

## B.Sc. Biotechnology (H) (6 semester duration)

### Course Structure

#### First Semester

Course Code	Course title	Credit Hrs.
BTM -111	Biochemistry-I	3+0
BTM -112	Microbiology-I	3+0
BTM -113	Cell Biology	3+0
BTM -114	Biochemistry lab-I	0+2
BTM -115	Microbiology lab-I	0+2
BTM -116	Cell biology lab-I	0+2
BTM -117	Cell Metabolism	3+0
BTM -118	Basic English	0+0

#### Second Semester

Course Code	Course title	Credit Hrs.
BTM -121	Biochemistry -II	3+0
BTM -122	Genetics	3+0
BTM -123	Microbiology-II	3+0
BTM -124	Biochemistry lab-II	0+2
BTM -125	Microbiology lab-II	0+2
BTM -126	Cytogenetics lab	0+2
BTM -127	Recombinant DNA Technology	3+0
BTM -128	Advanced uses of Computer	0+0

#### Third Semester

Course Code	Course title	Credit Hrs.
BTM -211	Molecular Biology	3+0
BTM -212	Biophysical chemistry	3+0
BTM -213	Instrumentation	3+0
BTM -214	Molecular biology lab	0+2
BTM -215	Biophysical techniques	0+2
BTM -216	Instrumentation lab	0+2
BTM-217	Plant and Animal Tissue Culture	3+0

### Fourth Semester

Course Code	Course title	Credit Hrs.
BTM -221	Genetic engineering	3+0
BBT-222	Developmental biology	3+0
BTM -223	Immunology	3+0
BTM -224	Genetic engineering lab	0+2
BTM -225	Immunology lab	0+2
One month mandatory Industrial summer internship		

### Fifth Semester

Course Code	Course title	Credit Hrs.
BBT-311	Plant biotechnology	3+0
BBT-312	Animal Biotechnology	3+0
BTM-313	Biostatistics and Bioinformatics	3+0
BBT-314	Plant and Animal Biotechnology lab	0+2
BTM-315	Biostatistics Computer application and Bioinformatics lab	0+2
BTM- 316	Basic Fermentation techniques	3+0

### Sixth Semester

Course Code	Course title	Credit Hrs.
BBT-321	Food and Industrial Biotechnology	3+0
BBT-322	Environmental biotechnology	3+0
BBT-323	Food and Industrial Biotechnology Lab	0+2
BBT-324	Bioethics, legal issues and patenting	3+0
BBT-325	Project Work	0+6

## SEMESTER I

### **BTM -111: Biochemistry I (3+0)**

1. Basic chemistry of biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids
2. Amino acids: Classification and properties
3. Proteins: Classification based on structure and functions, structural organization of proteins (primary, secondary, tertiary and quaternary structures).
4. Photosynthesis: Structure of photosynthetic apparatus, Light and Dark reactions, C<sub>3</sub> and C<sub>4</sub> cycle
5. Lipids: Structure, properties, classification and functions

### **BTM -112: Microbiology I (3+0)**

1. History of microbiology, Scopes in microbiology, Concept of microbial diversity
2. Microscopy: Fluorescence, Phase contrast, Electron Microscope
3. Introduction to eubacteria, archaea and eukaryotic microorganisms
4. Structural differences between Gram positive, Gram negative and archaea cells
5. Microbial growth: batch, continuous and synchronized cultures
6. Microbial nutrition: phototrophs, chemotrophs, heterotrophs
7. Microbial Media: simple, differential and selective
8. Pure culture technique: Isolation, preservation and maintenance of culture

### **BTM -113: Cell Biology (3+0)**

1. Introduction: the Cell theory, structural organization of a prokaryotic and eukaryotic cell.
2. Plasma membrane: structural organization, function, transport across the membrane.
3. Cellular organelles: structure and functions of rough and smooth endoplasmic reticulum, Golgi complex, **Protein Trafficking**, Lysosome, Peroxisome, Vacuoles, Mitochondria, Chloroplast.
4. Nucleus and nucleolus, chromatin structure and organization
5. Cytoskeleton and extra cellular matrix
6. Cell divisions: Cell cycle and control of cell cycle, cell death (apoptosis and necrosis), cancer.

