BT CT 1.1 - BIOMOLECULES

50 Hrs

Unit 1

Chemical bonding: Covalent bonds, Ionic bonds, Hydrogen bonds, Co-ordinate bonds, Electrostatic forces, Vander-Waal's forces, Hydrophobic forces, Molecular orbitals in chemical bond formation, Sigma and Pi bonds, Bond length, Bond strength, Bond energy and bond radius, formation of chemical bonds with carbon and other elements. Geometry of carbon compounds, stereo-isomers, tetrahedral structure, Conformation and Configuration of Optically active molecules, asymmetric and chiral centers, D and L isomers, R and S configurations, Cis-trans configuration.

05 Hrs

Unit 2

Water: Structure & Properties of water, water as a solvent and its importance in biological system. pH and buffers - weak acid and weak base, Ionization of water and equilibrium constant, acid base theory and preparation of solutions, normality, molarity and molality. Henderson-Hasselbalch equation, Hydrogen ion and Hydroxyl ion concentration (pH), the pH scale, pK and pH relation, buffers concept, Importance and preparation of buffers.

05 Hrs

Unit 3

Bio-organic reactions: Acid-base, Covalent and Metal ion catalysis, Concept of nucleophiles and electrophiles, Nucleophilic and substitution reactions SN_1 and SN_2 reactions and their importance. Oxidoreduction reactions

03 Hrs

Unit 4

Carbohydrates: Properties and characteristics of Carbohydrates. Derivatives of monosaccharaides, amino sugars, deoxy-sugars and glycosides Purification and Structure of homo and hetero polysaccharides, Starch, Cellulose, Glycogen, Dextrin, Hemi-cellulose, Xylan, Pectin, Lignin, Agar-agar, Chitin, Hyalouronic acid, Heparin, Chondritinsulphate, Peptidoglycon and carbohydrates on cell surface.

09 Hrs

Unit 5

Nucleic acids: Structure of nucleotides, DNA and RNA, conformation of DNA, RNA– mRNA, rRNA and tRNA.

04 Hrs

Unit 6

Amino acids and Proteins: Classification, Structure and Properties of amino acids and classification of proteins. structural organization of proteins – primary, secondary, tertiary and quaternary structures (Haemoglobin – its conformational changes with respect to oxygen transportation), Conformational analysis, Ramachandran's plot and its significance, techniques of isolation and purification of proteins, Protein denaturation and renaturation kinetics with respect of RNA'ase, stability of proteins, Glycoproteins (N-glycan and O-glycan)

10 Hrs

Unit 7

Lipids: Classification of phospholipids, Glyco and Sphingolipids, structure, properties and reactions of lipids. Cholesterol and its derivatives

05 Hrs

Unit 8

Vitamins: Chemistry Fat and water soluble vitamins and their significance in metabolism.

03 Hrs

Unit 9

Secondary metabolites: Alkaloids, Pigments and Secondary metabolites: General introduction, Chemistry of medicinally and industrially important Alkaloids, Terpenoids, Carotenoids, Essential oils.

Pigments: Chemistry of chlorophylls, Cytochromes, Heme, Phenolics and Tannins.

03 Hrs

Unit 10

Antibiotics: Structure and Chemistry of Penicillin, Streptomycin, Chloramphenicol and Tetracyclins, Vancomycin, Peptide-antibiotics.

03 Hrs

PRACTICALS

BTCP-1.5 Based on BTCT 1.1 Biomolecules

1. Safety in Laboratory – Biosafety and Safety notices.
2. Preparation of buffers: Citrate, Phosphate, Tris-HCl Buffer.
3. Chromatography techniques:
   a. Separation of Plant Pigments and Amino acids by paper chromatography (Ascending and Descending).
   b. Separation of Lipids by Thin Layer Chromatography.
4. Qualitative analysis of Carbohydrates, Amino acids and Lipids.
5. Estimation of Carbohydrates by Anthrone method.
6. Estimation of reducing sugars by DNS method.
7. Estimation of protein by Biuret and FCR method.
8. Estimation of Vitamins- Vitamin C, Thiamine and Riboflavin.
9. Estimation of Blood cholesterol.
10. Estimation of DNA by DPA method.
11. Estimation of RNA by Orcinol method.
12. Determination of Saponification values of fats.

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Course outcomes

Program code with title	**BT CT 1.1 - BIOMOLECULES**	
Units	**Course Outcome**	**No of hours**
Unit 1	**Chemical bonding:** The students would understand the different chemical bonding, bond energy, confirmations and configurations of different biomolecules**.**	**05 Hrs**
Unit 2	**Water: St**udents will understand the structure and properties of water molecules and its physical and physiological properties. **St**udents will also understand the pH and buffers preparations and its importance.	**05 Hrs**
Unit 3	**Bio-organic reactions: St**udents will understand the acid- base concepts, and related bio reactions.	**03 Hrs**
Unit 4	**Carbohydrates: S**tudents get to know the types of carbohydrates, properties and their biological functions.	**09 Hrs**
Unit 5	**Nucleic acids:** Students will understand the structure and confirmations of Nucleic acids.	**04 Hrs**
Unit 6	**Amino acids and Proteins** Students will understand the types properties and functions of different amino acids in biological systems .	**10 Hrs**

Unit 7	**Lipids:** Students will get to know the classification of different lipids.	**05 Hrs**
Unit 8	**Vitamins: S**tudents will get to know the chemical nature of different vitamins and significance.	**03 Hrs**
Unit 9	**Secondary metabolites:** Students will familiarize with the different secondary metabolites	**03 Hrs**
Unit 10	**Antibiotics: St**udents will understand the structure and significance of antibiotics.	**03 Hrs**

BTCT 1.2-Microbiology

50 Hrs

Unit 1

History and scope of Microbiology

02 Hrs

Unit 2

Microbial diversity: Prokaryotes and Eukaryotes. Classification systems, Criteria used for microbial classification, morphological, staining, biochemical methods, serological techniques, Phage typing, DNA base composition, DNA finger printing, rRNA sequence Numerical Taxonomy, Chemotaxonomy, Classification of bacteria according to Bergey's Manual of systematic Bacteriology.

06Hrs

Unit 3

Isolation of microorganisms:

Culture media: Definition, Components and different types of culture media

Sterilization techniques: Physical and chemical methods

Methods of isolation: Serial dilution, spread plate, streak plate and pour plate methods

06Hrs

Unit 4

Identification of microorganisms:

Microscopy: Working principles and different types of microscopy

Stains and staining techniques: Different types of stains, methods of staining and their applications.

06 Hrs

Unit 5

Microbial nutrition and growth: Nutritional requirements, Growth curve, measurement of growth, Factors affecting the microbial growth.

04 Hrs

Unit 6

Viruses: Salient features and Structure of viruses, Multiplication of viruses (Lytic and Lysogenic cycles), viroids and prions.

02Hrs

Unit 7

Bacteria: General characters, classification, morphology and ultrastructure of bacteria. Bacterial multiplication, Spirochetes, Rickettsia, Chlamydia, Mycoplasma, Cyanobacteria, Actinomycetes and Extremophiles, Importance of bacteria in biotechnology

04 Hrs

Unit 8

Fungi: General characters, Structure and Classification of fungi. Importance of fungi in fermentation and antibiotic production

02Hrs

Unit 9

Algae: General characters, Structure and Classification of Algae. Economic importance of Algae

02 Hrs

Unit 10

Agriculture microbiology: Plant microbe interactions, Bio-fertilizers and bio-pesticides. Integrated pest management, transgenic plants

04 Hrs

Unit 11

Medical microbiology: Important diseases caused by microorganisms. Different types and modes of actions of antibiotics.

04 Hrs

Unit 12

Food microbiology: Microbes as foods, Fermentation, Fermented foods. Food spoilage and preservation techniques.

04 Hrs

Unit 13

Environmental microbiology: Aerobiology, Soil microbiology and Aquatic microbiology. Waste treatment, Bioremediation and biodegradation of Xenobiotics, Biotechnological applications of microorganisms in the environment.

04 Hrs

PRACTICALS

BTCP- 1.6 Based on BTCT 1.2-Microbiology

1. Laboratory safety rules and regulation.
2. Principal and working of laminar air flow, Autoclave, Hot air oven, Incubator, colony counter, haemocytometer and microscope.
3. Culture media preparation
   Preparation of Nutrient broth, agar plates, stabs and slants
   Preparation of Blood Agar, Chocolate agar, MacConkey agar and EMB agar

4. Microbial techniques for culturing Bacteria: Streak Plate, pour plate, spread plate and standard plate.
5. Staining techniques:

Program code with title	**BT CT 1.2 - MICROBIOLOGY**	
Units	**Course Outcome**	**No of hours**
Unit 1	**History and scope of Microbiology:** Students will understand the history and contribution of scientists in the field of microbiology.	**02 Hrs**
Unit 2	**Microbial diversity:** Students will learn about the classification of microorganisms and different methods of classification.	**06Hrs**
Unit 3	**Isolation of microorganisms:** Students will learn the different techniques for the isolation of microorganisms from different environment samples.	**06Hrs**
Unit 4	**Identification of microorganisms:** Students familiarize with the different methods of isolation of microorganisms.	**06Hrs**
Unit 5	**Microbial nutrition and growth:** Students know about the different factors influencing the growth of microorganisms.	**04 Hrs**
Unit 6	**Viruses: S**tudents know about the structure and classification of viruses.	**02 Hrs**
Unit 7	**Bacteria: S**tudents study in detail about the structure general properties and Importance of bacteria in biotechnology.	**04 Hrs**
Unit 8	**Fungi: S**tudents know about the structure and	**02 Hrs**

	classification and economical significance of fungi.	
Unit 9	**Algae: S**tudents know about the structure and classification and economical significance of Algae.	**02 Hrs**
Unit 10	**Agriculture microbiology: S**tudents know about the important plant microbe interactions, biopesticides and biofertilizers.	**04 Hrs**
Unit 11	**Medical microbiology: S**tudents study in detail about the different types of diseases and their mode of transmission and importance of antibiotics.	**04 Hrs**
Unit 12	**Food Microbiology:** Students familiarize with fermentation, fermented foods, spoilage and preservation of food.	**04 Hrs**
Unit 13	**Environmental microbiology:** Students will study in detail about the different microbial interaction role of microorganisms in the degradation of xenobiotics in the environment.	**04 Hrs**

Preparation of bacterial smear, simple staining, Gram's staining, acid fast staining, Negative staining, Capsular staining, Endospore staining and Flagella staining.

6. Biochemical tests :

   IMVIC Test, Catalase, Starch hydrolysis, citrate utilization, Fermentation of carbohydrates, Gelatin liquefaction test and IMVIC Test, oxicase test
7. Determination of Bacterial growth curve.
8. Study of antibiotic sensitivity test of bacteria: Disc/well diffusion method.

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BT CT 1.2 – MICROBIOLOGY

BTCT 1.3 - BIOPHYSICAL AND BIOCHEMICAL TECHNIQUES

50 Hrs

Unit 1

Introduction to biophysics: Scope of Biophysics, Bonds between atom & molecules, Ionic, Covalent, Hydrogen, Electrostatic, Disulphide & Peptide bonds, and Vander Waal's forces, Bond energies, Bond angles.

03 Hrs

Unit 2

Acids and Bases, Mole & Normality, Weak acids, Amphoteric electrolytes, pH, Calculation of pH from H & OH Concentration, measurements of pH, Henderson Haselbatch equation, Titration curve & pK values, Buffers & Stability of their pH, Numerical problems.

03 Hrs

Unit 3

Microscopy: Light Microscopy – Design and working of Compound, Phase contrast, Interference, Dark field Polarizing & Fluorescence microscope, Electron microscopy– Design and working of Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM), AFM. Super resolved fluorescence microscopy, Cryo-electron microscopy.

04 Hrs

Unit 4

Centrifugation: Basic principles, Forces involved, RCF Centrifugation, techniques- principles, types and applications. Centrifuges & Ultra-centrifuges types, optical methods used and applications of preparative (Differential, Density Gradient) and analytical (sedimentation velocity, sedimentation equilibrium) ultra-centrifugation.

05 Hrs

Unit 5

Chromatography techniques: Basic Concepts of adsorption & partition Chromatography, Principle Experimental set-up, Methodology & Applications of all types of Adsorption & Partition Chromatography methods-chromatography using paper, thin layer, HPTLC column (gel filtration, ion exchange, affinity), gas (GC,GLC), LCMS, HPLC: types of HPLC, Mobile phase elution , normal phase and reverse-phase HPLC,

column packing material, efficiency of column, types of HPLC – principles of methodologies, HPLC pumps -efficiency and suitability, Different injectors and Detectors; Ion Chromatography.

