



**DEPT. OF BIOTECHNOLOGY**  
**MAHATMA GANDHI UNIVERSITY, NALGONDA**  
**CHOICE BASED CREDIT SYSTEM (CBCS)**  
**M.Sc. BIOTECHNOLOGY**  
(Proposed Scheme from Academic Year 2015 onwards)

### Semester Pattern

- ✓ The syllabus is divided into four semesters. In all the semesters there are four theory papers. The first three semesters carry two practical each and Seminars. A project work is required to be completed in the fourth semester. Apart from the project, the student will also have to complete a practical and a seminar in the fourth semester. Each theory paper is divided into four units and all the units carry equal weightage. All papers and practical are compulsory. Each theory paper carries 100 marks. Each practical carries 100 marks. 100 marks are allotted to a project work to be carried out during the fourth semester. The project is compulsory. 100 marks are allotted to the Project Presentation.
- ✓
- ✓ Number of theory and practical periods: The syllabus is based on 8 theory periods and 9+3 practical periods per week. Candidates are required to pass separately in theory and practical examination.
- ✓ Study tour: Students of M. Sc. Biotechnology are encouraged to visit some research institutes of national and international repute during the two-year course.
- ✓ Seminars: In all the semesters every student has to give at least one seminar and submit a written summary of the same.
- ✓ Project work: In the fourth semester, 100 marks are allotted to the project work. The project is compulsory.



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**Schedule for Instruction & Examination**

**Semester I**

Sub Code	Subject	Credits	Instruction Hrs/week	Internal Marks	Sem Exams Marks	Exam Time (Hrs)	Total Marks
<b>THEORY</b>							
BT 101	Cell Biology	4	4	20	80	3	100
BT 102	Genetics	4	4	20	80	3	100
BT 103	Biochemistry	4	4	20	80	3	100
BT 104	Microbiology	4	4	20	80	3	100
<b>PRACTICALS</b>							
BT 105	Cell Biology & Genetics	4	9	-	100	6	100
BT 106	Biochemistry & Microbiology	4	9	-	100	6	100
BT 107	Communicative English & Soft Skills (Add on Paper)	2	2*	10	40	2	50
BT 108	Seminar	1	2	-	-	1	25
<b>Total</b>		<b>27</b>	<b>36</b>	-	-	-	<b>675</b>

\* - Timings 9.00-10.00 AM, 5.00-6.00 PM

**Semester II**

Sub Code	Subject	Credits	Instruction Hrs/week	Internal Marks	Sem Exams Marks	Exam Time (Hrs)	Total Marks
<b>THEORY</b>							
BT 201	Molecular Biology	4	4	20	80	3	100
BT 202	rDNA Technology	4	4	20	80	3	100
BT 203	Immunology	4	4	20	80	3	100
BT 204	Bio-Statistics & Analytical Techniques	4	4	20	80	3	100
<b>PRACTICALS</b>							
BT 205	Molecular Biology & rDNA Technology	4	9	-	100	6	100
BT 206	Immunology & Analytical Techniques	4	9	-	100	6	100
BT 207	Human Values & Professional Ethics (Add on Paper)	2	2*	10	40	2	50
BT 208	Seminar	1	2	-	-	1	25
<b>Total</b>		<b>27</b>	<b>36</b>	-	-	-	<b>675</b>

\* - Timings 9.00-10.00 AM, 5.00-6.00 PM

**Minor Project – 45 days** (1<sup>st</sup> summer holidays)

Sub Code	Subject	Credits	Instruction Hrs/week	Internal Marks	Sem Exams Marks	Exam Time (Hrs)	Total Marks
<b>THEORY</b>							
BT 301	Bioinformatics	4	4	20	80	3	<b>100</b>
BT 302	Bioprocess Technology	4	4	20	80	3	<b>100</b>
BT 303	Plant Biotechnology	4	4	20	80	3	<b>100</b>
BT 304	Animal Biotechnology	4	4	20	80	3	<b>100</b>
<b>PRACTICALS</b>							
BT 305	Bioinformatics & Bioprocess Biotechnology	4	9	-	100	6	<b>100</b>
BT 306	Plant & Animal Biotechnology	4	9	-	100	6	<b>100</b>
BT 307	Interdisciplinary (ID) Paper	4	4*	20	80	3	<b>100</b>
BT 308	Seminar	1	2	-	-	1	<b>25</b>
<b>Total</b>		<b>29</b>	<b>36</b>	-	-	-	<b>725</b>

\* - Timings 9.00-10.00 AM, 5.00-6.00 PM

Note - Study tour for students to important industries &amp; organizations

**Semester IV**

Sub Code	Subject	Credits	Instruction Hrs/week	Internal Marks	Sem Exams Marks	Exam Time (Hrs)	Total Marks
<b>THEORY</b>							
BT 401	Industrial Biotechnology	4	4	20	80	3	<b>100</b>
BT 402	Environmental Biotechnology	4	4	20	80	3	<b>100</b>
BT 403	IPR, Ethics, Biosafety	4	4	20	80	3	<b>100</b>
BT 404	Optional Papers 1) Medical Biotechnology or 2) Nanobiotechnology	4	4	20	80	3	<b>100</b>
<b>PRACTICALS</b>							
BT 405	Industrial & Environmental Biotechnology 1) Medical Biotechnology or 2) Nanobiotechnology	4	9	-	100	6	<b>100</b>
BT 406	M.Sc. Project Work	4	9	-	100	6	<b>100</b>
BT 407	Interdisciplinary (ID) Paper	4	4*	20	80	3	<b>100</b>
BT 408	Seminar	1	2	-	-	1	<b>25</b>
<b>Total</b>		<b>29</b>	<b>36</b>	-	-	-	<b>725</b>

\* - Timings 9.00-10.00 AM, 5.00-6.00 PM

**Total number of credits for M.Sc Biotechnology = 112****Total number of marks = 2800**

## **SEMESTER - I**

### **PAPER – I BT 101 CELL BIOLOGY**

#### **UNIT 1 : INTERNAL ORGANISATION OF CELL**

- Membrane structure – lipid bi layer and membrane proteins.
- Electric properties of membrane. Transport across membranes – active transport, ionic gradient, carrier proteins, Na<sup>+</sup> K<sup>+</sup> pump, ATPase, ABC transporters, Ion channels  
Intra cellular compartmentalization – Cytosol, mitochondria, chloroplast, endoplasmic reticulum, peroxisome, lysosomes, endosomes.
- Transport of molecules between nucleus and cytosol.
- Transport into mitochondria and chloroplast, endocytosis and exocytosis.
- Protein sorting.
- Structure and functions of mitochondria. Structure and function of chloroplast. Multi drug resistant efflux forms

#### **UNIT 2 : CELL COMMUNICATION**

- Overview of extracellular signaling.
- Basic characteristics of Paracrine, endocrine, autocrine systems.
- Tight junctions and Gap junctions .
- Second messengers and their role in signal transduction. Second messengers Camp, lipid derived second messengers (phosphatidyl inositol derived second messenger) & IP3. Role of calcium as second messenger.
- Cell surface receptors in signal transduction. G-protein coupled receptor – structure and function. Ion channel receptors. Tyrosine kinase linked receptors  
Receptors with intrinsic enzyme activity (RTK). Interaction and regulation of cell signaling pathways

