. Computational Methods for Macromolecular Sequence Analysis by R F Doolittle. Academic Press, 1996.
8. Computational Methods in Molecular Biology. S.L. Salzberg, D B Searls, SK Kasif Eds, Elsevier, 1998.
9. Bioinformatics: The Machine Learning Approach by Baldi & Brunak II Edn (2003)
10. Statistical Methods in Bioinformatics An Introduction by Warren J. Ewens & Gregory R Grant, Springer,2004
11. Introduction To Bioinformatics by Terresa K. Attwood & David J. Parry Smith, Pearson Education, 2004.
12. Bioinformatics by D.R.Westhead, J.H.Parish and R.M.Twyman, Viva Books Pvt. Ltd. 2003
13. Bioinformatics And Genomes-Current Perspectives by Miguel A.Andrade, Horizon Scientific Press, 2003.
14. Bioinformatics- Genes, Proteins And Computers by C.A.Orengo, D.T.Jones and J.M.Thornton, BIOS Scietific Publisher Ltd.,2003.
15. Introduction To Bioinformatics by Arthur M.Lesk, Oxford University Press, 2003.
16. Bioinformatics- Managing Scientific Data by Zoe' Lacroix and Terence Critchlow, Morgan Kaufman Publisher, 2004.
17. Fundamental Concepts of Bioinformatics by Dan E.Karane and Michael L.raymer, Pearson Education, 2003
18. Bioinformatics- Approaches And Applications by Chiranjib Chakraborty, Biotech Books, 2004

**7th Semester B. Tech (Bio-Technology)**
**STEM CELL IN HEALTH CARE**
**BTT-403 E**

| L | T | | |
|---|---|---|---|
| 4 | 1 | Theory | : 100 Marks |
| | | Sessional | : 50 Marks |
| | | Total | : 150 Marks |
| | | Time | : 3 Hrs. |

**Note for paper setter:** Question paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting at least one from each unit.

## UNIT – I

**Cell Diversification in Early Animal Embryo:**

Initial difference among various blastomers arising from spatial segregation, new types of cell from inductive interactions, complex pattern of cell responses from a simple morphogenic gradient, different reactions of the cells to a signal based upon the time of its reception, the role of intracellular clock, an unusual style of early development in mammals from protected uterine environment, same developmental potential of all the cells of every mammalian embryo, effect of environment on the pace and the pathways of mammalian embryonic stem cell development.

## UNIT –II

**2. Renewal by Stem Cells:**
Epidermis: unlimited divisions of stem cells and production of differentiated progeny, epidermal stem cells in the basal layer: synthesis of a sequence of different Keratins from epidermal cells during maturity, epidermal stem cells as a subset of basal cells, regulation of basal cells proliferation according to thickness of epidermis, seclusion of secretory cells in the epidermis of the glands having their own population kinetics.

**3. Genesis Modulation and Regenration of Skeletal Muscle:**
Formation of new skeletal muscle cells from fusion of myoblasts, change in the properties of muscle cells with change in their protein isoforms, persistence of myoblasts as quiescent stem cells in the adult.

## UNIT-III

**4. Fibroblasts and their Transformations:**
**The connective tissue cell family: change of character by fibroblast in response to the signals in the extra cellular matrix, the influence of extra cellular matrix on the connective tissue cell differentiation by affecting cell shape and attachment, regulation of the production of cells by sequential action of signaling molecules, continuous remodeling of bone by cells within it, secretion of bone matrix by osteoblasts and erosion of bone matrix by osteoclasts. Erosion of cartilage by osteoclasts during development leading to bone formation, stabilization of the body structure by connective tissues framework and selective cohesion of cells**

## UNIT-IV

**5. The Concept of Hemopoietic Stem Cells:**
Hemopoietic stem cell disorders: classification and manifestation of hemopoietic stem cell disorders, plastic hemopoietic stem cell disorders, myelo dysplastic, myelo proliplastic, clinical applications of colony stems, complications of gene therapy, replacement therapy and marrow transplantations,

Immunological principles, Preservation and clinical use of blood and blood components, hemapheresis procedures and oxiplantations.