Membrane Techniques - Criteria of protein purity, equilibrium dialysis, ultra filtration and various membrane techniques.

08 Hrs

Unit 6

Electrophoretic techniques: Principle, Electrophoretic mobility (EPM) estimation, factors affecting EPM, Instrument design & set-up, Methodology & Applications of Free & Zone (Paper, Cellulose acetate, Agarose & Starch gel, Pulsed-field, PAGE, SDS-PAGE, Capillary) Electrophoresis techniques, Principle, Experimental set-up, Methodology & Applications isoelectric focusing, 2D electrophoresis.

06 Hrs

Unit 7

Spectroscopic techniques: Spectroscopy, Beer-Lambert's law, types of detectors, UV-Visible spectroscopy, Infrared spectroscopy, Raman spectroscopy, Fluorescent spectroscopy, Flame photometry, Atomic absorption, Plasma emission mass, ESR and NMR spectroscopy, ORD and CD. X-Ray Diffraction, X-Ray crystallography, Biological importance of Lasers, Microwaves and Radiations

10 Hrs

Unit 8

Synthesis of Nanomaterial's: Physical methods: Methods based on evaporation, sputter deposition, chemical vapour deposition (CVD), electric arc deposition. Chemical Methods: colloids and colloids in solution, synthesis of nanoparticles by colloidal routes, micro emulsions, Sol-Gel method.

Biological Methods: Introduction to biomaterials, Synthesis using microorganisms and plant extracts.

05 Hrs

Unit 09

X-ray crystallography: Unit cell, cell content, crystal symmetry, crystal systems, Bravais lattices, symmetry elements and operations, point groups and space groups. Bragg's law. Diffraction of x-rays by crystals, Atomic scattering factors and structure factors, amplitude and phase, Fourier transformation.

04 Hrs

Unit 10

Radioisotope techniques: Nature of radioactivity, detection and measurement. GM counter and Scintillation counter, Auto radiography, Safety aspects and applications

02 Hrs

PRACTICALS

BTCP-1.7 Based on BTCT 1.3-Biophysical and Biochemical techniques

1. Instrumentation: Spectrophotometer, Electrophoresis, Centrifuges, Micropipettes, Chromatographic techniques: Column, HPLC, GLC, GC-MS and NMR.
2. Demonstration of Beer-Lambert's Law.
3. Determination of pH using Indicators.
4. Determination of pKa value of acetate buffer.
5. Titration of strong acid with strong base.
6. Titration of weak acid and weak base.
7. Titration of mixture of strong and weak acids.
8. Titration curves of amino acids.
9. Colorimetric estimation of Inorganic phosphate.
10. Agarose gel electrophoresis for separation of Nucleic acids.
11. Separation of proteins by SDS-PAGE and Native PAGE.
12. Density Gradient centrifugation and separation of blood components.
13. Determination of acid value of fats.
14. Absorption curves of two different dyes.
15. Liposome Preparation: Sonication, light scattering, unicellular and multi cellular vesicles.
16. Synthesis and characterization of Nanoparticles from plants and microbial extracts.

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13. Stuart A. Hoenig & Daphne H. Scott, Medical Instrumentation and Electrical Safety, Wiley Medical.
14. Joseph J. Carr & John M. Brown, Introduction to Biomedical Equipment Technology, John Wiley and Sons.

BT CT 1.3 - BIOPHYSICAL AND BIOCHEMICAL TECHNIQUES

Program code with title	**BT CT 1.3 - BIOPHYSICAL AND BIOCHEMICAL TECHNIQUES**	
Units	**Course Outcome**	**No of hours**
Unit 1	**Introduction to biophysics: S**tudents will learn about the scope of biophysics and different type of chemical bonds involved.	**03Hrs**
Unit 2	**Acids and Bases**: Students will get the details regarding the acid bases, normality and buffers.	**03Hrs**
Unit 3	**Microscopy:** Students will familiarize with different types of microscope and its application.	**04Hrs**
Unit 4	**Centrifugation: S**tudents will learn about the different types and application of microscopes.	**05Hrs**
Unit 5	**Chromatography techniques: S**tudents will learn about the different types and application of microscopes..	**08 Hrs**
Unit 6	**Electrophoretic techniques: S**tudents will learn about the different types and application of chromatographic techniques.	**06Hrs**

Unit 7	**Spectroscopic techniques:** Students will get to know the principal, Experimental set-up, Methodology & Applications of spectroscopic techniques.	**10 Hrs**
Unit 8	**Synthesis of Nanomaterial's:** Students will learn about the different methods for symthesis of nanoparticles and their applications.	**05Hrs**
Unit 9	**X-ray crystallography:** Students will learn about the principle and the applications of X-ray crystallography.	**09Hrs**
Unit 10	. **Radioisotope techniques:** Students will learn about the different methods and applications of Radioisotope techniques.	**02 Hrs**

BT CT 1.4 - CELL BIOLOGY AND GENETICS

50 Hrs

Unit 1

Cell Theory and the cell: The cell theory, Organization of Prokaryotic and Eukaryotic cells, plasma membrane – organization, present model and functions, Mechanisms of membrane transport.

05 Hrs

Unit 2

Cell organelles: Structure and functions of Endoplasmic reticulum, Golgi complex, Mitochondria, Chloroplast, Ribosome, Lysosomes and Peroxisomes.

Nucleus: Microscopic and submicroscopic organization, structure and functions of nuclear membrane, Ultrastructure of Nucleolus.

08 Hrs

Unit 3

Eukaryotic chromosome: Chromatin, nucleosome structure, chromosome model, centromeric DNA, organization of telomere. Laws of DNA consistency and C-value paradox, Heterochromatin and its significance, Special types of chromosomes-B chromosomes, polytene and lampbrush chromosomes, sex chromosomes and sex determination, karyotyping.

08 Hrs

Unit 4

C**ell division:** Mitotic apparatus, cytokinesis, chromosome movement. Regulation of eukaryotic cell cycle-overview of cell cycle, cyclin and cyclin dependent kinases, molecular mechanism of regulating mitotic events. Cell cycle control in mammalian cells, Mutation causing loss of cell cycle control. Meiotic process- stages, Chromosome pairing, Chiasma formation, molecular mechanism of recombination, synaptonemal complex, recombination nodules and holiday junction, model of recombination.

08 Hrs

Unit 5

Numerical changes in chromosomes: Euploidy, haploidy their fundamentals and practical significance. Polyploidy-Types induction genetic significance, Aneuploidy-Types and genetics significance.

04Hrs

Unit 6

Principles of Heredity: Introduction, concepts and theories of Mendelian genetics, chromosomal theory of inheritance, extra chromosomal inheritance and interaction of genes.

03 Hrs

Unit 7

Genome Organization and Structural Analysis of Gene: Organization of *E coli* Genome- Functional classes of predicted genes common features of the genome of Achaea and eukaryotes, genome size and organization in yeast, *Arabidopsis*, *C. elegans* and *Drosophila*. Bar-locus complex loci and Pseudoalleles complementation, fine structure of rII locus, split genes and overlapping genes.

04 Hrs

Unit 8

Linkage and Crossing Over: Introduction to linkage, gene mapping in eukaryotes, sex linked inheritance, genetic control of chromosome pairing and molecular mechanism of crossing over, gene conversion.

02 Hrs

Unit 9

Sex Determination and Dosage Compensation: Sex determination in *Drosophila* and mammals, Secondary sex determination in mammals, Dosage compensation in *Drosophila* and mammals.

02Hrs

Unit 10

Mutation: Mutation and their types. Base pair and frame shift mutation, genetic suppression. Luria-Delbruck fluctuation test. Use of base analogs, alkylating agents and ionizing radiations to induce mutagenesis and their mechanism.

Molecular basis of mutation – spontaneous and induced mutation and their role in evolution.

Detection of mutation by Ame's test.

Chloroplast mutations in *Chlamydomonas*, variations in mirabilis, Mitochondrial mutations in yeast and *Neurospora*. Human diseases caused by mutations in mitochondrial genome.

04 Hrs

Unit 11

Population Genetics: Gene pools, allele frequencies, Hardy Weinberg equation, non-random breeding, genetic drift, gene flow, selection, speciation.

02 Hrs

PRACTICALS

BTCP 1.8 Based on BTCT-1.4-Cell Biology and Genetics

1. Micrometry: Calibration and measurement of Onion epidermal cells yeast and spores.
2. Study of Mitosis using onion root tips.
3. Study of Meiosis using grasshopper testis or Onion flower buds.
4. Buccal epithelial smear for study of Barr bodies.
5. Differential counting of WBC's using blood smear.
6. Culture and maintenance of *Drosophila melanogaster* cultures.
7. Mounting of Salivary gland chromosomes form *Drosophila* larvae.
8. Study of Auxotrophic mutants using replica plate technique.
9. Isolation and vital Staining of Mitochondria
10. Isolation of Chloroplast by density gradient method.
11. Isolation of protoplasts by osmotic/enzymatic method.
12. Karyotype analysis in humans: Normal: Male and Female, Abnormal: Down syndrome, Turner, Cri Du chat and Klinefelter's Syndrome.

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BT CT 1.4 - CELL BIOLOGY AND GENETICS

Program code with title	**BT CT 1.4 - CELL BIOLOGY AND GENETICS**	
Units	**Course Outcome**	**No of hours**
Unit 1	**Cell Theory and the cell S**tudents will learn about the cell theory and mechanism of membrane transport.	**03Hrs**
Unit 2	**Cell organelles**: Students will get the details regarding the Structure and functions of different cellular organelles .	**03Hrs**
Unit 3	**Eukaryotic chromosome:** Students will familiarize with the structural organization and karyotyping	**04Hrs**
Unit 4	C**ell division S**tudents will learn the different stages of cell cycle.	**05Hrs**
Unit 5	**Numerical changes in chromosomes: S**tudents will learn about the euploidy, polyploidy and their significance.	**08 Hrs**
Unit 6	**Principles of Heredity: S**tudents will learn about the different types and application of	**06Hrs**
Unit 7	**Genome Organization and Structural Analysis of Gene:** Students will get to know the organization of genetic material.	**10 Hrs**
Unit 8	**Linkage and Crossing Over:** Students will learn about the linkage, gene mapping in eukaryotes.	**05Hrs**
Unit 9	**Sex Determination and Dosage Compensation:** Students will learn about the sex determination.	**09Hrs**
Unit 10	**Mutation:** Students will learn about the different types of mutation and molecular basis of mutation.	**02 Hrs**
Unit 11	**Population Genetics:** Students will learn about the gene pool and Hardy Weinberg	**02Hrs**

	equation.	

BIOTECHNOLOGY SECOND SEMESTER SYLLABUS

FROM 2019-20 ONWARDS

BTCT 2.1- MOLECULAR BIOLOGY, BIOINFORMATICS AND BIOSTATICS

Unit 1

Organization of genetic material: Genome organization in viruses, bacteria and eukaryotes. Interrupted genes, gene clusters, structure of nucleosome, chromatin and chromosome.

03Hrs

Unit 2

Structural Polymorphism of DNA: DNA Structure A, Band Z DNA, Super coiled DNA and DNA Binding Proteins,

DNA viruses: Double stranded (Pox virus and SV40 virus) and single stranded DNA viruses.

Replication: Rolling circle replication, semi-conservative replication, replication fork-leading and lagging strands, enzymes involved at different steps of replication.

Folded fiber model of *E. coli* chromosome, split genes, over-lapping genes, DNA amplification, the law of DNA constancy and C-value paradox. Structure, types and replication of RNA virus

07Hrs

Unit 3

Transcription: DNA Binding Proteins, Classes of RNA Molecules and RNA Polymerases, Prokaryotic and Eukaryotic transcription, Post transcription modification – mRNA processing, 5-capping, 3-polyadenylation, Splicing Mechanisms, rRNA and tRNA processing.

03Hrs

Unit 4

Translation: Genetic code and wobble hypothesis, tRNA and the Aminoacyl-tRNAsynthetases, Clover leaf structure of tRNA prokaryotic and Eukaryotic translation machinery, Ribosomes, Mechanism of prokaryotic and eukaryotic transcription, Post translational modification of proteins, inhibitors of protein translation.