#### **UNIT 3 : CELL CYCLE AND CELL DIVISION**

- Components in cell cycle control - Cyclin, CDKs .Check points in cell cycle  
Intracellular control of cell cycle events, phase dependent cyclic CDK complexes eg. Yeast.
- Abnormalities in Cell Cycle – Cancer.
- Mechanics of Cell Division- An over view of M-Phase. Different stages of mitosis.
- Cohesins and Condensins in chromosome segregation. Microtubules in spindle assembly. Structure of kinetoshore, centrosomes and its functions.
- Sister Chromatid separation. Cytokinesis actin & myosin in the generation of contractile ring.
- Meiosis – Significance.Chiasma formation - Synaptonemal complex. Recombination during meiosis - Recombination nodules

#### **UNIT 4 CELL DEATH PATHWAY**

- Introduction to Necrosis, Senescence, Apoptosis - Programmed cell death.
- Mechanisms of apoptosis.
- Apoptosis triggered by internal signals. Apoptosis triggered by external signals. Apoptosis inducing factor.
- Apoptosis in cancer, immune system, organ transplants.
- Apoptosis in plants

#### **BOOKS RECOMMENDED**

1. Cell & Molecular Biology . E.D.D De Robertis & E.M.F De Robertis, waverly publication.
2. Molecular Biology of the cell. Alberts, B; Bray, D, Lewis, J., Raff, M., Roberts, K and Watson, J.D. 1991 3rd edn. Garland publishers, Oxford

**PAPER – II BT 102 GENETICS****UNIT 1: PRINCIPLES OF GENETICS**

- Mendel's experiments - Monohybrid ratios- Dihybrid and Tri hybrid ratios –
- Laws of independent assortments - Test cross and Back cross.
- Incomplete dominance - eg Flower Color.
- Co-dominance - eg MN Blood groups.
- Pleiotropism
- Penetrance and Expressivity - Irregular dominance-eg: Polydactyly
- Chromosomal Theory of Inheritance. Extension to Mendel's Laws. Multiple Allelism - eg. Coat color in Rabbits eye color in Drosophila, ABO Blood groups, Rh blood groups – incompatibility and pseudoallelism
- Non allelic interactions - Types of Epistasis
- Sex determination in Drosophila, Birds, Man, X-linked inheritance - Hemophilia, Color blindness, X-inactivation. Y-linked inheritance - Holandric genes. Inheritance patterns in Man - Pedigree analysis

**UNIT 2: CHROMOSOME ORGANIZATION AND CHROMOSOMAL ABERRATIONS**

- Chromosome morphology - Classification – Karyotyping. Features of Centromere and Telomere.
- Specialized chromosomes - Polytene & Lamp brush chromosomes.
- Euchromatin and Heterochromatin. Chromatin organization - Nucleosome, loops and Scaffolds.
- Variation in chromosome number – Euploidy, Aneuploidy. Variation in chromosome structure deletions, duplication translocations and inversions

**UNIT 3 : LINKAGE AND GENE MAPPING**

- Cytological proof of crossing over,
- gene mapping, determination of map distances based on two and three point test crosses,
- Mitotic Crossing Over, Tetrad analysis – Neurospora.
- Gene mapping in man – Genetic mapping, sib pairs, TDT test

**UNIT 4 : ORGANELLAR INHERITANCE**

- Non- Mendelian Inheritance .Variegation in leaves of higher plants- *Mirabilis jalapa*
- Maternal inheritance - Shell coiling in snails Leber's Optic Atrophy in man.
- Uniparental inheritance - mutations in extra nuclear genes in chlamydomonas.
- Plasmids, IS element

**BOOKS RECOMMENDED**

1. An introduction to Genetic Analysis by Anthony, J.F. J.A. Miller, D.T. Suzuki, R.C. Richard Lewontin, W.M-Gilbert, W.H. Freeman publication, 1998.
2. Principles of Genetics by E.J.Gardner and D.P. Snusted. John Wiley & Sons, New York 7th edition 1984.
3. The science of Genetics, by A.G. Atherly J.R. Girton, J.F. Mcdonald, Saundern College publication, 1999.
4. Principles of Genetics by R.H. Tamarin, International edtn McGrawhill - 1996
5. Theory & problems in Genetics by Stansfield, Schaum out line series McGrahill –2000

**PAPER – III BT 103 BIOCHEMISTRY****UNIT 1: CHEMISTRY OF BIOMOLECULES**

- Carbohydrates: Classification, structure, configuration, conformation
- Stability, formation of glycosidic bond, disaccharides & oligosaccharides.
- Polysaccharides: structural (cellulose, chitin) storage (starch, glycogen, insulin).
- Hemicelluloses
- Liginins, Pectins
- Glycoso-amino-glycans
- Blood group substances, glycoproteins, proteoglycans & bacterial cell wall polysaccharides (peptidoglycans).
- Classification, characteristics of amino acids. Essential & Non essential amino acids.
- Classification of proteins, Structural organization of proteins – primary, secondary, tertiary, quaternary
- Ramchandran's plot.
- Structure, properties & classification of lipids, fatty acids. Porphyrins

**UNIT 2: CHEMISTRY OF BIOMOLECULES – II**

- Nucleic Acids: Structure of purines, pyrimidine's, nucleosides and nucleotides.
- Watson & Crick model of DNA, Different forms of DNA.
- Circular DNA & super coiling.
- Types of RNA. Structure of t-RNA.
- Denaturation & renaturation of DNA
- Melting Curves. Calculation of  $T_m$

**UNIT 3: BIOENERGETICS**

- Law of thermodynamics, Biological oxidation, Gibbs energy, free energy changes
- redox potential & phosphate potential.
- High energy compounds. Glycolytic Pathway.
- TCA Cycle, Oxidative Phosphorylation, Photophosphorylation ,
- Electron Trasnport Chain, Glyoxylate Cycle, Pentose Phosphate Pathway.
- Gluconeogenesis.
- Photosynthesis. -Photosystems. Light & Dark Phases.
- C3 & C4 and CAM Pathways.
- Bioluminescence.
- Fatty acid Metabolism -  $\beta$ - Oxidation of fatty acids

**UNIT 4: ENZYMOLOGY**

- Introduction – special characteristics of enzymes, co-factors, specificity of enzymes.
- Nomenclature & classification of enzymes, Steady state concept – Importance of  $K_m$  &  $V_{max}$ .
- Michaelis-Menton equation. Factors affecting the rate of the reaction:
- Enzyme activation. Types of Enzyme inhibitions. Enzyme inhibitors
- Properties of enzymes: isolation methods & purifications.
- Regulation- Hill equation, cooperativity, Multiple sites on an enzyme.