### **BTM - 114: Biochemistry lab-I (0+2)**

1. Units of Biochemistry
2. Instruments/Equipments and Glass Ware Used in Biochemical Laboratory
3. Concentration of Solution
4. pH and It's determination
5. Buffer and It's uses
6. Qualitative tests of Carbohydrate
7. Estimation of glucose by O-Toluidine method.
8. Qualitative test of Amino acids
9. Qualitative test of Protein.
10. Estimation of Protein by Biuret method.
11. Titration of Mixture of strong and weak acids
12. Paper chromatography

### **BTM - 115: Microbiology lab-I (0+2)**

1. Introduction To The Microbiology Laboratory
2. Microscope And Microscopy
3. How To Use Microscope
4. Control Of Microorganisms
5. Preparation Of Culture Media
6. Pure Culture Techniques
7. Isolation Of Pure Culture
8. Sampling Of Microorganism
9. Preparation Of Bacterial Smear
10. Morphological Characteristics Of Bacteria
11. Cultural Characteristics Of Bacteria
12. Simple Staining
13. Negative Staining Of Bacteria
14. Differential Staining Of Bacteria
15. Special Staining Of Bacteria (Endospore Staining)
16. Special Staining Of Bacteria
17. Motility Test By Hanging Drop Technique
18. Calibration Of Micrometer
19. Measurement Of Microorganism By Using Ocular Micrometer

### **BTM - 116: Cell biology lab (0+2)**

1. Laboratory Safety
2. Osmotic Haemolysis
3. Plasmolysis: Study of plant cell in hypertonic solution
4. Study of plant cell types by cell maceration
5. Pipetting: Using micropipettors
6. Counting and determination of cell viability using haemocytometer
7. Paper chromatography
8. Mitosis in onion root tip cells
9. Meiotic cell Division in flower bud.

### **BTM – 117: Organic mechanism in biology (3+0)**

1. Common Mechanisms in Biological Chemistry – Overview of Digestion, Absorption, Metabolism (Anabolism & Catabolism), Nutrition, Respiration, Excretion.
2. Carbohydrates metabolism: Glycolysis, Krebs's Cycle and Oxidative Phosphorylation, Gluconeogenesis, Pentose phosphate pathway, Glyoxylate cycle.
3. Lipid Metabolism – Structures and roles of Fatty acids & Glycerols, beta oxidation of saturated fatty acids, oxidation of unsaturated fatty acids, oxidation of odd chain fatty acids, energy yield, ketone bodies.
4. Amino acid Metabolism – Amino acid breakdown (amino acid deamination, Urea cycle, metabolic breakdown of individual amino acids – glucogenic & ketogenic amino acids), amino acids as biosynthetic precursors (haem biosynthesis & degradation, biosynthesis of

epinephrine, dopamine, serotonin, GABA, histamine, glutathione); biosynthesis of essential & non-essential amino acids.

5. Nucleotide Metabolism – biosynthesis of purine & pyrimidine (de novo & salvage pathway); degradation of purine & pyrimidine.

## **BTM – 118: Basic English (0+0)**

### **BOOKS**

#### **CELL BIOLOGY**

1. Molecular Biology of cell – Bruce Alberts *et al.*, Garland Publications
2. Animal Cytology and Evolution – MJD, White Cambridge University Publications
3. Molecular Cell Biology – Daniel, Scientific American Books.
4. Cell Biology – Jack D. Bruke, The William Twilkins Company.
5. Cell Biology – Ambrose and Dorothy M Hasty, ELBS Publications.
6. Fundamentals of Cytology – Sharp, Mc Graw Hill Company
7. Cytology – Wilson and Morrison, Reinform Publications