03Hrs

Unit 5

Gene as a Unit of Mutation: Mutation, mutagens and types of Mutations, Molecular basis of spontaneous and induced mutations and their role in evolution. Transposon and site directed mutagenesis, environmental mutagenesis and toxicity testing**,** Hot spots, AME's Test, Comet Assay.

03Hrs

Unit 6

Computer Science: Computer Architecture, Internal and External devices, computer software,

Operating system: Windows, UNIX (Ubuntu), LINUX, Macintosh, application software's like word processor, formatting the document, tables, mail merge and spell check. Spread sheets basics with MS Excel, labels, MS Power point, MS access

Computer Viruses: Overview and prevention

Computer network: Advantages of Networks, Types of Network (LAN & WAN) WIFI. Internet protocol (TCP/IP) File transfer protocols (FTP) WWW, HTTP. Etc., Cloud computing.

07Hrs

Unit 7

Programming : Algorithm and flow chart, C and C^{++} programming, structure of C programme, Header file, Global declaration, Main function, variable declaration, control statement, conditional looping and unconditional control statement hub functions.

03 Hrs

Unit 8

Introduction to Bioinformatics: Introduction to Biological Databases - Types of databases (Primary, secondary and complex databases), Bioinformatics platforms: NCBI, DDBJ EMBL, PUBMED**.** Nucleic Acid Sequence databases, Protein sequence database; Genomics, Transcriptomics, Proteomics and Metabolomics, PDB retrieval, Database visualization, Accessing bibliographic database, Integrated Information Retrieval, Extra 2 system. Bioinformatics softwares: Schrodinger, IMAGE J.

04 Hrs

Unit 9

Sequence alignment and phylogenetic:

Pair wise sequence alignment: e.g. BLAST, FASTA & CONTIG sequences

Multiple Sequence Alignment: e.g. Clustal W & Clustal X,

Phylogenetic analysis with reference to nucleic acids –PHYLIP, MEGA and NTYSIS (3D &2D)

Primer designing: Primer 3, applied biosystems,

03Hrs

Unit 10

Structural biology: Modeling, Protein secondary structure prediction – Chou Fasman rules –neural networks discriminant analysis, Prediction of trans-membrane segments in membrane proteins. Protein 3D structure prediction homology - identification of active sites/pockets, threading potential energy functions – energy minimization moleculardynamics simulated annealing.

b) Drug Design and discovery, steps in drug discovery, ADME, Lead identification, QSAR.

04Hrs

Unit 11

Commercial application of bioinformatics: Definition, genome technology, High throughput sequencing and assembly. Genomics in medicine, Disease monitoring, profiles for therapeutic molecular targeting. Diagnostics, drug discovery and genomics, Gene evolution, Comparative proteomics and its applications, IPR and Bioinformatics patents

03Hrs

Unit 12

Biostatistics:

1. Organization, description and graphical representation of data.
2. Summary measures of – Central tendency (mean, mode, median), dispersion (Standard Deviation, Standard error) correlation (2-D, 3-D, Pearson, R value, Heatmap) and regression Chi square tests, tests of significance (t test, P-value, F, ANOVA.
3. Statistical softwares: MS Excel, MS access, Statistica, SPSS, Graph pad.

07Hrs

PRACTICALS

BT CP 2.5 Based on BT CT 2.1 Molecular Biology, Bioinformatics and Biostatistics

1. Isolation and estimation of DNA, RNA and plasmids.
2. Inheritance and pedigree analysis of simple Mendelian traits.

3. Induction and study of physical and chemical mutagens in bacteria/fungi
4. RFLP and RAPD analysis.
5. Demonstration of Southern blotting / Northern blotting/Western blot
6. Basic computer operations, Internet and its applications.
7. Programming in 'C'.
8. Virtual library – Bibliographic searches.
9. Sequence retrieval from nucleic acid and protein database.
10. Pair-wise comparison of sequences. (BLAST & FASTA)
11. Multiple sequence alignment.
12. Phylogenetic analysis
13. Primer designing.
14. Measures of Mean, Mode, Median, Central Tendency, Chi, Square Tests, t-test.
15. Organization, description and graphical representation of data
16. Mandatory visit to research institute/ Biotech industries

Program code with title	**BT CT 2.1- - MOLECULAR BIOLOGY, BIOINFORMATICS AND BIOSTATICS**	
Units	**Course Outcome**	**No of hours**
Unit 1	**Organization of genetic material:** Students will get to know the organization of genetic material.	**03Hrs**
Unit 2	**Structural Polymorphism of DNA** Students will get the details regarding different forms of DNA and replication.	**07Hrs**
Unit 3	**Transcription:** Students will familiarize with the DNA binding proteins and transcription machinery.	**03Hrs**
Unit 4	**Translation: S**tudents will learn about the genetic code translation and post translation modifications.	**03Hrs**
Unit 5	**Gene as a Unit of Mutation: S**tudents will learn about the different types of mutation transposans and AMe,S test	**03Hrs**
Unit 6	**Computer Science: S**tudents will learn about the basic concept of operating systems, different type of computer network and different type of viruses.	**07Hrs**
Unit 7	**Programming : S**tudents will learn about the Algorithm and flow chart and different programming languages.	**03Hrs**

Unit 8	**Introduction to Bioinformatics: :** Students will learn about the different Biological Databases and biological plotforms.	**04Hrs**
Unit 9	**Sequence alignment and phylogenetic:** Students will learn about the different sequence alignment tools and about phylogenetic sequences.	**03Hrs**
Unit 10	**Structural biology** Students will learn about the modeling and structural prediction databases.	**04Hrs**
Unit 11	**Commercial application of bioinformatics:** Students will learn about the Comparative proteomics and its applications, IPR and Bioinformatics patents.	**03Hrs**

REFERENCES

1. David Freifelder. (2004). Microbial genetics. 10th Edition, Norosa publisher, New Delhi.
2. Snustad PD and Simmons M.J (2000): Principles of Genetics 2nd Edition. John Wiley and sons, Inc. New York.
3. Fairbanks DJ and Anderson WR (1999): Genetics- continuity of life. Brooks and Cole Publication Company. New York.
4. Lewins B (2000): GENES VII. Oxford University Press, New York.
5. Streips and Yasbin (2001). Modern microbial Genetics. Wiley Ltd.
6. John Ringo (2004). Fundamental Genetics. Cambridge University Press**.**
7. Streips and Yasbin (2001): Modern microbial Genetics. Wiley limited.
8. Lodish HD, Baltimore A, Berk, B. L. Zipursky, P. Mastsydairs and J.Darnell (2004): molecular cell Biology. Scientific American Books Inc, New York.
9. Higgins & Taylor (2000). Bioinformatics, OUP.
10. Kulg, W.S and Cummins (2003) Concepts of genetics. 7th Edition Pearson educations.
11. David W. Mount, (2001) Bioinformatics: Sequence and Genome Analysis 2nd Edition.

BT CT 2.2 – IMMUNOLOGY AND IMMUNOTECHNOLOGY

50 Hrs

Unit 1

Immunology: Fundamental concepts and anatomy of the immune system, History and scope of immunology, cells involved in immune system – T-lymphocytes, B-lymphocytes, Monocytes, Macrophages, APC, Neutrophils, Mast cells, Types of immunity-Adaptive immunity, Innate immunity, Components of Innate and Acquired immunity; Phagocytosis, Complement and Inflammatory responses, Haematopoesis, Organs of the immune system- primary and secondary lymphoid organs, Lymphatic system, Lymphocyte circulation, Lymphocyte homing, Mucosal and Cutaneous associated Lymphoid tissue (MALT&CALT).

08 Hrs

Unit 2

Antigen: Concept of haptens, determinants, conditions of antigenicity, antigens and immunogenicity, super-antigen. Self and non-self-recognition, epitopes mapping, paratopes, nature of B-cell and T – cell epitopes, haptens, carbohydrate antigens, blood group antigens, synthetic peptides as antigens.

Immunoglobulin: Structure and properties of immunoglobulin classes, Theories of antibody formation, Multiple myelomas and structural basis of antibody diversity, Freund's adjuvants and its significance.

05Hrs

Unit 3

Antigen-antibody Interaction and Immunotechniques: Agglutination, Precipitation, Affinity, avidity and cross reactivity, Immuno double- diffusion, single radial immunodiffusion, Haemagglutination and Complement fixation, Direct and Indirect Immunofluorescence.

05 Hrs

Unit 4

Immunodiagnostics: Anti-microbial immunity: a general scheme, Defense against bacteria, viruses, fungi and parasites, Immunodiagnostics in virology – Serological methods for detection and quantitation of viruses including Hepatitis, Influenza, HIV and others.

04 Hrs

Unit 5

Immunotechniques and applications: Immuno-assays: SRID, ELISA, ELISA-PCR, RIA, Western Blotting, Immunoflurorescence and their application. Immune deficiencies and autoimmunity, Immunoelectrophoresis, Flow cytometry, Immunoblot, Complement fixation test (CFT), Montaux test, Applications of these methods in diagnosis of Microbial infections.

05Hrs

Unit 6

Expressions and Regulation of Immune Response: Regulation of immune response, Antigen processing and presentation, generation of humoral and cell mediated immune response, activation of B and T lymphocytes, cytokines and their role in Immune regulation, T cell regulation, MHC complex restriction, Immunological tolerance.

04 Hrs

Unit 7

Hypersensitivity reactions: Allergy, Type I- Anaphylaxis, Type II- Antibody dependent cell cytotoxicity and Type III- Immune complex mediated reactions, Type IV- delayed type hypersensitivity. Symptoms and Immunological methods of diagnosis of hypersensitive reactions,

Lymphokines and cytokines–Assay methods, Immunological tolerance and modulation

04 Hrs

Unit 8

Transplantation immunology: Structure and functions of MHC and the HLA systems, types of grafts, grafts rejection, GVH reactions, mechanism of graft rejection and prevention of graft rejection. Gene regulation and Ir-genes; HLA and tissue transplantation – Tissue typing methods for transplantations in humans; graft versus host reaction and rejection, Xeno-transplantation, (inter spices, intra Spices, Intra Genus) immunosuppressive therapy,

04 Hrs

Unit 9

Tumor immunology: Tumor specific antigens, Immune response to tumors, Theory of surveillance, Immunodiagnosis of tumors – detection of tumor markers – Alpha-fetoprotein, Carcino-embryonic antigen, Cancer therapeutics.

04 Hrs

Unit 10

Immunization & Vaccine technology and recombinant vaccines : Common immunization practice, types of vaccines and its application, edible vaccines, conventional vaccines, viral vaccines, bacterial vaccines, peptide vaccines, genetically engineered vaccines, Hybridoma technology, immunization of animals Isolation of stimulated spleen cells, myeloma cell lines used and fusion partners, Fusion method production, detection and applications of monoclonal and polyclonal antibodies, production and application of Lymphokines.

05 Hrs

Unit 11

Cytokines: Structure and receptors, signal transduction, modulation of immune response cytokine profile of diseases.

02Hr

PRACTICALS

BT CP 2.6 BASED ON BT CT 2.2 – IMMUNOLOGY AND IMMUNOTECHNOLOGY

1. Blood film preparation and identification of cells, WBC and RBC count
2. Determination of Blood groups and Rh factor.
3. Estimation of Hemoglobin.
4. Demonstration of antigen administration to animals Mice / Rat.(Intra-muscular, Intra- veinal, Intra-peritoneal)
5. Determination of Bleeding Time (BT) and Clotting Time (CT).
6. Separation of Serum / Plasma from whole blood, Electrophoretic separation of serum proteins/plasma
7. Precipitation of Immunoglobulins from serum by Ammonium sulphate precipitation.
8. Agglutination tests (Haemagglutination, Latex agglutination, Bacterial agglutination).
9. Immunoprecipitation tests – Radial Immunodiffusion test / Ochterlony double diffusion test.
10. Demonstration of ELISA
11. Demonstration of Western blot.
12. Identification of Bacteria by Using Fluorescent Ab Technique (FAT)
13. Determination of antibody titer of the serum.
14. Immunoelectrophoresis – Rocket Immunoelectrophoresis.
15. Demonstration of Agglutination Reaction of Unknown Bacterial Culture by Slide Agglutination Technique

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1. Abbas AK, Lichtman AHH, Shiv Pillai. (2017). Cellular and Molecular Immunology, 9thEdition, Elseiver Saunders Publishers.
2. Ananthanarayan, R and Paniker. (2017). Text book of Microbiology, 10thEdition, Universities press Private Limited, Hyderabad, India.