**REFERENCES:**


1. Developemental Biology by R.M.Twyman, Viva Books Pvt. Ltd., 2001
2. Hematology, William J. Willams, Ernest Beutler, Allan JU.Erslev, Marshall A. Lichman.
3. Essential Cell Biology, Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Kieth Roberts and Jamnes D. Watson, Garland Science, Taylor and Francis Group, 2nd Edition, 2003.
4. Stem Cell Biology by Marshak, Cold Spring Harbar Symposium Publication, 2001.
5. Molecular Biology of the Cell, Bruce Alberts, Dennis Bray, Alexander Johnson, Julian Lewis, Martin Raff, Kieth Roberts and Peter Walter, Garland Science, Taylor and Francis Group, 4th Edition, 2003.
6. Molecular and Cell Biology- Schaum's Outline of Theory and Problems by Willam D. Stansfield, Jaime S.Colorne and Raul J. Cano. Tata McGraw Hill Publisher, 2004.
7. The Cell- A Molecular Approach by Geoffrey M. Cooper and Robert E. Hausman, ASM Press, Sinauer associates, 3rd Edition, 2004.
8. Essential of Molecular Biology by George M. Malacinki, Jones and Bartlett Publisher, 4th Edition, 2002.
9. Introduction to Molecular Biology by Peter Paolella, McGraw Hill, 1998.
10. Cell Biology and Genetics by C. Starr and R. Taggart, 9th Edition, Brooks/ Cole Publishers, 2001.

**7th Semester B. Tech (Bio-Technology)**
**ESSENTIALS OF VIROLOGY**

**BTT-405 E**

| L | T | | |
|---|---|---|---|
| 3 | 1 | Theory | : 100 Marks |
| | | Sessional | : 50 Marks |
| | | Total | : 150 Marks |
| | | Time | : 3 Hrs. |

**Note for paper setter:** Question paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting at least one from each unit.

**UNIT-I**

**1. Introduction:**
Virus and Virion: General properties of viruses, nature of the virion. Nomenclature and Classification of viruses. Subviral particles- Viroids and Prions.

**2. Viral Replication & Multiplication**
Growth & Quantification: The virus host, Quantification of virus. Virus replication: General features of viral replication, virus multiplication- attachment and penetration, production of viral nucleic acid and protein.

**UNIT-II**

**3. Viral Diversity: Viruses of Prokaryotes**
Overview of bacterial viruses, Virulent Bacteriophage & T4, Temperate Bacteriophages, Bacteriophage lambda. RNA Bacteriophages; Icosohedral single stranded DNA Bacteriophages, Filamentous single stranded DNA Bacteriophages- T7, Mu: Double Stranded transposable DNA Bacteriophage. Life Cycle of Bacteriophages and their use in genetic analysis.

**4. Viral diversity- Viruses of Eukaryotes:**
Plant viruses. Positive strand RNA Viruses of animals- Poliovirus and Coronavirus. Negative strand RNA Viruses of animals- Rabies & Influenza. Double stranded RNA Viruses- Reoviruses. Replication of double stranded DNA Viruses of animals. Double stranded DNA Viruses-Herpesvirus, Pox Virus and Adenovirus. Viruses with reverse transcriptase- Retroviruses and Hepadnaviruses.

**UNIT-III**

**5 Experimental Virology**
Cultivation of viruses in embryonated eggs. Principles of animal cell culture. Primary and Secondary Cultures. Suspensiona and Monolayer cell cultures. Concept of cell lines and viral transformation. Serological methods in virology. Haemagglutination, Compliment fixation and Immunoflourescence metgods. ELISA and RIA. Physical and Chemical Assays of Viruses ( Proteins, Nucleic Acids, Radioactivity Tracers, Electron Microscopy ). Infectivity Assay ( Plaque mthod, end point method )- infctivity assay of plant viruses.

**UNIT-IV**

**6. Applications of Virology :**
Viruses and transgenic plants and animals. Overview of Tumor Viruses. Viral Vaccines: Conventional Vaccines. New Generation Vaccines including DNA Vaccines with examples. Interferons-Production and mode of action. Antiviral drugs.

**REFENCES:**

1. Brock: Biology of Microorganisms. By Madigan and Martinko. 11th Ed. 2005. Prentice Hall-Pearson Publications. New Jersey, US..
2. Microbiology. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. Tata McGraw Hill, New Delhi.
3. Introduction to Modern Virology. Dimmock, N.J. and Primrose, S.B.4th Ed. Blackwell Science Publications, Oxford.
4. Medical Virology. Morag, C & Tinbury, M.C. Churchil Livingstone, London.
5. Functionals of plant virology. Mathew, R.E. Academic Press. San Diego, US.
6. The genetics of bacteria and their viruses. William Hayes. Blackwell Scientific Publishers, Oxford.