#### **MICROBIOLOGY**

1. Microbiology – Pelzer, Chan, Krieg, Tata McGraw Hill Publications.
2. Microbiology – Concepts and Application by Paul A. Ketchum, Wiley Publications
3. Fundamentals of Microbiology- Frobisher, Saunders and toppan Publications.
4. Microbiology - Ronald M. Atlas
5. Introductory Biotechnology – R.B. Singh C.B.D. India (1990)
6. Industrial Microbiology – Casidal. E. Wiley Eastern Ltd.
7. Fundamentals of Bacteriology – Salley
8. Frontiers in Microbial technology – P.S. Bisen, CBS Publishers
9. General Microbiology- C.B. Powar, H.F. Dagainawala, Himalayan Publishing House

#### **BIOCHEMISTRY**

1. Principles of Biochemistry- Albert L. Lehninger CBS Publishers & Distributors
2. Biochemistry – Lubert Stryer Freeman International Edition.
3. Biochemistry – Keshav Trehan Wiley Eastern Publications
4. Fundamental of Biochemistry – Dr. A.C. Deb
5. Biochemistry- L.U. Satyanarayana, Books and Allied Pvt. Ltd.
6. Outlines of Biochemistry- Conn and Stumpf, Wiley Eastern Ltd., New Delhi.
7. Biochemistry-Voet and Voet, John Wiley and Sons.
8. Biochemical Methods- S. Sadasivam and A. Manickam, New Age International Publishers, New-Delhi.
9. Laboratory Manual in Biochemistry- J. Jayaraman, New Age International Publishers, New-Delhi.
10. Text Book of Practical Plant Chemistry- A. Buzarbarua, S. Chand and Co. New Delhi.

## **SEMESTER II**

### **BTM -121: Biochemistry –II (3+0)**

1. Human hormones: protein and steroid hormones, mechanism of hormone action.
2. Plant hormones: auxins, gibberellins, cytokinins, ethylene, abscisic acid
3. Vitamins: water and fat soluble vitamins, dietary source and deficiency syndromes
4. Enzymes: Classification, catalysis, mechanism of enzyme action, factors influencing enzyme activity, immobilization of enzymes, co-enzymes and cofactors, Isozymes.
5. Nitrogen metabolism and fixation of nitrogen in leguminous plants
6. Contractile protein, neurotransmitter

### **BTM -122: Genetics (3+0)**

1. Mendel's laws of inheritance
2. Extension of Mendelism: Incomplete dominance, co-dominance, pleiotropy, multiple allelism, complementation and epistasis,
3. Linkage and crossing over
4. Sex determination and sex linked inheritance
5. Numerical and structural changes in chromosomes
6. Mutation and mutagenesis
7. Extra-nuclear inheritance
8. Population genetics: Hardy-Weinberg equilibrium, maintenance and establishment of the equilibrium

### **BTM -123: Microbiology II (3+0)**

1. Bacterial genetics: conjugation, transformation and transduction
2. Microbial metabolism: photosynthesis, assimilation of inorganic nitrogen, phosphorous and sulphur
3. Viruses: Basic structure, classification, bacteriophages, lytic and lysogenic cycle, Virioids and prions.
4. Plant Microbe interactions
5. Mycoplasmas, Rickettsiae and Chlamydiae
6. Microbes and public health: Enterobacteriaceae, Mycobacterium, Gonococci, Candida, Aspergillus, Variola, Varicella-Zoster, etc.
7. Microbes and pharmaceutical industry

### **BTM - 124: Biochemistry lab II (0+2)**

1. Extraction and quantification of total lipids.
2. Estimation of Vitamin C from plant samples.
3. Preparation of starch from Potato and its hydrolysis by salivary amylase. Test of salivary amylase.
4. Estimation of total Protein (Lowry's method).
5. Preparation of acetate and phosphate buffers with different pH.
6. Extraction of casein from milk.
7. Effect of temperature / pH on enzyme activity
8. Assay of alkaline phosphatase.