### UNIT 1: GENERAL CHARACTERS OF MICROORGANISMS

- The concept of Microbial origin of Fermentations. Historical developments in Microbial Biotechnology.
- Microscopy, types of Microscopy.
- Classification, Structure and general characters of Bacteria, Archaea, Fungi and Algae.
- Nutrition in Microorganisms and assimilation of nutrients.
- Nutritional groups of microorganisms. Microbiological media and their applications.

### UNIT 2: VIRUSES AND THEIR CHARACTERS

- Classification and General Characters of viruses.
- Structure and replication of Bacteriophage (T2), TMV, Measles, HIV, SV40.
- Prions – Kuru, Bovine Spongy Encephalopathy
- Methods of cultivation of viruses. Importance of viruses in biotechnology.

### UNIT 3: MICROBIOLOGICAL TECHNIQUES

- Concept of sterilization. Methods of sterilization. Sterilization techniques used in Industries. Kinetics of thermal death of cells & spores.
- Concept of pure culture and methods of pure culture development.
- Methods of preservation of microbial cultures
- Microbial growth and growth curve. Exponential growth and synchronous growth
- Methods of measurement of growth

### UNIT 4 : RECOMBINATION IN BACTERIA AND VIRUSES

- Transformation : Competence factors, mechanism of transformation, mapping genes by transformation.
- Conjugation - Structure of F plasmid, Mechanism of transfer of F plasmid. Hfr, mechanism of integration of F plasmid into bacterial chromosome, circularization of chromosome. Conjugation mapping – different methods.
- Transduction. Generalized transduction, lysogenic and lytic cycle. Specialized transduction – structure of  $\lambda$  phage, mechanism of integration  $\lambda$  phage. Gene mapping by transduction

### BOOKS RECOMMENDED

1. Microbiology by M.J. Pelzar, E.S.N. Cfan and N.R. Kreig, McGraw Hill Publ.
2. Introductory Microbiology by J. Heritage, E.G.V. Erans, R.A. Killington, Cambridge University Press.
3. General Microbiology by H.G. Schlegel Cambridge University Press.
4. General Microbiology by Stanier, R.Y, J.L. Ingrahm, M.L. Wheel is & P.R. Painter.
5. Microbiology – concepts and Application. John Wiley and Sons, New York, 1988.

## **PRACTICALS**

### **BT 105 CELL BIOLOGY & GENETICS**

#### **CELL BIOLOGY**

1. Karyotyping of normal & abnormal chromosome sets
2. Preparation of mitotic & meiotic chromosomes from Hibiscus & onion root
3. Isolation of Mitochondria
4. Isolation of Chloroplast
5. Cell Cycle Synchronization

#### **GENETICS**

1. Breeding of Drosophila and observation of inheritance patterns
2. Preparation of polytene chromosomes
3. Quantitative Inheritance – Problems
4. Inheritance patterns in Man – Pedigree analysis
5. Monohybrid and dihybrid ratios, Multiple alleles, Epistasis - Problems
6. Localization of genes – two & three point test crosses – Problems
7. Tetrad analysis - Problems

### **BT 106 BIO CHEMISTRY & MICROBIOLOGY**

#### **BIO CHEMISTRY**

1. Carbohydrates- Identification methods
2. Identification of amino acids and proteins by color reactions.
3. Determination of acid value, saponification and Iodine number of oils and fats.
4. Separation of amino acids.
5. Verification of Beer-Lamberts Law and its deviation

#### **MICROBIOLOGY**

1. Microscopic observation, Staining and identification of bacteria, fungi and algae
2. Preparation of routine microbiological media
3. Sterilization methods
4. Culturing of microorganisms: pure culture techniques.
5. Isolation of bacteria, fungi and algae
6. Isolation of bacteriophages
7. Preservation and maintenance of microbial cultures
8. Measurement of microbial growth-turbidometry
9. Study for bacterial growth curve



## **SEMESTER – II**

### **PAPER I : BT 201 MOLECULAR BIOLOGY**

#### **UNIT 1: GENETIC MATERIAL AND GENOME REPLICATION**

- DNA as genetic material – Experiments of Griffith, Avery et al and Hershey & Chase.
- RNA as genetic material - TMV.
- Enzymes involved in the replication of DNA and their features.
- Replication of DNA – Semi conservative replication. Meselson and Stahl's experiment. Replication of circular DNA
- Maintenance of ends of linear DNA molecules. Regulation of eukaryotic genome replication
- DNA damage, repair and recombination– Mutations -physical and chemical. Types of DNA repair.
- Homologous and non homologous end joining

#### **UNIT 2 : GENOME ORGANIZATION. GENERAL FEATURES OF PROKARYOTIC GENOME ORGANIZATION**

- Organization of Prokaryotic genes. Organization of eukaryotic genome.
- Genome size, c-value paradox. Gene clusters and gene families, organization of chloroplast and mitochondrial genomes
- unique sequence, moderate and highly repetitive sequences, Palindromes. Satellite DNA. Transposons, Transposable elements, IS elements
- DNA re-association kinetics

#### **UNIT 3 : GENE EXPRESSION**

- Mechanism of transcription in prokaryotes. Initiation. Elongation. Termination. Mechanism of transcription in eukaryotes. Eukaryotic RNA polymerases.
- Transcription factors. Transcription activators- zinc fingerprints. HAL4, Homeodomain. Enhancers and mediators. Post transcriptional events.
- Splicing mechanism- alternate splicing, trans splicing, self splicing, tRNA splicing. Capping and polyadenylation.
- Correspondence of amino acid sequence in proteins with nucleotide sequence in DNA, single letter codes for amino acids. Properties of genetic code- universal code, degeneracy and redundancy.
- Mechanism of translation, assembly of ribosomal subunits, t-RNA structure.
- Peptide chain formation. Post translational modifications

#### **UNIT 4 GENE REGULATION**

- Co-ordinated Regulation of gene expression in Prokaryotes.
- Regulation of lactose operon. Regulation of Tryptophan operon.
- Regulation of Gene expression in Eukaryotes. Genes controlling yeast mating type.
- Regulation of Xenopus 5S rRNA in oocytes.
- Using a strategically placed enhancer as genetic switch – chicken globin genes.
- Gene regulation exerted at the level of translation – silk fibroin gene
- Regulation at splice site selection – Drosophila sex determination

#### **BOOKS RECOMMENDED**

1. Molecular Biology of the Gene by J.D. Watson, N.H. Hopkins, J.W, Robertis , A. Steitz & A.M. Weiner,
2. Genes VII. Benjamin Lewin, Oxford Univ. Press, Oxford
3. Molecular Biology by D, Freifelder Narosa Publishing house New York, Delhi,
4. Molecular Cell Biology Lodish, H., Baltimore, D; fesk, A., Zipursky S.L., Matsudaride, P. and Darnel
5. Advance Molecular Biology Twyman, R.M., Bios Scientific publishers Oxford 1998.
6. Molecular Biology by Brown, 3rd edition.