3. Bisen, S.P. (2014). Laboratory Protocols in Applied Life Sciences, CRC Press Taylor and Francis Group
4. CV Rao (2006) An Introduction to Immunology 2nd Edition, Alpha Science Intl Ltd.
5. Christopher, J., Burrell, Colin. R., Howard, Frederick. A. Murphy. (2016). Fenner and White's Medical Virology, 5th Edition, Academic Press.
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10. Plummer, D.T. (1971). Introduction to Practical Biochemistry, Tata MacGraw Hill.
11. Pavri, KM (1996), Challenge of AIDS, National Book Trust, India.

Program code with title	**BT CT 2.2- - IMMUNOLOGY AND IMMUNOTECHNOLOGY**	
Units	**Course Outcome**	**No of hours**
Unit 1	**Immunology** Students will get to know the fundamental concepts and cells involved in immunology.	**08Hrs**
Unit 2	**Antigen:** Students will get the details regarding epitopes, antigens and super antigens and also about immunoglobulins.	**05Hrs**
Unit 3	**Antigen-antibody Interaction and Immunotechniques:** Students will familiarize with the different type of antigen antibody interactions and its applications.	**05Hrs**
Unit 4	**Immunodiagnostics: S**tudents will learn about the different Serological methods for detection and quantization of viral diseases.	**05Hrs**
Unit 5	**Immunotechniques and applications: : S**tudents will learn about the different immunotechniques and applications of these methods in diagnosis of Microbial infections	**05Hrs**

Unit 6	**Expressions and Regulation of Immune Response:: S**tudents will learn about the regulation of immune response and immune tolerance and MHC cells.	**04Hrs**
Unit 7	**Hypersensitivity reactions: S**tudents will learn about the different types of hypersensitivity reactions.	**03Hrs**
Unit 8	**Transplantation immunology:** Students will learn about the different types of transplantation.	**04Hrs**
Unit 9	**Tumor immunology** Students will learn about the different mechanism of tumor formation and tumor antigens.	**04Hrs**
Unit 10	**Immunization & Vaccine technology and recombinant vaccines:** Students will learn about the different methods of immunization and also about the different types of vaccines.	**05Hrs**
Unit 11	**Cytokines** Students will learn about the different types of cytokines and receptors.	**02Hrs**

BTCT – 2.3 ENZYMOLOGY AND METABOLISM

50 Hrs

Unit 1

Bioenergetics: Thermodynamics– laws of thermodynamics, Gibbs free energy, endergonic & exergonic reactions. ATP-Structure, organization of respiratory electron transport system, mechanism of oxidative phosphorylation biological energy transducers, chemo-osmotic generation of ATP, High energy compounds.

Introduction to Metabolism- Catabolism, anabolism, catabolic, anabolic and amphibolic pathways

06 Hrs

Unit 2

Enzymes: Definition, structure, properties and classification of enzymes, Co-factors and Co-enzymes, Kinetics of enzyme catalyzed reactions. Michaelis –Menten equation K_M and V_{max}, single substrate and double substrate reactions. Lineweaver and Burk modification, enzyme kinetics and enzyme inhibitory kinetics (competitive, uncompetitive, noncompetitive and mixed inhibitions and determination of Ki)

Mechanism of enzyme action: Induced fit hypothesis nature of catalysis, mechanism of lysozyme action.

Enzyme regulation: Covalent and Allosteric regulation activation and inhibition of enzyme activity and isoenzymes, ribozymes and abzymes.

08 Hrs

Unit 3

Carbohydrate Metabolism: Sources of carbohydrates, enzymatic conversion of metabolites as glucose and fructose, Introduction, aerobic and anaerobic pathways, brief account of glycolysis, Kreb's cycle, Glyoxylate cycle, Gluconeogenesis, Pentose phosphate pathway (HMP shunt) & its regulation, Glycogenolysis and Glycogenesis, Substrate level phosphorylation, rate controlling steps and regulation of the metabolic pathways.

08 Hrs

Unit 4

Metabolism of lipids: Beta–oxidation of saturated, unsaturated and branched chain fatty acids. Peroxisomal beta– oxidation, alpha and omega oxidation Biosynthesis of fatty acids, biosynthesis of long chain fatty acids and branched chain fatty acids, desaturation. Biosynthesis of phospholipids De novo pathway and inter conversion, cholesterol biosynthesis and regulation.

06 Hrs

Unit 5

Metabolism of Amino acids and proteins: Synthesis of amino acid and their catabolism (Deamination, Decorboxylation, Transaminiation and Reductive transaminiation), Hydrolysis of proteins, proteases. Co-ordinated control of amino acid metabolism, formation of Ammonia and urea.

04 Hrs

Unit 6

Nucleotide metabolism: Pathway for degradation of purines and pyrimidines, de-novo biosynthetic pathway of ribonucleotides, Salvage pathways and related disorders, biosynthesis of deoxyribonucleotides. Regulation of degradation and biosynthesis.

04 Hrs

Unit 8

Photosynthesis: Chemistry and components of photosystems, absorption spectrum and active spectrum, Cyt-b, Cyt-f complex, ATP synthesis, pigments involved in photosynthesis, Chlorophyll a, Chlorophyll b, Bacterio-chlorophyll, Bacterio-rhodopsin, mechanism of light reaction and carbon fixation, C3, C4 and CAM pathways, Photorespiration and its impact in bacterial photosynthesis.

04 Hrs

Unit 9

Signal transduction: Inter and Intra cellular signaling, signaling molecules–proteins and non-protein signals, signal synthesis, release and transport. Target cells and tissues, signal receptors, distribution and interaction between the signal transduction and the mechanism of transduction

Role of secondary messengers, such as Calcium, cAMP, cGMP, Phosphotidyl inositol, phosphate A General view of plant signals, phytohormonesand their mechanisms

06 Hrs

Unit 10

Biochemistry of Hormones: Biosynthesis and regulation of hormones, mechanisms of hormone transduction, Cell-cell transport of hormones, Hormone receptors, signal component receptors.

04 Hrs

PRACTICALS

BT CP 2.7 Based on BT CT 2.3 Enzymology and Metabolism.

1. Qualitative and quantitative analysis of carbohydrates / proteins / amino acids / lipids.
2. Estimation of Chlorophyll.
3. Determination of pKa of proteins and amino acids.
4. Purification of enzymes/proteins using ammonium sulphate, pH precipitation and organic solvent methods.
5. Isolation of enzymes from different biological sources (bacterial / fungal / plant / animal cells).
6. Effect of substrate concentration, temperature and pH on enzyme activity.
7. Study of enzyme kinetics–effect of inhibitors, Determination of Km, Vmax and Ki of competitive and noncompetitive inhibitor.
8. Isolation of α-amylase from sweet potato, assay of enzyme activity and specific activity.
9. Isolation of protease from papaya, assay of enzyme activity and specific activity
10. Enzyme assay-Trypsin, Urease and Phosphatase.
11. Immobilization of enzymes.
12. Estimation of urea, creatine and Creatinine

REFERENCES

1. Nelson, D. L., Cox M. M. and Lehninger A. L. (2017) Lehninger principles of biochemistry 7th Edition: W.H. Freeman, New York.
2. Devlin, T.M (1997) With Clinical Correlations. Wiley- Liss .Inc, NY.
3. Mathews, C.K and Holde K. E. V (1996) Biochemistry. The Benjamin, Cummings Publishing Company, Inc, NY.
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6. Strayer. L. (2000) Biochemistry, 5thEdition. W. H Freeman and company New York.
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8. Fundamentals of Enzymology: Price, N.C and Sterans L. Oxford University press.
9. Palmer, T. (1999) Enzymes Harwood Publishing.
10. Hames, B.D, Hopper, N. M, Houghton, D. (2001): instant notes in Biochemistry, VIVA Books Pvt, Ltd New Delhi.

Program code with title	**BTCT – 2.3 ENZYMOLOGY AND METABOLISM**	

Units	Course Outcome	No of hours
Unit 1	**Bioenergetics:** Students will get to know the Thermodynamics– laws of thermodynamics, Metabolism- Catabolism, anabolism, catabolic, anabolic and amphibolic pathways.	**08Hrs**
Unit 2	**Enzymes:** Students will get the details regarding**:** Definition, structure, properties and classification of Michaelis –Menten equation Mechanism of enzyme action: Induced fit hypothesis nature of catalysis, mechanism of lysozyme action and Enzyme regulation:	**05Hrs**
Unit 3	**Carbohydrate Metabolism:** Students will familiarize with the. Sources of carbohydrates, , rate controlling steps and regulation of the metabolic pathways.	**05Hrs**
Unit 4	**Metabolism of lipids :S**tudents will learn about the **:** Biosynthesis of fatty acids, s De novo pathway and inter conversion, cholesterol biosynthesis and regulation.	**05Hrs**
Unit 5	**Metabolism of Amino acids and proteins: S**tudents will learn about the different Metabolism of Amino acids and proteins Synthesis of amino acid and their catabolism (	**05Hrs**
Unit 6	**Nucleotide metabolism: S**tudents will learn about the Pathway for degradation of purines and pyrimidines,. Regulation of degradation and biosynthesis.	**04Hrs**
Unit 7	**Photosynthesis: S**tudents will learn about the Chemistry and components of photo systems, Photorespiration and its impact in bacterial photosynthesis.	**04Hrs**
Unit 8	**Signal transduction:** Students will learn about the different types of **Inter** and Intra cellular signaling, signaling molecules–and the mechanism of	**06Hrs**

	transduction and also the Role of secondary messengers,	
Unit 9	**Biochemistry of Hormones**: Students will learn about Biochemistry of Hormones Biosynthesis and regulation and mechanisms of hormone transduction	**04Hrs**

BT ET 2.4 MOLECULAR CELL BIOLOGY

50hrs

Unit 1

Basics of Cell biology: Cell theory, Structure of Prokaryotic and Eukaryotic cells, Differences between Plant and Animal cells.

03 Hrs

Unit 2

Cell Organelles and Cell Architecture: Ultrastructure of Plasma Membrane, Different models of Plasma membrane structure. Ultrastructure and functions of cellular organelles: Nucleus, Chloroplast, Mitochondria, Endoplasmic Reticulum, Golgi bodies, Ribosomes, Lysosomes, Vacuoles and Centrosomes. Structure of microtubules, cilia, flagella and centrioles, Intermediate Filaments Actin and Myosin, functional role of actin filaments and motor proteins. Role of microtubules in intracellular movements.

10Hrs

Unit 3

Chromosomal organization: Molecular organization of eukaryotic chromosomes, Molecular features of telomeres, centromere, kinetochore, chromatin and heterochromatin. Mechanism and causes of chromosomal condensation and relaxation. Mutations, Chromosomal aberrations- deletions, duplications, translocation and inversion.Euploidy and Polyploidy.

06 Hrs

Unit 4

Cell Cycle: Cell cycle and division - mitosis, mitosis and meiosis, phases of cell cycle, DNA Replication, Transcription and Translation. Control system of Cell cycle and Checkpoints in cell cycle regulation,

08 Hrs

Unit 5

Apoptosis: Phenomenon of Apoptosis, Programmed cell death, Caspases, Apoptotic protease activating factor (APAF) mechanism of apoptosis at biochemical, cellular and gene level, Necrosis, factors regulating apoptotic death in normal cells and tumorous cells.

08 Hrs

Unit 6

Developmental biology and Cell Differentiation: Establishing multi-cellularity, formation of blastula, embryonic germ layer, tracking of migrating cells. Aggregation behavior in embryonic cells and possible understanding in the positional information on developing organs; Events during fertilization, post fertilization early embryonic development and in vitro fertilization, Roles of different proteins in fertilization and cellular differentiation, Stem cells and their differentiation application of Stem cells.

10Hrs

Unit 7

Molecular biology of Cancer: Characteristics of Cancer cells, The Genetic Basis of Cancer, Proto-onco genes and its regulation, Oncogenes, Viral Oncogenes, Regulation of gene expression and signal transduction in cancerous cells, cancer treatment**.**

05 Hrs

PRACTICALS

BT EP 2.8 Based on BTET 2.4 Molecular Cell Biology

1. Preparation of meiotic chromosomes using Haemotoxylin
2. Isolation of mitochondrial DNA
3. Isolation of Chloroplast DNA
4. Preparation of Salivary gland chromosomes – *Drosophila melanogaster*
5. Biosafety and lab protocol
6. Micrometry and measurement of given biological sample
7. Fixation of plant and animal tissues, preparation of paraffin blocks and micrometry staining and microscopic observation.
8. Sub cellular fractionation and marker enzymes.
9. Cytological methods, chromosome counting and karyotype analysis.
10. Analysis of Polytene chromosomes, bar bodies and chromosomes.