### **BTM - 125: Microbiology lab II (0+2)**

1. Generation time of bacteria(Growth curve)
2. Most probable number(MPN) of Coliforms in water
3. Isolation of pure culture by streak plate
4. Isolation of pure culture by pour plate method
5. Isolation of pure culture by pour plate method
6. Cultivation of anaerobes
7. Isolation and culture of rhizobium
8. Isolation and identification of *E.coli* from given water sample
9. Detection of extracellular bacterial enzyme production
10. Isolation of slime moulds
11. Antibiotic sensitivity testing
12. Germicidal effect of UV light on bacterial growth

### **BTM - 126: Cytogenetics lab (0+2)**

1. Basic sterilization techniques required for Media preparation & Cytological techniques.
2. Media preparation technique.
3. Blood Typing
4. Enumeration of WBC and RBC
5. Mitosis in hordeum vulgare
6. Mitotic aberration
7. Isolation of Lymphocytes
8. Demonstration of banding and Karyotyping with permanent slides.

### **BTM - 127: Recombinant DNA Technology (3+0)**

1. Gene Recombination and Gene transfer : Bacterial Conjugation, Transformation, Transduction, Episomes, Plasmids, Microinjection, Electroporation, Microprojectile, Shot Gun method, Ultrasonication, Liposome fusion, Microlaser.
2. Polymerase chain reaction (PCR), RT-PCR
3. Changing genes: site-directed mutagenesis and Protein engineering: Primer extension is a simple method for site directed mutation, PCR based site directed mutagenesis, Random mutagenesis, Use of Phage display techniques to facilitate the selection of mutant peptides, Gene shuffling, production of chimeric proteins.
4. Molecular Markers – RFLP, RAPD, AFLP
5. Molecular detection techniques - Southern, Northern and Western hybridization.

### **BTM - 128: Advanced uses of Computer (0+0)**

1. History and Generation of computer:-1st to 4th generation with their characteristics.
2. Basic concepts of computer
3. Introduction, different components of computer, basic design of computer.

4. Computer architects
5. Introduction to operating system
6. Algorithm and flow chart
7. Execution of a Program- spread sheet; data based concepts using MS-EXCEL, MS-POWER POINT and MS-WORD, Networking; LAN,MAN and WAN
8. Introduction to OS
9. Memory management –Memory allocation rule, Swapping, Overlay, Paging, Demand paging, segmentation, virtual memory.

## **BOOKS**

### **GENETICS**

1. Principles of Genetics – E.J. Gardener, M.J. Simmons and D.P. Snustad, John Wiley and Sons Publications.
2. Genetics- M.W. Strickberger, Prentice Hall of India Pvt. Ltd., New- Delhi.
3. Fundamentals of Genetics- B.D. Singh

## **SEMESTER III**

### **BTM -211: Molecular Biology (3+0)**

1. Nucleic Acids: Nucleic acid as the genetic material, structure and aggregation of DNA and RNA, DNA double helix, different conformations of double helix, DNA supercoiling, denaturation and renaturation of DNA, C-value paradox, Cot value and curve, chemical complexity
2. DNA replication, DNA damage and DNA repair (SOS and excision repair)
3. Homologous recombination, site specific recombination and transposons
4. Transcription in prokaryotes and eukaryotes
5. Regulation of gene expression in prokaryotes: *lac* and *trp* operons
6. Genetic code
7. Translation in prokaryotes and eukaryotes

### **BTM -212: Biophysical Chemistry (3+0)**

1. pH and Buffers
2. Chemical bonding: Ionic bond, covalent bond, hydrogen bond, peptide bond, Vander-Waals forces
3. Properties of water
4. Thermodynamics- the First law of thermodynamics, concept of internal energy, the Second law of thermodynamics, free energy, enthalpy, entropy, free energy in biochemical reactions, and in transport of non-ionic and ionic substances across the biological membranes.
5. Nucleic Acids: structure and aggregation of DNA and RNA, DNA double helix, different conformations of double helix, DNA supercoiling.
6. Concept of Protein folding: hydrophilic and hydrophobic amino acids