## $7^{th}$ Semester B. Tech (Bio-Technology)
## INTELLECTUAL PROPERTY RIGHTS IN BIOTECHNOLOGY

**BTT-407 E**

| L | T | | |
|---|---|---|---|
| 4 | - | Theory | : 100 Marks |
| | | Sessional | : 50 Marks |
| | | Total | : 150 Marks |
| | | Time | : 3 Hrs. |

**Note for paper setter:** Question paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting at least one from each unit.

### UNIT-I

**1. Introduction:**
Intellectual property, patent claims and legal decision making process, physical and intellectual property, biotechnological exploitation of plant genetic resources.

**2. Basic requirements of patentability:**
Patentable subject matter, novelty and public domain, non-obviousness

### UNIT-II

**3. Intellectual Property Rights :**
Patents, trade secrets, copy right, trade marks, strengthening PBR in UPOV, plant genetic resources and IPR, GATT and TRIP's, developing country responses and assessing complexities.

**4. IPR Protection:**
Choice of intellectual property protection, global system and IPP, new technology and IPP for plant material, international protection of high technology (Bio-Technology in GATT negotiations, legal protection of Bio-Technology innovations, conservation and use of genetic resources)

### UNIT-III

**5.PATENTING:**
International conventions, international co-operation, Obligations with patent application, implications of patenting, patenting in different countries

**6. Patenting a biological material:**
Current issues, patent for higher plants and animals, patenting transgenic organisms and isolated genes, patenting of genes and DNA sequence.

### UNIT-IV

**7. Special issues in Biotechnology patent:**
Consequences of reinforcing IPP for developing countries, options for developing countries, foreign patents, IPR issues in Indian context, current patent laws.

**8.Intellectual Property Managemnet**

**REFENCES:**

1. Biotechnology by John E. Smith, Cambridge University Press, 2004.
2. Biotechnology: An Introduction by Susan R. Barman.
3. Elements of Biotechnology by P.K.Gupta, rastogi Publications, 2003
4. A Textbook on Biotechnology by H.D.Kumar, East West Press Pvt. Ltd.
5. Modern Concepts of Biotechnology by H.D.Kumar, Vikas Publishing House Pvt. Ltd., 1998.

**7th Semester B. Tech (Bio-Technology)**

## BIOINFORMATICS LABORATORY

**BTT-409 E**

| | |
|---|---|
| Practical | : 50 Marks |
| Sessional | : 50 Marks |
| Total | : 100 Marks |
| Time | : 3 Hrs. |

**Note:** Each College based upon the facilities available can modify/change 30% of the experiments.

**List of Experiments:**

1. Computer basics
2. Searching biological database for relevant information
3. Data mining techniques in Bioinformatics.
4. Searching, retrieval and similarity analysis of biological database.
5. Sequence retrieval from nucleic acid and protein database.
6 Restriction mapping
7. Sequence (FASTA & BLAST) searches.
8. Pair wise comparison of sequences.
9. Evolutionary studies/ Phylogenic analysis.
10. Identification of genes in genomes.
11. Protein databank retrieval and visualization.
12. Superposition of structures.
13. Secondary structure prediction of proteins.
14. Pattern searching in nucleic acids.
15. Validation of 3D structures.

**REFERENCES:**


1. Bioinformatics- A Practical Guide to the Analysis of Genes and Proteins by Andreas D. Baxevanis and B.F.Francis Ouellette, 2nd Edition, A John Wiley and Sons, Inc. Publications, 1998.
2. Bioinformatics: Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor, 2001.
3. Biocomputing Informatics and the Genome Projects by Smith D.W., Academic Press, 1993.
4. Bioinformatics: A Biological Guide to Computing and the Internet, by Stuart M. Brown, NYU Medical Center, NY USA.2000.
5. Molecular Evolution- Computer analysis of protein and nucleic acid sequences, Methods in Enzymology, Vol.183, Academic Press, 1990.
6. Biological Sequence Analysis by Durbin, Eddy, Krogh and Mitchison. Allied Publishers Ltd.,1998.
7. Computational Methods for Macromolecular Sequence Analysis by R.F. Doolittle, Academic Press, 1996.
8. Computational Methods in Molecular Biology, by S.L.Salzberg, D.B.Searls, S. Kasif eds, Elsevier, 1998.
9. Bioinformtaics: The machine learning approach by Baldi & Brunak II Edn., 2003.