11. Detection of cell apoptosis by Comet Assay.
12. Cytophotometric estimation of nuclear DNA.
13. Structural and numerical changes in chromosomes and chromosome banding

REFERENCES

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1. Alberts, B., Bray, D., Lewis, J., Raf, M., Roberts, K., Watson, J.D. (1994). Molecular Biology of the Cell.
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9. Molecular Cell Biology, Scientific American Books Inc. NY.
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11. Wolfe, S.L. (1991). Molecular and Cellular Biology, Wordsworth Pub. Co.
12. Hallwell, B., Gutteridge, J.M.C. (2002). Free Radicals Biology and Medicine. Oxford Press.UK.

Program code with title	**BT CT 2.4 MOLECULAR CELL BIOLOGY**	
Units	**Course Outcome**	**No of hours**
Unit 1	**Basics of Cell biology:** Students will get to know the fundamental concepts in cell theory and their structure in detail.	**03 Hrs**
Unit 2	**Cell Organelles and Cell Architecture:** Students will get the details regarding different cell organelles structure and their function.	**10 Hrs**
Unit 3	**Chromosomal organization:** Students will familiarize with different levels of chromosome organization and also about the mutation.	**06 Hrs**
Unit 4	**Cell Cycle: S**tudents will learn about the cell cycle check points and its regulation.	**08Hrs**
Unit 5	**Apoptosis S**tudents will learn about the concept of biochemical and cellular, molecular aspects of cell death.	**08Hrs**
Unit 6	**Developmental biology and Cell Differentiation: s**tudents will learn about the stem cells and different stages of cell development and differentiation.	**10Hrs**
Unit 7	**Molecular biology of Cancer: S**tudents will learn regarding the oncogenes its expression and regulation.	**05Hrs**

BIOTECHNOLOGY THIRD SEMESTER SYLLABUS

FROM 2020-21 ONWARDS

BTCT 3.1 ANIMAL BIOTECHNOLOGY

Unit 1

Introduction to Tissue culture: Definition, principle and significance of tissue culture. Equipment's and materials for animal cell culture technology. Maintenance of sterility and use of antibiotics, detection of Mycoplasma and viral contaminants, tissue culture media, natural, synthetic media and Sera, Sterilization of cell culture media and reagents, role of carbon dioxide in animal cell culture

05 Hrs

Unit 2

Types of animal cell culture: Primary and secondary cell culture, development of cell lines or established cultures. Biological characterization of cell cultures, contact inhibition, cell transformation, cancer cells, indefinite cell lines. Measurement of cell viability, cytotoxicity, Screening of cytotoxic compounds and its importance

04 Hrs

Unit 3

Techniques of Animal cell culture: *In-vitro*, Disaggregation of tissue and primary culture, subculture and establishment of cell line, Cloning and selection, Cell separation, Characterization, Differentiation, Transformation and immortalization, Quantification of cell culture. Scale-up and cell synchronization.

04 Hrs

Unit 4

Stem cells and Tissue engineering: Overview; self-renewal potential; differentiation versus stem cell renewal; trans-differentiation; cell cycle dynamics of different stem cells. Stem cell assays and protocols: Isolation of defined stem cell populations; Progenitor cell assays, sources of progenitor cells, cytokine and chemotherapy approaches to mobilization of progenitor cells.

Stem cell Therapy: Clinical applications of stem cell therapy; neurodegenerative diseases- Parkinson's disease, Alzheimers, spinal cord injury, other brain syndromes; tissue systems failures- diabetes,

cardiomyopathy, kidney failure, liver failure hemophilia, lymphoma and leukemic malignancies requiring stem cell therapy.

Tissue Engineering: Basic cell biology, cell-matrix interactions, receptor biology, tissue ablation, engineering angiogenesis, vascularization, material based immune therapy and skin, bone, liver, muscle tissue engineering.

12 Hrs

Unit 5

Animal reproductive system with reference to insects and mammals: Organization, function, hormonal regulation of growth and reproduction in insects and mammals. Hormonal regulation of estrous cycle, menstrual cycle and pregnancy, IVF– embryo transfer technology in human and livestock. Mechanism of protein and steroid hormone action and importance of hormones as a biotechnological products.

09 Hrs

Unit 6

Hybridoma Technology: Production of murine monoclonal antibodies (MAbs)-Fusion strategies, HAT Selection; Strategies for production of human MAbs-Humanization and antigenization of MAbs-Chimeric, CDR-grafted, SDR-grafted, veneered MAbs.

03 Hrs

Unit 7

Antibody Engineering: Antibody fragments, Antibody gene cloning; Expression of recombinant antibody genes; Next generation display technologies for production of antibodies *in vitro;* combinatorial libraries and phage display libraries; Bio-specific and bi-functional antibodies; Immuno-conjugates; Catalytic antibodies.

03 Hrs

Unit 8

Polymeric Biomaterials: Polyolefins, Polyamides, acrylic polymers, fluro-carbon polymers, rubbers, thermoplastics. Physiochemical characteristics of biopolymers, biodegradable polymers for medical purposes, Synthetic polymeric membranes and their biological applications, Biopolymers in controlled release systems artificial skin. Dialysis membrane

Composite Biomaterials: Properties, classification and Applications of Composite Biomaterials in fabrication of bio-devices and implants. Applications of biomaterials in Drug delivery systems

05 Hrs

Unit 9

Gene therapy: Types of genetic diseases targeted for gene therapy. Human genome project and its applications

02 Hrs

Unit 10

The legal and socio-economic impact of biotechnology at national and international levels, public awareness, Biosafety regulations, guidelines for research in transgenic animals, public awareness of the processes of producing transgenic organisms.

03 Hrs

PRACTICALS

BT CP 3.5 Based on BT CT 3.1 Animal Biotechnology

1. Rearing, Maintenance and safety of laboratory animals – Rat/ Mouse/ Silkworm.
2. Preparation of animal cell culture media(Natural and Synthetic)
3. Viability test and Cell counting (Trypan Blue Staining)
4. Disaggregation of animal tissue by trypsinization
5. Studies on the Estrous cycle
6. Sperm counting and Sperm viability
7. Demonstration of techniques involved in Ovaryectomy, Orchiectomy, Adrenalectomy and Hysterectomy in mice/rat
8. Isolation of DNA from animal tissues
9. Isolation of Bovine Serum Albumin (BSA)
10. Demonstration of Cryo-preservation of animal cells.
11. Estimation of Cholesterol
12. Comet assay of blood sample
13. MTT assay for Cytotoxicity
14. Developmental stages of chick embryo
15. Initiation of primary culture from chick embryo
16. Visit Research institute to veterinary institute and IVF center.

REFERENCES

1. R. Ian Freshney (2010) Culture of Animal cells, 5th Edition, A John Wiley & Sons, Inc., Publications, USA

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5. Molecular Biotechnology: 4th Edition. (2010), Glick B.R., Pasternak J.J., Patten C. L., ASM press, USA
6. Gene Transfer to Animal Cells, 1st Edition (2005), R. M. Twyman, Taylor & Francis USA.
7. K. S. Khandpur, (1997) Handbook of Biomedical Instrumentation, Tata McGraw Hill, New Delhi,
8. F. H. Silver, (1994) Biomaterials, Medical Devices & Tissue Engineering: An integrated approach. Chapman & Hall,
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Program code with title	**BTCT 3.1 ANIMAL BIOTECHNOLOGY**	
Units	**Course Outcome**	**No of hours**
Unit 1	**Introduction to Tissue culture::** Students will get to know the fundamental of Tissue culture role of nutrients in animal cell culture	**05 Hrs**
Unit 2	**Types of animal cell culture:** Students will get the details regarding cell culture, cell lines Biological characterization of cell cultures and. Measurement of cell viability asayss and its importance	**04 Hrs**
Unit 3	**Techniques of Animal cell culture:** Students will familiarize with, Cell separation, Characterization, and . Scale-up and cell synchronization.	**04 Hrs**
Unit 4	**Stem cells and Tissue engineering: S**tudents will learn about **Stem** cells and Tissue engineering, Stem cell Therapy Clinical applications of stem cell therapy and basics of Tissue Engineering.	**12Hrs**
Unit 5	**Animal reproductive system with reference to insects and mammals**: **S**tudents will learn about the concept of, hormonal regulation, IVF– embryo transfer technology in human and livestock. Mechanism of protein and steroid hormone action and importance of hormones as biotechnological products.	**09Hrs**

Unit 6	**Hybridoma Technology: s**tudents will learn about the Production of monoclonal antibodies (MAbs)-Fusion strategies,	**03Hrs**
Unit 7	**Antibody Engineering: S**tudents will Antibody gene cloning technologies for production of antibodies.	**03Hrs**
Unit 8	**Polymeric Biomaterials:** Students will get to know about biopolymers, Composite Biomaterials: Properties,. Applications of biomaterials in Drug delivery systems	**05Hrs**
Unit-9	**Gene therapy: :** Students will get to know about genetic diseases gene therapy. Human genome project and its applications	**02Hrs**
Unit 10	**Socio-economic impact of biotechnology: S**tudents will learn Biosafety regulations, guidelines for research in transgenic animals	**03 Hrs**

BT CT 3.2 – ENVIRONMENTAL BIOTECHNOLOGY AND BIODIVERSITY

50 Hrs

Unit 1

Meaning, Scope and Concept of Environment and Environmental pollution

02 Hrs

Unit 2

Aerobiology: Air Ssampling techniques, Identification of airborne Bio-particles, Sources and characteristics of air pollutants, health hazards due to air pollution. Air borne diseases and controlling measures of air pollution

06 Hrs

Unit 3

Soil biology: Classification of soil based on physical and chemical characteristics, Microorganisms in various soil types. Soil pollution – sources and characteristics of soil pollutants, health hazards due to soil pollution, control measures of soil pollution

Interaction among soil microbes-mutualism, commensalisms, amensalism, parasitism, predation, competition, antibiosis and their significance Interrelationship between microbes, plant and soil Brief account on rhizosphere, Phyllosphere and Sphermoshere, Symbiotic and non-symbiotic association with

higher plants, role of enzymes of microbial origin in the release of plant nutrients

08 Hrs

Unit 4

Water Ecosystem: Fresh water and marine water ecosystems, Zonation of water ecosystem, water pollution-sources, and characteristics of water pollution and health hazards due to water pollution, eutrophication. Biological indicators of water pollution - Chemical, Microbiological and Biotechnological indicators Water purifications Brief account on water borne diseases and control measures

08 Hrs

Unit 5

Waste Treatment: Solid and Liquids wastes and their Characterization Physical, chemical and biological methods of solid waste treatment Saccharification, Gasification, Composting and wastewater recycling-chlorination, Ozonization, radiation, filtrations, reverse osmosis. Effluent treatment - (Dairy, Distillery, Tannery, Textile, Paper and sugar industries) Physical, chemical and biological sewage treatment-Trickling filters, oxidation pond, ditch and activated sludge treatment. Advanced waste water treatment-Rotating Biological Contactors (RBC), submerged aerobic filters, fluidized bed reactors, biological aerated flooded system and combination of anaerobic, denitrification and aerobic treatment of wastewater. Advanced activated sludge process.

08 Hrs

Unit 6

Bioremediation: Concepts and principles, *Insitu* and *Exsitu* Bioremediation and Phytoremediation. Biodegradation of pesticides and Xenobiotics (Halocarbons, C-1 compounds, aliphatic hydrocarbons, acyclic hydrocarbons, Aromatic hydrocarbons, polycyclic Hydrocarbons, Halogenated compounds) in soil and their influence on soil micro flora Biodegradation of natural polymers-Cellulose, Lignin, Pectin, Chitin Detergents, soaps and plastics. Bio-deterioration of paper, Leather, Wood, Textiles Mode of Deterioration and organisms involved. Bio-leaching, Bio-mining, and Production of Oils and fuels from wooden-waste.