**BTM -213: Instrumentation (3+0)**

1. Principles of pH meter, dialysis
2. Principles of different types of centrifugation, ultracentrifugation, application of analytical centrifugation and density gradient centrifugation.
3. General principles of chromatography, adsorption chromatography, column, affinity, TLC, partition, ion exchange, gel filtration and permeation chromatography.
4. Principles and application of gel electrophoresis
5. Spectroscopic techniques: principles and applications of spectroscopy,
6. Radioisotope technique: nature of radioactivity, principles of radioisotopes and radiations, units, radioactive decay, detection and measurement of radioactivity.
7. Thermo cycler and its variants
8. Microscopy

**BTM -214: Molecular Biology lab (0+2)**

1. Extraction of genomic DNA from animal cell (whole blood)
2. Isolation of Genomic DNA from plant tissue
3. Isolation of genomic DNA from Bacteria
4. Isolation of genomic DNA using teaching kit (whole blood)
5. Quantitative estimation of DNA and RNA
6. Determination of molecular weight of DNA bands based on Agrose gel electrophoresis
7. Southern blotting
8. Isolation of Protein
9. Quantification of Protein.
10. SDS-PAGE

**BTM -215: Biophysical Chemistry lab (0+2)**

1. To determine the pH of unknown sample
2. To prepare Phosphate, Bicarbonate & Citrate buffer
3. Isolation of Casein protein by Isoelectric precipitation
4. Paper Chromatography of Amino acids
5. SDS PAGE
6. Spectrophotometric quantification of DNA sample

**BTM -216: Instrumentation lab (0+2)**

1. Calibration of pH meter.
2. Paper chromatography of amino acids/sugars.
3. TLC of sugars/amino acids.
4. Cellular fractionation and separation of cell organelles using centrifuge.
5. Validity of Beer's law for colorimetric estimation of creatinine.
6. Absorption spectrum of NAD & NADH.
7. Rocket immuno-electrophoresis

## **BTM -217: Plant and Animal Tissue Culture (3+0)**

1. Introduction to Techniques - Introductory history, Laboratory organization, Media, Aseptic manipulation.
2. Basic concepts in cell culture - cell culture, Cellular Totipotency, Somatic Embryogenesis.
3. Growth Hormones - Plant cells (Composition of culture media, Growth hormones, Vitamins, Unidentified supplements, selection of media); Animal cells (substrate on which cells grow, Feeder layer on substrate, gas phase for tissue culture, media and supplements).
4. In vitro plant culture : approaches & methodologies - preparation steps for tissue culture, surface sterilization of plant tissue material, basic procedure for aseptic tissue transfer, incubation of culture.
5. Tissue culture methodologies - Plant cells (Callus Culture, Cell Suspension Culture, Organ Micro-culture, plant micro-propagation, Somatic Embryogenesis); Animal cells (Source of tissue, primary culture, differentiation of cells, growth kinetics, animal cell lines and their origin and characterization).

## **BOOKS**

### **BIOPHYSICAL CHEMISTRY**

1. Narayanan, P (2000) Essentials of Biophysics, New Age Int. Pub. New Delhi.
2. Roy R.N. (1999) A Text Book of Biophysics New Central Book Agency.

### **MOLECULAR BIOLOGY**

1. Glick, B.T and Pasternak J.J (1998) Molecular Biotechnology, Principles and application of recombinant DNA, Washington D.C. ASM press.
2. Howe.C. (1995) Gene Cloning and Manipulations, Cambridge University Press, USA
3. Lewin, B., Gene VI New York, Oxford University Press.
4. Rigby, P.W.J. (1987) Genetic Engineering, Academic Press Inc. Florida, USA.
5. Sambrook et al (2000) Molecular Cloning Volumes I, II, & III Cold spring Harbor Laboratory Press, New York, USA
6. Walker J.M. and Gingold, E.B. (1983) Molecular Biology and Biotechnology (Indian Edition) Royal Society of Chemistry U.K
7. Karp.G (2002) Cell and Molecular Biology, 3<sup>rd</sup> Edition, John Wiley and Sons; INC
8. Cell and Molecular Biology- P.K. Gupta, Rastogi Publishers, Meerut