### **PAPER – II : BT 202 r-DNA TECHNOLOGY**

#### **UNIT I ENZYMES AND VECTORS USED IN MOLECULAR CLONING.**

- Discovery of restriction enzymes - Restriction endonucleases and classification.
- Modifying enzymes used in molecular cloning; methylases, polymerases, ligases, kinases, phosphatases, nucleases, RNA dependent DNA polymerase, Terminal Deoxynucleotidyl transferase.
- E.Coli plasmid vectors – pBR322, pUC18, pET21. Bacterio-phage vectors –  $\lambda$  and M13. Cosmids, phagemids and Phasmids.
- Shuttle vectors - Yeast vectors, Baculo virus vector

#### **UNIT II CONSTRUCTION OF GENOMIC AND CDNA LIBRARIES.**

- DNA cloning.
- Strategies for construction of genomic libraries, chromosome walking.
- Strategies for construction of cDNA libraries. Subtraction libraries, normalized libraries

#### **UNIT III TECHNIQUES EMPLOYED IN MOLECULAR CLONING**

- Labeling of Nucleic acids and proteins
- Blotting and Hybridization techniques - Southern, Northern, Western, North- Western and Zoo blots and Colony hybridization
- DNA sequencing – Maxam and Gilbert method, Sanger's method. PCR technology and its applications.
- Cloned gene expression. Factors influencing cloned gene expression
- siRNA & Gene Silencing

#### **UNIT IV SELECTION AND ANALYSIS OF RECOMBINANT CLONES**

- Genetic selection – alpha complementation, insertional inactivation.
- Screening of libraries using labeled probes.
- Restriction mapping of cloned fragments. S1 Nuclease Mapping.
- Hybrid arrest and hybrid released translation.
- Site directed mutagenesis.
- Applications of rDNA technology

**PAPER – III BT 203 IMMUNOLOGY****UNIT I BASICS OF IMMUNOLOGY, IMMUNITY**

- Types of Immunity, Innate and Acquired Immunity.
- Cells of the Immune System – B & T Lymphocytes; T-cell sub-sets; The Antigen Presenting Cells
- Organs of the System :
  - Primary lymphoid organs (Bone marrow and Thymus)
  - Secondary lymphoid organs (Lymph nodes, spleen and mucosal-associated lymphoid tissue).
- Antigens - Immunogenicity versus Antigenicity, Factors that influence immunogenicity
- Haptens and the study of Antigenicity
- Epitopes - Properties of B-cell epitopes and T-cell epitopes,

**UNIT II IMMUNOGLOBULINS**

- Basic structure of Immunoglobulins - Immunoglobulin domains-variable region and constant region domains.
- Immunoglobulin classes - IgG, IgM, IgA, IgD and IgE; functions of Ig classes
- Antigenic determinants on immunoglobulins
- Antigen-antibody reactions – Precipitation, Agglutination, RIA, ELISA, Western Blot, Immunoprecipitation, Immunofluorescence
- Monoclonal & polyclonal Antibodies - Hybridoma Technology- Formation and selection of hybrid cells; Production of Monoclonal Antibodies and their clinical uses

**UNIT III MAJOR HISTOCOMPATIBILITY COMPLEX (MHC).**

- General organization and inheritance of MHC; MHC Haplotypes.
- The structure of MHC class-I and class-II molecules; organization of MHC class I and class II genes, peptide binding of MHC molecules.
- Antigen processing pathways
- Polymorphism of MHC class I and class II molecules; the role of HLA typing in organ transplantation.
- Cellular distribution of MHC molecules; MHC molecules and immune responsiveness

**UNIT IV THE HUMORAL AND CELL-MEDIATED IMMUNE RESPONSES.**

- The structure and functions of T-cell receptors ( TCR ); the TCR-peptide-MHC tri-molecular complexes.
- B-cell activation and proliferation by Thymus independent and Thymus dependent antigens; *in vivo* sites for induction of humoral response; B-cell differentiation,
- class-switching and generation of plasma cells and memory cells.
- Cell-mediated immune response: General properties of effector T-cells; Direct cytotoxic response; experimental assessment of cell-mediated cytotoxicity;
- Disorders of immune systems. Hypersensitivity.
- Immunosuppression & Transplantation.
- Vaccines, conventional, subunit & recombinant.
- Immunotoxins
- Tumor Immunology

## **BIO-STATISTICS AND ANALYTICAL TECHNIQUES**

### **UNIT 1 : DESCRIPTIVE STATISTICS**

- Sampling - Sampling procedure, homogenization of samples, samples size
- Measurement of averages and variation
- Measure of central values - Mean, median and mode,
- Measures of dispersion - range , mean deviation , standard deviation, coefficient of variation,
- Graphical representation of Data
- Probability, Concept of Probability. Binomial distribution, Normal distribution , Poisson distribution & their applications.

### **UNIT - 2 QUALITATIVE & QUANTITATIVE VARIABLES**

- Concept of Test of hypothesis, Null & Alternative hypothesis
- Chi square test & its applications
- Large Sample Tests- Z-test of Means & Proportions.
- Small sample test - T-test for Means, Paired T-test,
- Analysis of Variance and Co-variance. One-Way ANOVA, Two way ANOVA,
- F-test, Simple regression and correlation

### **UNIT- 3 BASIC TECHNIQUES**

- Dialysis, Ultrafiltration
- Spectroscopy Techniques - UV, Visible and Raman Spectroscopy
- Fluorescence; MS, NMR, PMR, ESR and Plasma Emission spectroscopy
- API-electrospray and MADI-TOF
- Types of centrifuge - Microcentrifuge, High speed & Ultracentrifuges;
- Units of radioactivity; Measurement of radioactivity; Geiger-Muller counter;
- Solid & Liquid scintillation counters
- Applications of isotopes in Biotechnology

### **UNIT 4 CHROMATOGRAPHY TECHNIQUES**

- TLC and Paper chromatography;
- Chromatographic methods for macromolecule separation - Gel permeation,
- Ion exchange, Hydrophobic, Reverse-phase and Affinity chromatography; HPLC and FPLC;
- Criteria of protein purity
- Electrophoretic techniques
- Theory and application of Polyacrylamide and Agarose gel electrophoresis;
- Capillary electrophoresis; 2D Electrophoresis; Disc gel electrophoresis; Gradient electrophoresis
- Pulsed field gel electrophoresis
- Protein crystallization

#### **Reference Books**

1. Freifelder D., Physical Biochemistry, Application to Biochemistry and Molecular Biology, 2nd Edition, W.H. Freeman & Company, San Fransisco, 1982.
2. Keith Wilson and John Walker, Principles and Techniques of Practical Biochemistry, 5th Edition, Cambridge University Press, 2000.
3. D. Holme & H. Peck, Analytical Biochemistry, 3 rd Edition, Longman, 1998.
4. R. Scopes, Protein Purification - Principles & Practices, 3 rd Edition, Springer Verlag, 1994.
5. Selected readings from Methods in Enzymology, Academic Press.