05 Hrs

Unit 7

Environmental Education: Agrochemicals, Global Warming, Ozone depletion, Greenhouse effect, acid rain their impact and biotechnological approaches in the environment**.**

03 Hrs

Unit 8

Biodiversity and its conservation: Current levels of biodiversity, extinction and endangered species, reasons of concern for loss of biodiversity, steps to preserve biodiversity, *In-situ* and *Ex-situ* conservation, gene banks, convention on biological diversity, Species conservation

04 Hrs

Unit 9

Biological control and Integrated Pest Management (IPM)

03 Hrs

Unit 10

Bioenergy: Biofuels, bio-ethanol, biodiesel, biogas, bio-hydrogen, Algal Biotechnology for Bio-energy, byproducts of sugar industries, Bioethanol,

03 Hrs

PRACTICALS

BT CP 3.6 Based on BT CT 3.2 Environmental Biotechnology and Biodiversity

1. Detection of coliforms for determination of purity of potable water samples by MPN method
2. Determination of DO, BOD, COD and TDS of water samples
3. Isolation of Bacteriophages from sewage water samples
4. Study of microflora of industrial waste and effluents
5. Selective enrichment of auxotrophic and antibiotic (Tet^R/Ref^R) mutants
6. Isolation of DNA from environmental samples
7. Isolation of Xenobiotic degrading bacteria by selective enrichment technique
8. Isolation of plasmids for degradation of polluted environment.
9. Study of effect of heavy metals on crop plants.
10. Study on Biogenic methane production
11. Estimation of Phosphate, sulphates, Nitrates, major cat ions (Na^+, K^+, Mg^{++} and Ca^{++}) and heavy metals in water samples
12. Effect of industrial effluents/ heavy metals on seed germination and seedling growth
13. Field excursion to an industrial area to assess environmental impact
14. Isolation and determination of Iron and Manganese reducing bacteria
15. Effect of herbicides (Glyphosate and 2, 4, - D) on chlorophyll content

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6. Agrawal, K.C. (1996). Biodiversity, Agro-botanical publications, new Delhi
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Program code with title	**BT CT 3.2 – ENVIRONMENTAL BIOTECHNOLOGY AND BIODIVERSITY**	
Units	**Course Outcome**	**No of hours**
Unit 1	**Scope of Environment :** Students will understand the Meaning, Scope and Concept of Environment and Environmental pollution	**02 Hrs**
Unit 2	**Aerobiology**: Students will learn different Air sampling techniques,. Air borne diseases and controlling measures of air pollution	**06Hrs**
Unit 3	**Soil biology**: Students will learn properties of soil, characteristics of soil pollutants and control measures of soil pollution. Students will also understand about the different types of interaction between soil and microbes.	**08Hrs**
Unit 4	**Water Ecosystem**: Students will learn about different water ecosystems and also about Biological indicators of water. Students will get to know about water borne diseases and control measures.	**08Hrs**
Unit 5	**Waste Treatment**: Students will learn about Characterization of waste and its treatment.	**08Hrs**
Unit 6	**Bioremediation**: Students will familiarize with Concepts and principles of Bioremediation and also about Bio-leaching, Bio-mining.	**05Hrs**

Unit 7	**Unit 7** **Environmental Education**: Students will understand the consequences of Global Warming and their impact and biotechnological approaches in the environment**.**	**03Hrs**
Unit 8	**Biodiversity and its conservation**: Students will understand the importance of biodiversity and different methods for their conservation.	**04Hrs**
Unit-9	**Biological control** : Students will understand the concepts of Integrated Pest Management (IPM).	**03Hrs**
Unit 10	**Bioenergy**: Students will get to know the Biofuels, and Bio-energy, byproducts.	**03Hrs**

BT CT 3.3 – BIOPROCESS ENGINEERING AND TECHNOLOGY

50 Hrs

Unit 1

Introduction to Bioprocess Engineering: Chronological development of fermentation industry, Industrial processes-Microbial biomass, Microbial metabolites, Recombinant products, Transformation process Isolation, Screening, Selection, Preservation and Maintenance of industrial important microorganisms.

03 Hrs

Unit 2

Fermentation Technology: Types of fermentation process, Solid-state fermentation, Liquid state fermentation, analysis of batch, fed batch and continuous bio-reactions. Stability of microbial reactors, analysis of mixed microbial population, Measurement and control of bio-process parameters

04 Hrs

Unit 3

Bioreactors: Basic design and function of a Bioreactor, body construction, aeration and agitation, attainment and maintenance of aseptic conditions, sterilization of Bioreactor. Ports for nutrients and inoculum, sampling, types of valves, Types of bioreactors: Specialized bioreactors– Tubular bioreactors, membrane bioreactors, Tower bioreactors, fluidized bed reactor, packed bed reactor and photo-bioreactors.

05 Hrs

Unit 4

Bioprocess Development: Upstream processing-Media Natural media, synthetic media and typical media. Media formulation strategies, sources of Carbon, Nitrogen, Vitamins and minerals Role of buffers, precursors, inhibitors, inducers and antifoam agents, Microbial growth kinetics, Specific growth rate. Monod equation, Strain improvement, Inoculum development for bacterial and fungal processes

05 Hrs

Unit 5

Sterilization and Fermentation Process controls: Midstream processing-Sterilization of fermentor, Media, feeds, air and filter sterilization, Method of batch sterilization and continuous sterilization process. Methods of measuring process Variables. Online Analysis and Control systems.Computer applications in fermentation technology.

04 Hrs

Unit 6

Downstream Processing: Objectives and criteria, removal of microbial cells and solid matter, Cell disruptions, foam precipitation, filtration, centrifugation, liquid-liquid extraction, chromatography, TFF membrane process, drying, crystallization, packaging. Quality control and quality assurance, Effluent treatment, DOC, COD and disposal.

06 Hrs

Unit 7

Immobilization: Definition and concepts of immobilization, enzyme and whole cell immobilization, Immobilization techniques – Adsorption, Cross-linking, ionic bonding, entrapment and encapsulation, Advantages and industrial applications of immobilized enzymes and cells

03 Hrs

Unit 8

Industrial Production: of Agar – Agar, Alginate, Alcohol (Ethanol), Organic acids (Citric, Acetic, Solvents (Glycerol & Acetone), Antibiotics (Penicillin & Streptomycin), Amino acids (Lysine & Glutamic acid), Single cell proteins (SCP), Vitamins (Riboflavin), Enzymes (Amylase, Lactase and Protease), Hydrocarbons – Biodegradable plastic or PHA and PHB, and recombinant protein (HCG, hepatitis – B vaccine).

12 Hrs

Unit 9

Food processing: Food spoilage and Food preservation Principles and general methods, elementary idea of canning, packing sterilization and Pasteurization of food products

Food fermentation technology – Sausages, olives, bread, Idli and acidophilus milk Hazard analysis and critical control point (HACCP) concepts.

04 Hrs

Unit 10

Entrepreneurship: Potential entrepreneurship opportunities in biotechnology. Product development, marketing, resources, research and training units, Industrial licensing and venture capital, Biotech parks, Biotechnology industries in India, contract research (CRO) and Intellectual property rights (IPRs).

04 Hrs

PRACTICALS

BT CP 3.7 Based on BT CT 3.3 Bioprocess Engineering and Technology

1. Study of Fermentor and bioreactor
2. Isolation and screening for industrially important microorganisms by crowd plat technique.
3. Study of antibiotic producing microorganisms in mass culture process and recovery of the product

4. Study of Alcohol fermentation – alcohol production from different substrates, Lab production of Wine, Estimation of percentage of Alcohol, Total acidity and volatile acidity in wine
5. Estimation of Alcohol by Potassium dichromate method.
6. Production of protease from *Bacillus* spp. by using Wheat bran, Coffee pulp through small scale fermentation process and its assay
7. Production of α- Amylase using *Aspergillus oryzae, Bacillus* sp. using Wheat bran in small scale Solid state fermentation and its assay
8. Production of citric acid by *Aspergillus niger, Pencillium citrannum* and its estimation.
9. Immobilization of yeast cells by calcium alginate gel entrapment and assay for enzymes Invertase and Catalase
10. Production of alpha amylase from immobilized cells of *Bacillus* sp.
11. Production and analysis of SCP from *Spirulina* and Yeast
12. Production of Yoghurt, Acidophilus milk and Temph.
13. Rapid platform test for milk
14. Fat estimation in milk and milk products
15. Methylene Blue reduction test
16. Detection and quantification of Siderophores produced by *Pseudomonas* spp
17. Mandatory visit to Research Institutes / Industries and submission of report.

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BT CT 3.3 – BIOPROCESS ENGINEERING AND TECHNOLOGY

Program code with title	**BT CT 3.3 – ENVIRONMENTAL BIOTECHNOLOGY AND BIODIVERSITY**	
Units	**Course Outcome**	**No of hours**
Unit 1	**Introduction to Bioprocess Engineering**: Student s will gain the knowledge about the development of fermentation industry, and Industrial processes and also about the Preservation and Maintenance of industrial important microorganisms ,	**03 Hrs**
Unit 2	**Fermentation Technology**: Students will be familiarized with different types of fermentation process and Measurement and control of bio-process parameters	**04 Hrs**
Unit 3	**Bioreactors**: Students will get to know the Basic design and function and different types of a Bioreactor.	**05Hrs**
Unit 4	**Bioprocess Development**: Students will get to know the upstream processing and Media formulation strategies. Students will also understand the Microbial growth kinetics and about Strain improvement.	**05Hrs**
Unit 5	**Sterilization and Fermentation Process controls**: Students will get to know the midstream processing, sterilization process and control of process variables in fermentation technology.	**04 Hrs**
Unit 6	**Downstream Processing**: Student s will gain the knowledge about the different methods for cell separation using different membranes. .	**06 Hrs**
Unit 7	**Immobilization**: Students will understand the importance of immobilization and Advantages and industrial applications of immobilized enzymes and cells	**03 Hrs**
Unit 8	**Industrial Production:** Students will understand the production of some industrially important molecules and antibiotics.	**12 Hrs**
Unit-9	**Food processing**: Students will understand the concept of food spoilage and food preservation and also about the different fermented food products.	**04 Hrs**
Unit 10	**Entrepreneurship**: Students will understand the Potential entrepreneurship in biotechnology. Student s will gain the knowledge about the Intellectual property rights (IPRs).	**04 Hrs**

BT ET 3.4 – PLANT AND ANIMAL TISSUE CULTURE

50 Hrs

Unit 1

Plant tissue culture and media: Introduction to Cell and Tissue culture. Tissue culture as a technique to produce novel plants and hybrids, Tissue culture media: (Composition and Preparation). Initiation, maintenance of callus and suspension culture and single cell clones.

07 Hrs

Unit 2

Cell and Organogenesis: Somatic embryogenesis, transfer and establishment of whole plants in soil. Shoot tip culture, rapid clonal propagation and production of virus free plants. Embryo culture and Embryo rescue. Anther, pollen and ovary culture for production of haploid plants and homozygous lines

10 Hrs

Unit 3

Protoplast isolation, fusion and cryopreservation: Selection of hybrids cells and regeneration of hybrid plants, Symmetric and asymmetric hybrids and cybrids. Cryopreservation and DNA banking for germ plasm conservation.

08 Hrs

Unit 4

Animal cell, tissue and organ culture: Historical perspectives, development and scope. Requirements for animal cell, tissue and organ culture – Equipments and materials for animal cell culture technology, advantages and limitations of tissue culture, aseptic handling, facilities, required media and cell lines. Organ and embryo culture: Choice of models, organ culture and histotypic culture Filter – well inserts, neuronal aggregates, whole embryo culture eggs, chick and mammalian embryos.

07 Hrs

Unit 5

Initiation of cell and primary culture: Cultivation of animal cell in mass using Bioreactors, Biology of cell culture, evaluation of culture dynamics and maintenance of cell lines. Primary culture: Isolation of mouse and chick embryos, human biopsies, methods for primary culture, nomenclature of cell lines, Sub culture and propagation, immortalization of cell lines, cell line designation, selection of cell line and routine maintenance.

06 Hrs

Unit 6

Cell separation and characterization: Density based, antibody based, magnetic and fluorescence based cell sorting. Characterization of cells based on morphology, chromosome analysis, DNA content, RNA and protein, enzyme activity, antigenic markers, cytotoxicity assays, Cell quantitation and Cell culture contamination, monitoring and eradication, Cryo preservation.