10. Statistical Methods in Bioinformatics- An Introduction by Warren J Ewens & Gregory R Grant, Springer, 2004.
11. Bioinformatics Computing by M.D.Bryan Bergeron, Prentice Hall of India Pvt. Ltd. 2003.
12. Bioinformatics – Methods and Protocols by Stephen Misener and Stephen A. Krawtetz, Humana Press.

**BTT-411E Training Report :**

Students will be required to submit training report of the project being performed by them after 6$^{th}$ Semester. Evaluation will be done on the basis of seminar and viva-voce examination internally conducted by the concerned instructor.

**BTT-413 E Minor Project :**

There will be 10 credit hours for the minor project. The topic for the project will be decided by the departmental committee of the concerned college.

**ANNEXURE-I**

**ELECTIVE-I**
**7th Semester B. Tech (Bio-Technology)**
**BIOSENSORS AND BIOINSTRUMNETATION**
**BTT-415 E**

| L | T | | |
|---|---|---|---|
| 3 | 1 | Theory | : 100 Marks |
| | | Sessional | : 50 Marks |
| | | Total | :150 Marks |
| | | Time | : 3 Hrs. |

**Note for paper setter:** Question paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting at least one from each unit.

## UNIT – I

**1. Introduction**
**Electrical quantities and units, functional elements of an instrumentation system, static and dynamic characteristics, principle of analog and digital meters, CRO, energy meters, time and frequency meters, multimeters.**

2. **Transducers:** Classification, resistive strain gauges, RTD, LVDT, Piezoelectric transducers, Electromagnetic transducers, Optical transducers, Transducers for biomedical science and their applications.

**3. Analytical Instruments**
**pH meters, radiometric devices, fluorescence spectrophotometers, chromatology (chromatographic techniques- GC and HPLC), electrophoresis, lab on a chip – related instrumentation, Validation, commissioning and maintenance of the above equipments.**

## UNIT – II

4. Assay Technologies and Detection methods

**Introduction, bioassay design and implementation, radiometric assay, scintillation proximity assay, fluorescence methodology to cover all types of fluorescence measurements and instrumentation, Reporter gene assay applications. Bio-analytical applications.**

5. Automation and Robotics

**Introduction: management and services issues of a centralized robotics HTS (high throughput screening) core, flexible use of people and machines, Bar-code technology and a centralized database, factors for the successful integration of assays, equipment, robotics and software. Perspectives on scheduling.**

UNIT – III

6. Data retrival, handling and integration

**Database systems, systems integration, data management and tracking**

7. Cardiac and Vascular system

**Overview of cardiovascular system, types of blood pressure sensors, Lumped parameters modeling of a catheter- sensor/system, heart sounds, cardiac catheterization, indirect measurement of blood pressure, measuring blood flow rate, measuring blood volume, pacemakers, defibrillators, cardiac-assist devices and heart valves- related instrumentation of equipments and involved sensors.**

8. Respiratory system

**Modeling the respiratory system, measuring gas flow rate and lung volume, tests of respiratory mechanics, measuring gas concentration, tests of gas transport, ventilators, anesthesia machines-related instrumentation of equipments and involved sensors.**

UNIT – IV

9. Biosensors

**Introduction to biosensors: concepts and applications, biosensors for personal diabetes management, micro fabricated sensors and the commercial development of biosensors, electrochemical sensors, chemical fibrosensors, Ion-selective FETs, noninvasive blood-gas monitoring, blood-glucose sensors. Noninvasive biosensors in clinical analysis, Applications of biosensors based instruments to the bioprocess industry. Applications of biosensors to the environmental samples, Introduction to biochips and their application to genomics, BIA core- an optical biosensors**

REFERNECES:


1. **Introduction to Bio-analytical Sensors by Alice J Cunningham New York, John Wiley, 1998.**
2. **Applied Biosensors by Doland L.Wise, 1989**
3. **Advances in Laboratory Automation – Robotics, Eds. J.R.Strimataitis and J.N. Little, Zymark Corporation, Hopkinton, MA 1991.**
4. **Instrument methods of analysis by H W Willard, L L Merrit, J A Dean and F A Sttle. VI edition, East- West publishers. 1992.**
5. **Biosensors and their applications by C Yang Victor & TNgo That, Plenum Press NY, 2000.**
6. **Biosensors- An Introduction by R.Eggins Brain.**
7. **Automation technologies for genome characterization, edited by Tony J Beugelsdijk, John Wiley & Sons, Inc.2002.**
8. **Transducers and instrumentation by D V S Murthy, Prentice Hall, 1995.**
9. **Commercial sensors by Graham Ramasay, John Wiley & Son, INC, 1998.**
10. **Biosensors by Jon Cooper and Tony Cass, Oxford university Press, 2004.**

**ELECTIVE-I**

**7th Semester B. Tech (Bio-Technology)**

BIOCHIPS & MICROARRAY TECHNOLOGY

**BTT-417 E**

| L | T |
|---|---|
| 3 | 1 |

| | |
|---|---|
| Theory | : 100 Marks |
| Sessional | : 50 Marks |
| Total | : 150 Marks |
| Time | : 3 Hrs. |

**Note for paper setter**: Question paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting at least one from each unit.

UNIT – I

1. Introduction

   **Basics of biochips and microarray technology, historical development of biochip technology**

2. Biochip and Microarray construction

   DNA microarrays, oligonuleotide, cDNA and genomics microarrays, microchip production technologies, megaclone technology for fluid microarray labels, microarray scanners./headers, microarray robotics. Microfluidics systems, chips and mass spectrometry.

UNIT-II

3. Biochip and Microarray construction (Continued)

   Biochips, microarrays, Chromosome on a chip, tissue chip, RNA chip, Protein chip technology, glycochips, biochips assays, combination of microarray and biosensor technology, biochip versus gel-based methods, process flow for production and analysis of a chip, standardization of microarray analysis, bioinformatics and microarrays, integrated biochip system, evaluation of conventional microarray technology. Electrical detection methods for microarrays, SERS (Surface-Enhanced Raman spectroscopy)-based microarrays.

UNIT-III

4. Applications of Biochip Technology

   **Molecular diagnostics and pharmacogenomics, Application of microarray technology in drug discovery and development, Gene expression studies, use of DNA chip technology for drug safety, use of microchips for drug delivery, biochips as neural prostheses, use of biochips in health care, use of microarrays in population genetics and epidemiology, use of microarray in forensics. DNA chip technology for water quality management, Bioagent chip, Application of microarray in the agro-industry, use of microarray in genetic disease monitoring, point of care (POC) applications, Limitations of biochip technology**

UNIT-IV

5. Commercial aspects of Biochip technology

**Markets for biochip technologies, commercial support for the development of biochips, government support for biochip development, business strategies and patent issues**

6. DNA Computing

**Introduction, junctions, other shapes, biochips and large-scale structures. Discussion of Robinson and Kallenbach's methods for designing DNA shapes, DNA cube. Computing with DNA, Electrical analogies for biological circuits. Challenges and future trends.**

REFERENCES:


1. **Biochips and Microarrays-technology & Commercial Potential, Published byUrck Publishing, 2000.**
2. **DNA Arrays: Technology and Experimetal strategies, Grigorenko, E.V (ed), CRC Press, 2002.**
3. **Microarray Analysis Mark Schena; J. Wiley & Sons (ed., New York), 2002.**

*ELECTIVE-I*

**7th Semester B. Tech (Biotechnology)**

NANOBIOTECHNOLOGY

**BTT-419 E**

| L | T | | |
|---|---|---|---|
| 3 | 1 | Theory | : 100 Marks |
| | | Sessional | : 50 Marks |
| | | Total | : 150 Marks |
| | | Time | : 3 Hrs. |

**Note for paper setter:** Question paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting at least one from each unit.

UNIT-I

**1. Introduction to Nanotechnology**

Definition of nanobiotechnology, A brief history of the Super small, Bottom-up versus top-down, discussion on nanofabrication, nanolithography, nanobiotechnology, nanotubes and buckyballs, Structure-property relations in materials, materials characterization techniques, microelectronic fabrication, scanning tunneling and atomic force microscopy, Biomolecule-suface interactions, DNA microarrays, Quantum dots and hybrid biological/ inorganic devices.