## **PRACTICALS**

### **BT 205 MOLECULAR BIOLOGY & rDNA TECHNOLOGY**

#### **MOLECULAR BIOLOGY**

1. Isolation of plasmid DNA
2. Isolation of DNA from Plant Cells
3. Isolation of DNA from Human whole blood
4. Determination of purity and concentration of DNA - Spectrophotometric method
5. Isolation of RNA
6. Ames test - Induction of mutations by chemical agents
7. Determining melting temperature of DNA
8. Reassociation Kinetics and estimation of cot values, construction of cot curves
9. Expression of GFP genes

#### **rDNA TECHNOLOGY**

1. Amplification of genomic DNA by PCR technique
2. Restriction digestion DNA and size determination of the fragments
3. Double digestion of DNA and restriction mapping
4. Cloning of foreign DNA fragments into E. coli
5. Selection of recombinant clones by alpha complementation / insertional inactivation
6. Analysis of recombinant clones
7. PCR based site directed mutagenesis

### **BT 206 IMMUNOLOGY**

1. Blood grouping, CBP
2. Micro-hemagglutination Test
3. Single Radial Immunodiffusion
4. Outcherlony double diffusion
5. Rocket Immunoelectrophoresis
6. Enzyme-Linked Immuno-sorbent Assay
7. Radial Immuno diffusion and m Double diffusion

#### **ANALYTICAL TECHNIQUES**

1. To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis
2. Spectrophotometer and validating the Beer- Lambert's Law.
3. Titration of Amino Acids and separation of aliphatic, aromatic and polar amino acids by TLC.
4. An Enzyme Purification Theme (such as E.coli Alkaline phosphatase or Lipase)
5. Ammonium Sulfate precipitation
6. Ion-exchange Chromatography
7. Gel Filtration
8. Assessing purity by SDS-PAGE Gel Electrophoresis
9. Biophysical methods (Circular dichroism spectroscopy, fluorescence spectroscopy).

## **SEMESTER – III**

### **BT 301 BIOINFORMATICS**

#### **UNIT 1: FOUNDATIONS OF COMPUTATIONAL BIOLOGY**

- Computer hardware & software.
- Introduction to computer languages – C, C++, JAVA, PERL
- Foundations to bioinformatics – History, overview, applications
- Bioinformatics data – nucleic acid sequence, protein sequence
- Bioinformatics databases –DNA, RNA, Protein & Drug databases.
- Bioinformatics tools and Resources – Bioinformatics web- portals, free online tools, downloadable free tools, software packages

#### **UNIT 2: COMPARISON METHODS IN BIOINFORMATICS**

- Basics of sequence alignment - Dot-matrix comparison. - match, mismatch, gaps, scoring alignments, gap penalty, protein vs DNA alignment.
- Pairwise alignment algorithms – Needleman and Wunch algorithm, Smith Watermann algorithm.
- Pair wise alignment based heuristic algorithms - Blast algorithm, FASTA algorithm.
- Multiple sequence alignment algorithms – progressive alignment algorithms, Iterative alignment algorithms.
- Multiple sequence alignment based databases searching: Consensus sequence, patterns, profiles. PAM and BLOSUM matrices

#### **UNIT 3: GENOMIC AND PROTEOMIC APPLICATION OF BIOINFORMATICS.**

- Bioinformatics for genome sequencing.
- EST Clustering and analyses.
- Finding genes in prokaryotic and eukaryotic genomes: open reading frames, contents, signals.
- Bioinformatics for Genome maps and markers.
- Bioinformatics for understanding Genome variation.
- Protein structure prediction and classification.

#### **UNIT - 4: APPLICATIONS OF BIOINFORMATICS**

- Medical application of Bioinformatics – disease genes, drug targets, pharmacogenomics, drug designing.
- Structural biology - Homology modeling .
- Bioinformatics for micro array designing and transcriptional profiling.
- Bioinformatics for phylogenetic analysis

#### **BOOKS RECOMMENDED**

1. Bioinformatics: Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor Laboratory Press
2. Biological Sequence Analysis : Probabilistic Models of Proteins and Nucleic Acids by Richard Durbin, Sean R. Eddy, Anders Krogh, Graeme Mitchison, Cambridge University Press.
3. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Second Edition by Andreas D. Baxevanis, B. F. Francis Ouellette, Wiley-Interscience
4. Foundations to bioinformatics – Evolution, similar macromolecular components, constancy of gene number and core proteome in closely related organisms
5. Bioinformatics data – nucleic acid sequence, protein sequence, protein structure, genomic, proteomic and metabolomic information
6. Bioinformatics databases – types, design, file formats, access tools with examples
7. Bioinformatics tools and Resources – free online tools, downloadable free tools, software packages, internet, Bioinformatics books and Journals, Bioinformatics web-portals

**BT 302 BIOPROCESS TECHNOLOGY**

**UNIT 1: FUNDAMENTALS OF BIOPROCESS ENGINEERING.**

- Introduction to bioprocess engineering.
- Bioprocess kinetics : Quantitative description of cellular process,
- Kinetic modeling,, Model structures.
- Material balances and energy balances
- Mass balances for ideal bioreactors.

**UNIT 2: UPSTREAM PROCESS**

- Designing of bioreactors: Bioreactor types, design configurations, design features
- Transport phenomenon in bioprocess system: Mass transfer, heat transfer, Oxygen transfer,
- Shear stress effects and energy inputs in bioreactors.
- Sterilization of media and air : Design of sterilization process (batch and continuous), sterilization of bioreactor, feed and liquid waste, sterilization of air, exhaust air

**UNIT 3: DOWNSTREAM PROCESS AND PRODUCT RECOVERY.**

- Downstream processing: A multi stage operation .
- Unit operations: solid liquid separation: filtration, centrifugation, filter aids, flocculation, foam separation
- Recovery of intracellular components: Mechanical and non-mechanical (chemical and enzymatic methods).
- Concentration of biological products : Evaporation, liquid-liquid extraction, aqueous two phase system (ATPS), membrane filtration, pervaporation, perstraction, precipitation, adsorption etc.
- Purification of product: chromatography methods: Size exclusion chromatography, ion exchange, column-chromatography, chromato-focussing, affinity chromatography,
- Product formulation: Crystallization, drying, lyophilization.
- Process integration

**UNIT 4. BIOPROCESS CONTROL MEASUREMENT AND AUTOMATION.**

- Classes of sensors: In-line, on-line and off-line sensors.
- Physical and chemical sensors for media and gases:
- Instrumentation and principles for measurement of temperature, flow rate, pressure, agitation shaft power, foam sensing, biomass, dissolve oxygen, pH, carbon dioxide etc.
- Automation and control system: manual control, automatic control, PID control and complex control systems.
- Application of computers in bioprocess engineering: Data logging, analysis and control.
- Process economics : Cost benefit analysis

**BT 303 PLANT BIOTECHNOLOGY**

**UNIT -I CLONAL PROPAGATION OF PLANTS.**

- Introduction to totipotency of Plant cells.
- Introduction of Plant Tissue culture.
- Types of media.
- Initiation of Callus and suspension cultures.
- Micropropagation. Protoplast culture and fusion. Development of somatic hybrids to overcome the incompatibility barriers organogenesis and embryogenesis.
- Encapsulation and production of synthetic seeds. Production of haploids through Anther and pollen culture. Technology of freeze preservations and crop improvement