05 Hrs

Unit 7

Culturing of specialized cells: Epithelial, mesenchymal, neural, ectodermal, hematopoietic, gonad and tumor cell Lymphocyte preparation and culture of amniocytes, fish cells and confocal microscopy, Stem cell culture and its applications

03 Hrs

Unit 8

Cell and tissue engineering: Growth factors for *in-situ* tissue regeneration, biomaterials in tissue engineering, approaches for tissue engineering of skin, bone grafts, nerve grafts, Haemoglobin based blood substitutes, bio artificial or bio-hybrid organs, Limitations and possibilities of tissue engineering. Hybridoma technology and production of monoclonal antibodies

04 Hrs

PRACTICALS

BT EP 3.8 Based on BT ET 3.4 Plant and Animal Tissue Culture

1. Sterilization and preparation of plant tissue culture media.
2. Isolation of Ex-plant and maintainace of culture
3. Micro-propagation of Auxiliary buds and adventitious shoot
4. Anther culture for Haploid production.
5. Microspore culture for Haploid production
6. Initiation and establishment of cell suspension cultures.
7. Protoplast isolation and culture
8. Embryogenesis in cultured cells/Tissue.
9. Preparation of Synthetic seeds.
10. In-vitro pollination and cultures of ovary/ovule
11. Demonstration of bio-assay of hormones
12. Isolation of DNA from animal tissues
13. Demonstration of Cryo-preservation and Thawing
14. Sperm counting and Sperm viability
15. Animal Cell Culture: Preparation of media (Natural and Synthetic)
16. Preparation of metaphase chromosome from selected cells
17. Role of serum in cell culture
18. Estimation of Cholesterol

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2. Reinert, J.R. and Bajaj, Y.P.S. (1997): Applied Fundamental aspects of Plant cell, tissue and organ culture, Spinger and Verlag, Berlin.
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BT ET 3.4 – PLANT AND ANIMAL TISSUE CULTURE

Program code with title	**BT ET 3.4 – PLANT AND ANIMAL TISSUE CULTURE**	
Units	**Course Outcome**	**No of hours**
Unit 1	**Plant tissue culture and media**: Students will get to know the Cell and Tissue culture and its , maintenance.	**07 Hrs**
Unit 2	**Cell and Organogenesis**: Students will gain the knowledge of embryogenesis and production of virus free plants by different methods.	**10Hrs**
Unit 3	**Protoplast isolation, fusion and cryopreservation**: Students will understand the processs of Selection of hybrids and also about the Cryopreservation and germ plasma conservation.	**08 Hrs**
Unit 4	**Animal cell, tissue and organ culture**: Students will understand the historical perspectives, development and advantages and limitations of tissue culture. Students will gain the knowledge of organ and embryo culture.	**07Hrs**
Unit 5	**Initiation of cell and primary culture**: Students will gain knowledge about the bioreactors, cell lines propagation and its maintenance.	**06 Hrs**
Unit 6	**Cell separation and characterization**: Students will gain knowledge about the different methods of cell separation cytotoxicity assays and about Cryo preservation.	**05 Hrs**
Unit 7	**Culturing of specialized cells**: Students will understand the different cell culture and its applications.	**03 Hrs**
Unit 8	**Cell and tissue engineering**: Students will understand the importance of growth factors in tissue regeneration and also about the Hybridoma technology and production of monoclonal antibodies.	**04 Hrs**

BIOTECHNOLOGY FOURTH SEMESTER SYLLABUS

FROM 2020-21 ONWARDS

BT CT 4.1 GENETIC ENGINEERING

50 Hrs

Unit 1

Introduction to Genetic Engineering: Scope and importance of Genetic engineering

02 Hrs

Unit 2

Cloning Vectors: Brief account of naturally occurring plasmids (Conjugative and Non conjugative plasmids, Degradative plasmids, Resistance plasmids, Fertility plasmids, Col-Plasmids), artificial plasmids (pBR322, pUC vectors, Ti and Ri plasmids), Bacteriophages, Phagemids, Cosmids, Fosmids, Artificial chromosomes (BAC's, YAC's), Shuttle vectors, expression vectors, M13 derived vectors and Viral vectors (SV40 and Bovine Papilloma Virus).

08 Hrs

Unit 3

Tools of Genetic Engineering: Restriction endonucleases- nomenclature and types, recognition sequences and mechanism of action. DNA Modification enzymes (nucleases, kinases, Alkalinephosphatase, Klenow-Fragment polymerase, Lambda-Exonuclease and Exonuclease-III) and ligases- types and mechanism of action.

05 Hrs

Unit 4

Cloning and Construction of gene Libraries: cDNA library- isolation and purification of mRNA, Synthesis of cDNA, cloning of cDNA in to plasmids and phage vectors,

Genomic DNA Library: Isolation and purification of Genomic and Plasmid DNA, preparation of DNA fragments for cloning, Construction of genomic DNA library with different vectors and screening techniques.

05 Hrs

Unit 5

Selection, Screening and Analysis of Recombinants: Blotting Techniques- Southern Blotting, Northern Blotting, Western Blotting and DOT Blot, Nucleic Acid hybridization (Colony Hybridization and Plaque Hybridization), Immunological methods and *In vitro* Translation. Chromosome walking,

Gel Electrophoresis: Agarose gel Electrophoresis, PAGE and PFGE

06 Hrs

Unit 6

Labeling and Detection Techniques: Labeling of DNA, RNA and Proteins (Radioactive and non-radioactive isotopes). DNA Sequencing (Chemical and Enzymatic method).

04 Hrs

Unit 7

Transformation Techniques:

Transformation and Transfection techniques: Preparation of competent cells of bacteria, chemical methods- calcium phosphate precipitation method and liposome mediated method. Physical methods-Electroporation and Gene gun method. Biological methods-Agrobacterium mediated transformation, Co-cultivation methods, Chloroplast transformation, method of DNA transfer to yeast, mammalian and plant cells.

06 Hrs

Unit 8

Polymerase chain Reaction: Methodology, types and applications.

03 Hrs

Unit 9

Chemical Synthesis of genes: Methods (Phosphodiester, Phosphotriester and Phosphite ester methods principle and strategies). Oligonucleotide synthesis and application, synthesis of complete gene.

04 Hrs

Unit 10

Antisense and Ribozyme technology: Molecular mechanism of antisense molecules, inhibition of splicing poly-adenylation and translation, disruption of RNA structure and capping Biochemistry of

Ribozyme, hammer head, hairpin and other Ribozymes, strategies for designing Ribozymes, application of antisense and Ribozymes technologies.

03Hrs

Unit 11

Applications of Genetic engineering and rDNA technology: Transgenic plants (disease resistant, weedicide resistant, frost resistant, halo-tolerant and pest resistant) production of growth hormones, interferon, insulin, recombinant vaccines, gene therapy, anti-sense RNA technology RNA; requirement of recombinant molecules in health, pharmaceuticals, agriculture and industrial sectors, research labs.

04 Hrs

PRACTICALS

BT CP 4.4 Based on BTCT 4.1 Genetic Engineering

1. Isolation and Electrophoretic separation of genomic DNA from Bacteria, Plant and Animal tissues.
2. Gel elution and purification of DNA fragment
3. Isolation and electrophoretic separation of RNA from Bacteria, Plant and Animal tissues.
4. Quantification and purity check of Isolated DNA using UV spectrophotometer.
5. Isolation, purification and electrophoretic separation of plasmid DNA from Bacteria.
6. Restriction Digestion of Genomic DNA and Plasmid DNA with Restriction Endonucleases and separation of digested products in Agarose gel.
7. Effect of Agarose concentration on migration of DNA fragments.
8. DNA Ligation using T4 DNA Ligase and *E.coli* DNA ligase
9. Preparation of Competent cells using Calcium Chloride Method.
10. Transformation of Bacterial cells (blue white Selection).
11. Blotting techniques: Southern, Northern and Western Blotting
12. Amplification of DNA using Polymerase chain Reaction.

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16. PCR Technology - Principles and Applications for DNA Amplification by Henry A. Erlich (Ed.) Stockton Press. (1989).
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19. Recombinant DNA and Biotechnology: Guide for Teachers. 2nd Edition by Helen Kreuz. (2001). ASM Publications
20. Molecular Biotechnology: Principles and Applications of Recombinant DNA. 2 nd Edition. (1998) by Bernard R. Glick and Jack J. Pastemak, ASM Publications.
21. From genes to clones by Winnaker.
22. Manipulations and expression of recombinant DNA by Robertson.
23. Gene targeting – A practical approach by Joyner.
24. Vedamurthy, A.B., and Mahesh, S. (2002) Biotechnology – IV including recombinant DNA technology, Environmental Biotechnology and Animal Cell Culture. New Age Publishers, New Delhi.

Program code with title	**BTCT 4.1 Genetic Engineering**	
Units	**Course Outcome**	**No of hours**
Unit 1	**Introduction to Genetic Engineering**: Student will understand the Scope and importance of Genetic engineering	**02 Hrs**
Unit 2	**Cloning Vectors**: Student will understand the different types of bacterial viral and fungal vectors and their properties and its importance in genetic engineering.	**08 Hrs**
Unit 3	**Tools of Genetic Engineering**: Student will gain the knowledge about the different enzymes used their mechanism and role in genetic engineering.	**05 Hrs**
Unit 4	**Cloning and Construction of gene Libraries**: Student will understand about the different type of library construction and screening using suitable vectors..	**05 Hrs**
Unit 5	**Selection, Screening and Analysis of Recombinants:** Students will get insight in to Blotting Techniques and different types of electrophoresis.	**06 Hrs**
Unit 6	**Labeling and Detection Techniques**: Student will understand the different methods of Labeling of DNA, RNA and Proteins. Student will gain the knowledge about the DNA Sequencing	**04 Hrs**
Unit 7	**Transformation Techniques:** Student will understand the concept of transformation and transfection techniques and other methods of gene insertion.	**06 Hrs**
Unit 8	**Polymerase chain Reaction**: Student will understand the types and applications of Polymerase chain Reaction	**03 Hrs**
Unit 9	**Chemical Synthesis of genes**: : Student will understand the Different methods for Oligonucleotide synthesis and application, synthesis of complete gene.	**04 Hrs**
Unit 10	**Antisense and Ribozyme technology:** Student will understand the Molecular mechanism of antisense molecules and application of antisense and Ribozymes technologies.	**03 Hrs**
Unit 11	**Applications of Genetic engineering and rDNA technology:** Student will understand the use of transgenic organisms , recombinant molecules in health, pharmaceuticals, agriculture and industrial sectors, research labs for the welfare of human kind.	**04 Hrs**

BT CT 4.2 – PLANT BIOTECHNOLOGY

50 Hrs

Unit 1

Plant tissue culture and media: Introduction to Cell and Tissue culture. Tissue culture as a technique to produce novel plants and hybrids, Tissue culture media: (Composition and preparation). Initiation & maintenance of callus and suspension culture and single cell clones.

04 Hrs

Unit 2

Cell and Organogenesis: Somatic embryogenesis, transfer and establishment of whole plants in soil. Shoot tip culture, rapid clonal propagation and production of virus free plants. Embryo culture and Embryo rescue. Anther, pollen and ovary culture for production of haploid plants and homozygous lines.

06 Hrs

Unit 3

Protoplast isolation, fusion and cryopreservation: Selection of hybrid cells and regeneration of hybrid plants, Symmetric and asymmetric hybrid and cybrids. Cryopreservation, slow growth and DNA banking for germ plasm conservation

05 Hrs

Unit 4

Basic techniques in r-DNA technology: Biolistics (Particle bombardment) Electroporation, microinjection and Agro bacterium mediated gene transfer. T-plasmid derived vector systems, structure and restriction site Mechanism of T-DNA transfer from Agrobacterium to plant cells. Marker and reporter genes used in plant system. Manipulation of gene expression in plants Isolation and uses of different promoters, production of marker free transgenic plants

08 Hrs

Unit 5

Plants transformation Technology: Basis of tumor formation, hairy root, features of Ti and Ri plasmids, mechanisms of DNA transfer, role of virulence genes, use of Ti and Ri as vectors, Binary vectors, use of 35S and other promoters. Genetic markers, use of reporter gene with introns, use of scaffold attachment regions, methods of nuclear transformation, viral vectors and their applications multiple

gene transfers, vector-less or direct DNA transfer. Transformation of monocots, Trans gene stability and gene silencing.