**UNIT-II**

**2. BioMEMS**

Introduction and overview, biosignal transduction mechanisms. Electromagnetic transducers: basic sensing mechanisms, basic actuating mechanisms. Case studies in biomagnetic sensors. Mechanical transducers: basic sensing mechanisms, basic actuating mechanisms. Case studies in microfluidic devices. Chemical transducers: basic sensing mechanism, basic actuating mechanism, ultimate limits of fabrication and measurement.Recent developments in BioMEMS.

**UNIT-III**

**3. Applications of Nanotechnology in the Life Sciences**

Nanobiotechnology overview, Buckyballs and buckytubes, fluidics, manufacturing, diagnostics and sensors, drug delivery, valuing nanobiotechnology, drug delivery revenues, biosensors revenues, nanobiosensors, health risks and challenges, Fullerenes, Carriers, Dendrimers, nanoparticles, membrane/matrices, nanoshells, quantum dot nanocrystals, nanotubes, targeting and functionlization, leading segments of biotechnology.

**UNIT-IV**

**4. Applications of nanotechnology in the life sciences (continued):**

Leading applications of nanobiotechnology: drug delivery. bioavailability, sustained and targeted release, nanorobots. Benefits of nano drug delivery. Drug delivery using nanocrystals, drug discovery using Resonance Light Scattering (RLS) technology, rapid ex-vivo diagnostics, benefits of nano-imaging agents, nanoscale biosensors, nanosensors, nanosensors as diagnostics, nanotherapeutics

**REFERENCES:**


1. Unbounding the future by K Eric Drexler, C.Pelerson, G.Pergamit Willaim Marrow and Company, 1993
2. Biological molecules in Nanotechnology By Stephen Lee and Lynn M Savage,2004
3. Nanotechnology By mark Ratner and Dan Ratner, Prentice Hall, 2005.

*ELECTIVE-I*

**7th Semester B. Tech (Biotechnology**
**PHARMACEUTICAL BIOTECHNOLOGY**
**BTT-421 E**

| L | T | | |
|---|---|---|---|
| 3 | 1 | Theory | : 100 Marks |
| | | Sessional | : 50 Marks |
| | | Total | :150 Marks |
| | | Time | : 3 Hrs. |

**Note for paper setter:** Question paper will consist of four units. Eight questions will be set in the question paper by selecting two from each unit. The students will be required to attempt five questions, selecting at least one from each unit.

**UNIT-I**

**1. Introduction:**
Development of drugs and pharmaceutical industry, organic therapeutic agents and their uses, economics of drug development.

**2. Important processes and their applications:**
Chemical conversion processes: alkylation, carboxylation, condensation and cyclisation; dehydration. esterification (alcoholysis), halogenations, oxidation and sulphonation, Complex chemical conversions, Fermentation.

**UNIT-II**

**3. Drug metabolism and Pharmacokinetics:**
Drug metabolism, half-life of drugs, physico-chemical principles, radioactive labeled compounds, pharmacokinetics and action of drugs on human bodies.

**4. Metabolomics:**
Metabolomics, pharmacogenesis, single nucleotide polymorphism, inborn errors of metabolism, drug targets.

**UNIT-III**

**5. Manufacturing principles:**
GMP, GLP and clean room concept, compressed tables, wet granulation, dry granulation or slugging, direct compression, tablet formulation, coating, pills, capsules, sustained action dosage form, parental preparations, oral liquids, ointments.

**6. Pharmaceutical products, analysis and control:**
Vitamins, cold remedies, laxatives, analgesics, non steroidal contraceptives, external antiseptics, antacids and others, antibiotics, biological and hormones, Preservation of these products, Analytical methods and tests for various drugs and pharmaceuticals, packaging techniques and quality control.

**UNIT-IV**

**7. Nutraceuticals:**

Water and fat soluble vitamins, functions and nutritional importance of vitamins, deficiency diseases of vitamins. Estimation of vitamins from the sample, Evaluating the nutritional status of vitamins, Assay of vitamins.

**8. Recombinant proteins:**

Therapeutic proteins regulatory aspects, analytical enzymes, brief account of applications of recombinant proteins, delivery and targeting of therapeutic proteins, first generation and second generation therapeutic proteins, Future prospects of recombinant proteins.

**REFERENCES:**


1. Enzymes Technology for Pharmaceutical & Bio-technological Applications by Herbert A. Kirst, Wu-Kuang Yeh, Milton J.
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