**UNIT II PRODUCTION OF COMMERCIALY USEFUL COMPOUNDS BY CELL CULTURES.**

- Advantages of cultured plant cells and tissues as a source of secondary plant products.
- Cell line selection and commercial production of pharmaceutically important compounds using cell culture techniques.
- Physical and chemical factors that influence the production of secondary metabolites in vitro. permeabilisation, elicitation and immobilisation of cells for enhanced production of secondary products.
- Induction of hairy root cultures and their uses.
- Biotransformations using cell culture methods

**UNIT III MOLECULAR MECHANISMS OF ABIOTIC STRESS TOLERANCE IN CROP PLANTS**

- Drought stress tolerance.
- Flooding stress tolerance or submergence tolerance.
- Salt stress tolerance.
- High and low (cold) temperature stress tolerance.
- Photooxidative (light) stress tolerance.
- Metal stress tolerance

**UNIT IV MOLECULAR MECHANISMS OF BIOTIC STRESS TOLERANCE IN CROP PLANTS.**

- Biotic stress tolerance mechanisms
- Bacterial resistance.
- Fungal resistance.
- Viral resistance.
- Molecular markers and crop improvement.



**BT 304 ANIMAL BIOTECHNOLOGY**

**UNIT I ANIMAL TISSUE CULTURE**

- Equipment's and materials for animal cell culture technology,
- Primary and established cell line cultures. Development & maintenance of cell lines.
- Media for cultured cells & tissues - Introduction to the balanced salt solutions and simple growth medium. Natural & defined media. Sterilization of media
- Role of serum and supplements, Serum & protein free defined media and their application
- Chemical, physical and metabolic functions of different constituents of culture medium
- Role of carbon dioxide.

**UNIT II ANIMAL IMPROVEMENT**

- Conventional methods of animal Improvement – Selective Breeding, Cross Breeding.
- Embryo Biotechniques for augmentation of replication efficiency and faster multiplication of superior germplasm. Super ovulation, Oestrus Synchronization, embryo collection and transfer.
- In vitro maturation of oocytes, in vitro fertilization, embryo culture, preservation of embryo, ovum , semen.
- Micromanipulation and cloning.
- Somatic cell cloning. Embryo sexing.
- Transgenesis for animal improvement and production of animals as bioreactors for proteins of pharmaceutical value.
- Marker assisted selection and genetic improvement of live stocks.

**UNIT III DEVELOPMENT AND USE OF TRANSGENIC ANIMALS**

- Transgenic mice - methodology
- Retroviral Vector method. DNA microinjection method.
- Engineered embryonic stem cell method.
- Knocking in and knocking out of genes. Applications

**UNIT IV VACCINES AND THERAPEUTIC AGENTS**

- Sub-unit Vaccines.
- Live recombinant vaccines.
- Attenuated Vaccines.
- Anti-idiotypic vaccines.
- Monoclonal antibodies as therapeutic agents (transplant rejection).
- Genetically engineered Immunotherapeutic agents

**PRACTICALS**

**BT 305 BIOINFORMATICS & BIOPROCESS TECHNOLOGY**

**BIOINFORMATICS**

1. Introduction to computer hardware and software
2. Introduction to Pubmed, NCBI & EMBL
3. Introduction to FASTA & BLAST
4. Dot-matrix comparison – understanding stringency
5. Searching DNA databases with FASTA and BLAST
6. Searching protein sequence databases with FASTA and BLAST
7. Pairwise alignment
8. Multiple sequence alignment
9. Compositional analysis of DNA – GC/AT content - codon usage - codon bias
10. Protein structure visualization
11. Understanding the bioinformatics behind human, rice, yeast and E.coli genome projects
12. Microarrays

**BIOPROCESS TECHNOLOGY**

1. Quantitative description of bioprocess by estimating specific growth rate of target organism using kinetic models and determination of yield co-efficient
2. Cell/tissue immobilization, production of biomass and harvesting of biological organism for analysis
3. Development of laboratory scale bioreactors
4. Recovery of product from fermentation broth and optimization of parameters
5. Extraction of protein from a crude bioprocess homogenate using Aqueous Two Phase System (ATPS)
6. Purification and identification of unknown compounds from a mixture of compounds using column chromatography and TLC

**BT 306 PLANT & ANIMAL BIOTECHNOLOGY**

**PLANT BIOTECHNOLOGY**

1. Germination of seeds without media
2. Preparation of MS media
3. Induction of callus
4. Preparation of somatic embryos and preparation of synthetic seeds
5. Isolation of protoplast
6. Induction of hairy root cultures for the production of secondary metabolites
7. Confirmation of BT genes in BT cotton by PCR
8. Genetic transformation of plants using *Agrobacterium tumefaciens*
9. Preparation of Nostoc & Azolla biofertilizers

**ANIMAL BIOTECHNOLOGY**

1. Preparation of chick embryo liver cultures
2. Cell counting & cell viability
3. Measurement of phagocytic activity
4. Injection of DNA sequence to egg embryos
5. Embryonic fixing
6. Cell fusion with PEG
7. Trypsinization of monolayer

**BT 401 INDUSTRIAL BIOTECHNOLOGY**

**UNIT I BIOPROCESS & FERMENTATION TECHNOLOGY**

- Introduction of Industrial biotechnology & bioprocess engineering
- Fermentation design – overview of aerobic & anaerobic fermentation process.
- Fermentation process and factors affecting fermentation process.
- Bioreactor: Bioreactor types & design
- kinetics & Transport phenomenon in bioprocess system
- Kinetic modeling, Model structures. Material balances. Mass transfer, heat transfer, Oxygen transfer, shear stress effects and energy inputs in bioreactors.
- Sterilization of media and air
- Design of Fermentation media. Substrates used as Carbon and nitrogen sources

**UNIT II ISOLATION, SELECTION AND PRESERVATION OF INDUSTRIAL MICROORGANISMS**

- Industrial cultures – Bacteria, Algae, Fungi, Actinomycetes.
- Primary and secondary screening of microorganisms for industrial products.
- Isolation and preservation of microorganisms for industrial products.
- Strain development – mutation, selection & recombination

**UNIT 3: DOWNSTREAM PROCESS AND PRODUCT RECOVERY.**

- Downstream processing: A multi stage operation Unit operations: solid liquid separation: filtration, centrifugation, filter aids, flocculation, foam separation (theory and equipments).
- Recovery of intracellular components: Mechanical and non-mechanical (chemical and enzymatic methods).
- Concentration of biological products : Evaporation, liquid-liquid extraction, aqueous two phase system (ATPS), membrane filtration, pervaporation, perstraction, precipitation, adsorption
- Purification of product: chromatography methods: Size exclusion chromatography, ion exchange, chromatofocussing, affinity chromatography, immobilized ion metal chromatography, Resins
- Product formulation: drying, crystallization