08 Hrs

Unit 6

Application of plant transformation in plant productivity and performance: Herbicide resistance, phosphoinothricin, Glyphosate, sulfonyl urea, atrazine, insect resistance/ Bt genes, Non Bt like protease inhibitors, alpha amylase inhibitor, virus resistance coat protein mediated, nucleo capsid gene disease resistance, chitinase, 1-3 B gluconase, RJP antifungal proteins, thionins, PR proteins, nematode resistance, Abiotic stress, post-harvest losses, long self-life of fruits and flowers use of ACC synthase, polygalactouranase and ACC oxidase. Male sterile lines, bar and barnase systems, Carbohydrate composition and storage ADP glucose pyrophosphates

08 Hrs

Unit 7

Molecular marker aided breeding: RFLP maps linkage analysis, RAPD markers. STS micro satellites SCAR (Sequence Characterized Amplified Regions) SSCP (Single strand conformational polymorphism) AFLP, QTL, map based cloning, molecular markers assisted selection, Molecular characterisation of homozygous and heterozygous for plant breeding.

06 Hrs

Unit 8

Plant genomics: Arabidopsis thaliana (Mad–Box gene) as a model for plant genomics and Plant proteomics, Rice genome project, Genetic diversity and phylogenetic studies, Comparative genomics and analysis for selection of best species.

05 Hrs

PRACTICALS

BT CP 4.5 Based on BTCT-4.2-Plant Biotechnology

1. Aseptic culture techniques for establishment and maintenance of cultures
2. Preparation of stock solutions of MS basal medium and plant growth regulator stocks.
3. Isolation of Explant and maintenance of culture. Sub culture of callus, Organogenesis and Transfer of plants to soil.
4. Micropropagation by Proliferation of Auxiliary buds and by adventitious shoot proliferation.
5. Initiation and establishment of cell suspension cultures.

6. Anther culture for Haploid production.
7. Microspore culture for Haploid production.
8. Protoplast/ embryo isolation and culture.
9. Embryogenesis in cultured cells.
10. Preparation of Synthetic seeds.
11. *In vitro* fertilization and cultures of ovary/ovule.
12. Extraction and quantification of secondary metabolites from callus.
13. Histological preparation by Squash preparation of tissues to trace the path of differentiation.
14. Isolation of plant genomic DNA (C-TAB method) and Agarose electrophoresis.
15. PCR amplification of genomic DNA.
16. Preparation of competent cells
17. Transformation of protoplast by Electroporation.
18. Isolation of total RNA from plant.

REFERENCES

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2. Reinert, J.R. and Bajaj, Y.P.S. (1997): Applied Fundamental aspects of Plant cell, tissue and organ culture, Spinger and Verlag, Berlin.
3. Anthony, R.C., Wilhelm, G. and Joseph, E. (1995). Methods in plant molecular biology – A Laboratory course manual, Cold Spring Harbour Laboratory Press, USA.
4. Bhan (1998). Tissue culture, Mittal Publications, New Delhi.
5. Fu, TJ, G Singh and WR Curtus. (1999). Plant cell and tissue culture for the production of food ingredients. Kluwer Academic/ Plenum Press
6. Gamborg, O. and Philip, G.C. (1998). Plant cell, tissue and organ culture. Narosa Publishing House.
7. Gupta, P.K. (1996). Elements of Biotechnology, Rastogi Publications, Meerut.
8. Heldt (1997). Plant Biochemistry and Molecular Biology, Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.
9. Murray, D.R. (1996). Advanced methods in molecular biology, Vol – 55, Plant cell electroporation and electrofusion protocols, Humana Press in corp., USA.
10. Ravishankar, G. and Venkatraman, L.V. (1997). Biotechnological applications of Plant tissue and cell culture, Oxford and IBH publishing Co. Pvt. Ltd.
11. Gistou, P.and Klu,H. (2004). Hand Book of Plant Biotechnology, Vol. II, John Publication and I.
12. Slatu, A., Nigil, W., Scott and Mark Flower (2003). The Genetic manipulation of plant, Oxford University Press.

Program code with title	**BT ET 3.4 – PLANT AND ANIMAL TISSUE CULTURE**	

Units	Course Outcome	No of hours
Unit 1	**Plant tissue culture and media**: Students will gain the knowledge about the Cell and Tissue culture technique and maintenance of callus and suspension culture.	**04 Hrs**
Unit 2	**Cell and Organogenesis**: Students will understand the Somatic embryogenesis, clonal propagation and embryo culture techniques..	**06 Hrs**
Unit 3	**Protoplast isolation, fusion and cryopreservation**: Students will gain knowledge about Selection of hybrid cells and regeneration of hybrid plants and about cryopreservation, and germ plasm conservation.	**05 Hrs**
Unit 4	**Basic techniques in r-DNA technology**: Students will understand the different methods of gene transfer and use of gene markers. Students will gain knowledge about Isolation and uses of different promoters, production of marker free transgenic plants.	**08 Hrs**
Unit 5	**Plants transformation Technology**: Students will understand the process of insertion of desired genes in to various vectors and their applications. Students will gain knowledge about the trans gene stability and gene silencing.	**08 Hrs**
Unit 6	**Application of plant transformation in plant productivity and performance**: Students will understand the process of introducing the resistant genes to increase the productivity of plants.	**08 Hrs**
Unit 7	**Molecular marker aided breeding**: Students will understand the use of markers and markers assisted selection, Molecular characterisation of homozygous and heterozygous for plant breeding	**06 Hrs**
Unit 8	**Plant genomics**: Students will understand the plant genomics and Plant proteomics of plants and Comparative genomics and analysis for selection of best plants.	**05 Hrs**

BT CT 4.3 – MEDICAL BIOTECHNOLOGY

50 Hrs

Unit 1

Medical Biotechnology: Scope and Importance, Medical Biotechnology' Indian scenario.

02 Hrs

Unit 2

Cancer Biology: Types of tumors, pre-disposing factors, cellular changes involved in tumor formation genes associated with cancer (Oncogenes and Tumor suppressive genes). Tumor formation, promotion and progression, prevention of cancer, carcinogens, airborne, foodborne and human Papilomavirus, Methods of tumor detection, tumor markers, treatment of cancer chemotherapy, radiotherapy, immunotherapy and gene therapy.

07 Hrs

Unit 3

Microbial diseases in humans: Mode of infection, symptoms, epidemiology and control measures of diseases caused by

Viruses: HIV, Hepatitis-B, Rabies, HSV-1, H1N1

Bacteria: Goneria, Tuberculosis, Anthrax, B, Plague

Fungi: Aspergillosis, Histoplasmosis, Cryptococcosis

Protozoa: Malaria, Amoebiasis

08 Hrs

Unit 4

Diagnostics: Immunological diagnostics-RIA, ELISA, Florescence immune assays, Immuno-electrophoresis and Heam-agglutination assay, Molecular diagnostic methods- PCR, DNA Fingerprinting, DNA Microarray in forensic science and disease diagnosis.

06 Hrs

Unit 5

Stem cells: Types, sources, properties, Induced pluripotent stem cells (IPSCs) and applications of stem cells in tissue repair, tissue engineering, Organ Printing and regenerative medicine. Embryonic stem cells and its preservation

05 Hrs

Unit 6

Human genome project and its applications: Examples of genes identified with various human diseases, molecular detection of pre symptomatic genetic diseases, Importance in health care, pre-natal diagnosis, genetic manipulation and ethical implications.

05 Hrs

Unit 7

Gene therapy: Human diseases targeted for gene therapy, Types vectors, nanotechnology based gene therapy and other delivery systems for gene therapy. *Ex-vivo* and *In-vivo* gene therapy, tissue of choice for gene therapy *In-vitro* gene therapy and gene therapy of genetic diseases e.g. Neurological, Metabolic disorders and Cystic fibrosis, gene therapy for Acquired diseases (ADA gene in SCID), Cardiovascular diseases, Cancer etc. Importance of humanized antibodies and plasminogen activating factor in treating thrombosis

05 Hrs

Unit 8

Nano-biotechnology: Introduction, types and synthesis of nano-materials, Nano biosensors, nanoparticles in drug delivery and gene delivery, Quantum Dots, Nanoparticles in realtime monitoring and disease diagnostics and cancer therapy Risk potential of nano-materials.

05 Hrs

Unit 9

Pharmaco-biotechnology: Role of biotechnology in the production of pharmaceutical products, Drug targeting, Monoclonal antibodies and their application in Medicine.

04 Hrs

Unit 10

Ethical issues involved in stem cell research: Use of cell cultures as alternative for animal model for research, testing of drugs on human volunteers, use of animals for research and testing. Animal cloning, human cloning, ethical and social issues, organ transplantation and xeno transplantation

03 Hrs

PRACTICALS

BT CP 4.6 Based on BT CT 4.3 Medical Biotechnology

1. Detection of malarial parasite from human blood sample.
2. Study antibiotic sensitivity test by using paper disc as well as agar cup plate method.
3. Anaerobic culture method for anaerobes of clinical importance.
4. Presumptive identification of pathogens using colony morphology on selective/differential/ selective-differential/ Enrichment media.
5. Isolation and characterization of clinically significant species of *Staphylococcus sp., Streptococcus sp., Cornybacterium sp., Bacillus sp., Nocordia sp., Neisseria sp., Candida sp.,* and *Cryptococcus sp., Enterobacteriaceae sp.,, Vibrio sp., Pseudomonas sp.,* and *Aeromonas sp.,.*
6. Drug susceptibility testing by various methods according to NCCLS.
7. Determinations of MIC for selected antibiotics (Kirby-Bauer method and Checker board method).
8. Preparation of culture media: Simple tissue culture methods for growing different pathogenic microorganisms.
9. Conventional methods for isolation and identification of pathogenic bacteria / fungi.
10. Lymphocyte viability test in Rat/Mice (Typhan blue Dye exclusion test).
11. Microbial flora of mouth and study of commensal flora of human body.
12. Bacteriological examination of Urine, Blood, Pus Samples from Hospitals.
13. Estimation of urine bacteria by Calibrated loop direct streak method.
14. Study of stem cell from embryonic fluids.
15. Study of different cancer cell lines
16. Mandatory visit to hospital and medical research centers.

REFERENCES

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2. Colle, J. G. (1989). *Practical medical microbiology*. Edninburgh: Churchill Livingstone.
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14. Wilson, K., & Walker, J. M. (2007). *Principles and techniques of biochemistry and molecular biology*. Cambridge: Cambridge University Press. Artificial Cells: Biotechnology, Nanomedicine, Regenerative Medicine, Blood Substitutes, Bioencapsulation, Cell/stem Cell Therapy. World Scientific.

BT CT 4.3 – MEDICAL BIOTECHNOLOGY

Program code with title	**BT CT 4.3 – MEDICAL BIOTECHNOLOGY**	
Units	**Course Outcome**	**No of hours**
Unit 1	**Medical Biotechnology:** students will be able to classify medically important microorganisms, normal microbial flora and their significance.	**02 Hrs**
Unit 2	**Cancer Biology**: Students will be able to Types of tumors, Tumor formation, prevention of cancer, , Methods of tumor detection, tumor markers, treatment of cancer chemotherapy, radiotherapy, immunotherapy and gene therapy.	**07 Hrs**
Unit 3	**Microbial diseases in humans**: Students will be able to understand **Mode** of infection, symptoms, epidemiology and control measures of diseases caused by viruses,bacteria,fungi and protozoa.	**08Hrs**
Unit 4	**Diagnostics**: **Diagnostics**: Students will be able to understand the different immunological, molecular diagnostic methods.	**08Hrs**
Unit 5	**Stem cells**: Students will be able to understand the Types, sources,	**06 Hrs**

	properties, stem cells. Embryonic stem cells and its preservation	
Unit 6	**Human genome project and its applications:** Students will be able to understand the genes for a various human diseases and its importance in health care.	**05Hrs**
Unit 7	**Gene therapy**: **:** Students will be able to understand the Human diseases targeted for gene therapy, gene therapy of genetic diseases Cardiovascular diseases, Cancer etc.	**05 Hrs**
Unit 8	**Nano-biotechnology** Students will be able to understand the Introduction, types and synthesis of nano-materials, Nanoparticles in realtime monitoring and disease diagnostics and cancer therapy Risk potential of nano-materials.	**05Hrs**
Unit 9	**Pharmaco-biotechnology:** Students will be able to understand the role of biotechnology in the production of pharmaceutical products	**04Hrs**
Unit 10	**Ethical issues involved in stem cell research:** Students will be able to understand the use of cell cultures, use of animals for research.	**03Hrs**