**UNIT IV PRODUCTION OF MICROBIAL PRODUCTS**

- Organic acids – citric acid, acetic acid & gluconic acid. Amino acids – glutamic acid. Alcohols & beverages – ethanol, beer, wine. Enzymes – proteases, lipases, cellulases & pectinases.
- Antibiotics – penicillin, erythromycin
- Biosensors
- Vaccines – hepatitis-B, polio
- Vitamins – B 12
- Dairy products – cheese, yoghurt

## **BT 402 ENVIRONMENTAL BIOTECHNOGY**

### **UNIT I: BIOMASS AND BIO-FUELS**

- Plant biomass (Cellulose, starch, pectin, gum materials),
- Animal biomass (chitin, milk whey, Slaughter house wastes),
- Microbial biomass (algal blooms -in fresh and sea waters,
- Fungal- Mushrooms, yeasts and bacterial fermentation biomass wastes).
- Concepts of single cell proteins, probiotics and their applications.
- Biomass feed stocks to fermentations.
- Microbial production of fuels: alcohols, hydrogen and methane.
- Microbial production of polymers (xanthan gums)

### **UNIT II: BIOREMEDIATION AND BIO-LEACHING.**

- Types and sources of pollution - Inorganic, organic and biotic.
- Clinical examples of air, water and land pollutions.
- Environmental impact of pollution and measurement methods.
- Composting of organic wastes, microbial bioremediation of oil spills.
- Waste water treatment - sewage treatment and common industrial effluent treatment .
- Concepts of bioremediation (in-situ and ex-situ),
- Bioremediation of toxic metal ions – biosorption and bioaccumulation principles.
- Concepts of phytoremediation .
- Microbial biotransformation of pesticides and xenobiotics.
- Microbial leaching of ores – direct and indirect mechanisms

### **UNIT III: BIOFERTILIZERS AND BIOPESTICIDES.**

- Biofertilizers and their importance in crop productivity.
- Algal and fungal (mycorrhizae) biofertilizers.
- Bacterial biofertilizers (rhizobial, free living N<sub>2</sub> fixers and phosphate solublizing bacteria), their significance and practice. Biopesticides : Bacterial (Bt pesticides), fungal (Trichoderma).
- Viral biopesticides – Baculovirus, NPV insecticides.
- Production of biofertilizers and biopesticides for large scale application.

### **UNIT IV : GENETIC ENGINEERING IN ENVIRONMENTAL BIOTECHNOLOGY.**

- Genetically engineered microorganisms in environmental health.
- Genetically engineered plants and microorganisms in agriculture and productivity.
- Genetically engineered bacteria in bioremediation of organic pesticides, insecticides oil spills.
- Hazards of genetically engineered microorganisms, plants and animals.
- Policies of genetic engineering research

**BT 403 INTELLECTUAL PROPERTY RIGHTS, ETHICS & BIOSAFETY**

**UNIT 1 INTELLECTUAL PROPERTY RIGHTS**

- Intellectual property rights: Classification and forms. Rationale for protection of IPRs
- Importance of IPRs in the fields of science and technology.
- Patents – Concepts and principles of patenting – Patentable subject matter
- Procedure of obtaining patents – Rights of patents – Infringement of patent rights.
- Remedies for infringement of patent rights
- Plant and Animal variety protection act, The strategy of protecting plants and animals
- Recent Developments in Patent System and Patentability of biotechnological inventions.
- IPR issues in Indian Context Role of patent in pharmaceutical industry,
- Case studies Rice, Haldi, neem, etc.
- Patentability and emerging issues

**UNIT 2 ETHICAL ISSUES**

- Introduction
- Causes of unethical acts, ignorance of laws, codes, policies and Procedures, recognition, friendship, personal gains.
- Professional ethics – professional conduct
- Ethical decision making, ethical dilemmas.
- Teaching ethical values to scientists,
- Good laboratory practices,
- Good manufacturing practices

**UNIT 3 QUALITY MANAGEMENT**

- Basic standards, Need of standards
- Analytical standards- Reference materials/controls (positive & negative), matrix effect in standards.
- Biological standards - Microbial cell lines and standards.
- Quality Management - Quality system. Types of Quality systems. ISI, ISO, HACCP, USFDA 21 CFR
- Inspection and testing, Handling, Storage, Packaging, Preservation of the material, Internal quality audits,
- Quality assurance. – Indian (NABL) & International systems

**UNIT 4 BIOSAFETY**

- Biosafety in the laboratory institution: Laboratory associated infections and other hazards,
- assessment of biological hazards and levels of biosafety,
- prudent biosafety practices in the laboratory/ institution
- Biosafety regulations in the handling of recombinant DNA processes and products in institutions and industries,
- biosafety assessment procedures in India and abroad.
- Biotechnology and food safety: The GM-food debate and biosafety assessment procedures for biotech foods & related products, including transgenic food crops,
- Ecological safety assessment of recombinant organisms and transgenic crops,
- Biosafety assessment of biotech pharmaceutical products such as drugs / Vaccines etc.
- International dimensions in biosafety: Cartagena protocol on biosafety, bioterrorism and convention on biological weapons

**BT 404 MEDICAL BIOTECHNOLOGY****UNIT I: CLASSIFICATION OF GENETIC DISEASES**

- Chromosomal disorders – Numerical disorders e.g. trisomies & monosomies,
- Structural disorders e.g. deletions, duplications, translocations & inversions,
- Chromosomal instability syndromes.- Gene controlled diseases – Autosomal and X-linked disorders, Mitochondrial disorders and Multifactorial conditions
- Identification of disease genes .Functional cloning –eg. haemophilia gene .Positional cloning – eg. DMD and CGD genes.
- Candidate gene approach – eg. Marfan’s syndrome, Alzheimer’s disease.
- Molecular basis of human diseases - Pathogenic mutations. Gain of function mutations: Oncogenes, Huntingtons Disease, Pittsburg variant of alpha 1 antitrypsin.
- Loss of function - Tumour Suppressor Genes, PAX- 3 gene.
- Gene Dosage Effect - PMP22 Collagen gene.
- Genomic Imprinting -Mechanisms, Praderwilli / Angelman syndrome, WAGR syndrome, Beckwith Weidemann Syndrome.
- Dynamic Mutations - Fragile- X syndrome, Myotonic dystrophy.Mitochondrial diseases: MELAS, LHON, MERRF. Immuno Pathology, Hepatitis, HIV, Autoimmune Disorders-SLE, RA

**UNIT : II DIAGNOSTICS.**

- Prenatal diagnosis - Invasive techniques - Amniocentesis, Fetoscopy, Chorionic Villi Sampling (CVS),
- Non-invasive techniques - Ultrasonography, X-ray, TIFA, maternal serum and fetal cells in maternal blood.
- Diagnosis using protein and enzyme markers, monoclonal antibodies.
- DNA/RNA based diagnosis Hepatitis, CML – bcr/abl, HIV - CD 4 receptor.
- Microarray technology- genomic and c DNA arrays, application to diseases

**UNIT III : THERAPEUTICS**

- Clinical management and Metabolic manipulation – PKU, Familial Hypercholesterolemia, Rickets, ADA, Congenital hypothyroidism.
- Gene therapy - Ex-vivo, Invivo, Insitu gene therapy Strategies of gene therapy: gene augmentation – ADA defeiciency, CFTR Prodrug therapy/ suicide gene – glioma, evoking immune response – melanoma TFO,
- Antisense therapy, Ribozymes, Protein Aptamers, Intrabodies.
- Vectors used in gene therapy Biological vectors – retrovirus, adenoviruses, Herpes Synthetic vectors– liposomes, receptor mediated gene transfer.
- Gene therapy trials – Familial Hypercholesterolemia, Cystic Fibrosis, Solid tumours.
- Cell and tissue engineering: Encapsulation technology and therapeutics-Diabetes, Hypothyroidism, Haemophilia
- Bioartificial organs, Artificial Cells- For Haemophilia, Phenyl Ketonuria, Diabetes.
- Stem cell therapy - Embryonic and adult Stem Cells, Totipotent, Pluripotent and Mulltipotent Cells.
- Testing and generation of embryonic stem cells,Testing for adult stem cells and differentiation.Potential use of stem cells – Cell based therapies.Nanomedicine – Nanoparticles, Nanodevices-medical microrobotics, nanorobotics , Microbiovers, Nanomedicine and Nanosurgery – for cancers, neurological disorders.

**UNIT IV : GENE PRODUCTS IN MEDICINE**

- Functional cloning – anti-haemophilic factor .
- Positional cloning- Dystrophin.
- Gene products in medicine – Humulin, Erythropoietin, Growth Hormone/Somatostatin, tPA, Interferon.
- DNA based vaccines. subunit vaccines – Herpes Simplex Virus. Attenuated Vaccines– Cholera, Salmonella

**REFERENCE BOOKS**

1. Medical Biotechnology; Albert Sasson (2006), United Nations Publications
2. Medical Biotechnology; S. N. Jogland (2000), Himalaya Publication
3. Medical Devices and Systems in Biomedical Engineering Handbook, Vol 2; Joseph Bronzino & Bronzino and Bronzino
4. The Proteus effect, Ann B Parson (2006); National Academic Press
5. Biotechnology and Biopharmaceuticals (2003), Rodney J.Y. Ho an milo Gilbaldi, Wiley John & sons.
6. Stem Cell Now : Christopher Thomas Scott (2005) Penguin group (USA)
7. Biotechnology Demystified Sharon Walker (2006) McGrow Hill Publication

**BT 404 NANOBIO TECHNOLOGY****UNIT - I BASICS of BIONANOTECHNOLOGY**

- Introduction to nanomaterials,
- Structure and functional properties of Biomaterials
- Role of size in nanomaterials, nanoparticles, semiconducting nanoparticles, nanowires, nanoclusters, quantum wells
- Water environment and their importance in bionanomachines.
- Overview of natural Bionanomachines: Thymidylate Synthetase , ATP synthetase, Actin and myosin,
- Quantum Dot structures and their integration with biological structures.
- Lipids as nano-bricks and mortar: self assembled nanolayers.

**UNIT 2 NANO-BIOSENSORS**

- Biosensors
- Definition and classification – potential based sensors; electrochemical sensors; acoustic/mechanical sensors; thermal and phase transition sensors; sensors in modern medicine-
- Biomembrane based sensors. Diagnostic imaging techniques (digital imaging; molecular imaging).
- Nanoengineered biosensors

**UNIT 3 NANOMEDICINE AND NOVEL DRUG DELIVERY SYSTEMS**

- Application of nano materials in medicine
- Nanoparticles as carrier for genetic material, neuroscience, cancer therapy, cardiovascular medical devices
- Tissue regeneration (tissue engineering).
- Dendrimers as nanoparticulate drug carriers.
- Drug delivery systems –polymer drug conjugates; polymeric micelles; liposomes.
- Nanoparticles for drug delivery

**UNIT 4 APPLICATIONS OF NANOBIO TECHNOLOGY**

- Bio-Barcode
- Assay Understanding of antibody based diagnostic techniques (immunoassay) - micro and nano immunosensors
- Nanotechnology in agriculture – Fertilizer and pesticides.
- Designer proteins, Peptide nucleic acids,
- Future of Bionanotechnology

## References:

1. C. M. Niemeyer, C. A. Mirkin, —Nanobiotechnology: Concepts, Applications and Perspectives||, Wiley – VCH, (2004).
- 2 T. Pradeep, —Nano: The Essentials||, McGraw – Hill education, (2007).
3. Challa, S.S.R. Kumar, Josef Hormes, Carola Leuschaer, ||Nanofabrication Towards Biomedical Applications, Techniques, Tools, Applications and Impact||, Wiley – VCH, (2005).
4. Nicholas A. Kotov, —Nanoparticle Assemblies and Superstructures||, CRC, (2006).
5. David S Goodsell, “Bionanotechnology||, John Wiley & Sons, (2004)

**PRACTICALS**

**BT 405**

**INDUSTRIAL BIOTECHNOLOGY**

1. Development of laboratory scale bioreactors: know how
2. Cell/tissue immobilization
3. Extraction of protein from a crude bioprocess homogenate using Aqueous Two Phase System (ATPS)
4. Purification and identification of unknown compounds from using column chromatography, TLC
5. Production of organic acids - Citric acid production & estimation
6. Production of alcohol (wine)- Alcohol production & estimation
7. Screening Production and assay for lipase producing organisms
8. Penicillin production and estimation

**ENVIRONMENTAL BIOTECHNOLOGY**

1. Biomass estimation by different methods
2. Isolation of Biofertilizer microbes by biological enrichment method
3. Production of microbial biofertilizers and biopesticides
4. Efficacy testing for biofertilizers (nodulation test for rhizobia) and biopesticides
5. Estimation of BOD & COD
6. Testing for microbiological quality of potable water (Coli form test)
7. Microbial degradation of organic matter
8. Testing for effect of chemical pesticides on soil microbial respiration
9. Testing for microbial biodegradation of pesticides
10. Development of genetically engineered microorganisms for bioremediation

**MEDICAL BIOTECHNOLOGY**

1. Genotyping of candidate genes for diseases by RFLP
2. Screening for known mutations by PCR
3. Screening for unknown mutations by SSCP and sequencing
4. Detection for dynamic mutations - Trinucleotide repeat polymorphism
5. Identification of disease gene expression by RT PCR
6. Sequencing of cDNA and cloning in expression vectors
7. Identification of fetal cells in maternal blood for detecting genetic defects
8. Detection of congenital abnormalities by triple test

**BIONANOTECHNOLOGY**

1. Nanostructured DNA Templates
2. Probing DNA structure with Nanoparticles
3. Fluoroimmunoassays using Antibody- conjugated Quantum Dots
4. Surface- Functionalized Nanoparticles for controlled Drug Delivery
5. Quantum Dot- encoded Beads
6. Ultrasensitive DNA sequence detection using nanoscale ZnO sensor arrays
7. Electrochemical Biosensors for the Detection of Pesticides
8. Membrane-Based Electrochemical Nanobiosensor for Escherichia coli Detection and Analysis of Cells Viability