## SEMESTER IV

### **BTM - 221: Genetic Engineering (3+0)**

1. Introduction to Genetic Engineering: definition, history and scope.
2. Restriction enzymes- definition, characteristics and uses.
3. Cloning and cloning vectors: Plasmid vectors,  $\lambda$  vectors.
4. Construction and screening of Genomic DNA library and c DNA library.
5. DNA finger printing.
6. Nucleic acid sequencing: Di-deoxy and Chemical sequencing methods
7. Genetic engineering in animals: Production of transgenic mice, ES cells can be used for gene targeting in mice, Applications of gene targeting, Using Yeast to study Eukaryotic gene function, Therapeutic products produced by genetic engineering-blood proteins, human hormones, immunomodulators and vaccines, Transgenic animals, Production of proteins of Pharmaceutical value.
8. Genetic engineering in plants: Use of *Agrobacterium tumefaciens* and *Arhizogenes*, Ti plasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants, Use of plant viruses as episomal expression vectors.

### **BBT - 222: Developmental Biology (3+0)**

1. Introduction to Developmental Biology, Germ cells, Basic concepts in embryology, Genetics and Development.
2. Gametogenesis: Spermatogenesis and Oogenesis; Gametogenesis in angiosperms
3. Fertilization and embryogenesis: overviews in animals and higher plants.
4. Integrating cells into tissues:- Cell adhesion, cell junctions, extra cellular matrix and connective tissues
5. Genetic regulation of development
6. Stem cell Biology

### **BTM -223: Immunology (3+0)**

1. History and scope of Immunology
2. Types of Immunity: acquired and innate; Inflammation, cell mediated and humoral immunity
3. Cells, tissues and organs of the immune system
4. Antigen: antigenicity vs. immunogenicity
5. Immunoglobulin: structure, function and diversity; antigen-antibody reactions, concept of ELISA, Immuno Assay.
6. T cell and B cell maturation and activation
7. Cytokines, Interleukins, T Cell and B Cell defects.

### **BTM -224: Genetic Engineering lab (0+2)**

1. Isolation of genomic DNA from bacteria, plant and animal tissue.
2. Isolation of plasmid DNA (*E. coli*).
3. Restriction digestion of DNA.

4. Separation of DNA by Gel Electrophoresis.
5. SDS-PAGE for protein profiling.
6. Isolation of chloroplast DNA.
7. Demonstration of Replica plating technique.
8. Identification of Lac<sup>+</sup> bacteria by blue white screening using IPTG.
9. Ligation of DNA.
10. Demonstration of Southern blotting.
11. Demonstration of western blotting.

### **BTM -225: Immunology lab (0+2)**

1. Antigen – antibody reaction
2. ABO-Blood grouping
3. Ouchterloney immunodiffusion.
4. Radial immunodiffusion.
5. Differential leukocyte count (DLC)
6. Blood film preparation.
7. ELISA (Kit).

## **Books**

### **GENETIC ENGINEERING**

1. Glick, B.R and Padernak J.J (1994) Molecular Biotechnology, Principles and Applications of Recombinant DNA, American Society for Microbiology, Washington D.C
2. Christopler, H. (1995) Gene Cloning and Manipulating, Cambridge University Press
3. Nicholl, D.S.T (1994) An Introduction of Genetic Engineering, Cambridge University Press.
4. Old, R.W. and Primrose, S.B. (1986) Principles of Gene manipulation, An introduction to genetic engineering (3rd Edition) Black well Scientific Publications
5. Lewin, B. (1994) Genes VI, New York, Oxford University Press.
6. Gene Cloning- T.A. Brown, Blackwell Publisher
7. Molecular Cloning: A Laboratory Manual, Maniatis, Fritch and Samrock.

### **IMMUNOLOGY**

1. William, E. Paul (1989) Fundamental immunology, 2nd Edition Raven Press, New York.
2. William, R. Clark (1991) The Experimental Foundations of Modern Immunology (4th Edition) John Wiley and Sons, New York.
3. Ivan, M, roitt (1994) Clackwell Scientific Publications, London

## SEMESTER V

### **BBT-311: Plant Biotechnology (3+0)**

1. Introduction, history and scope of plant cell and tissue culture
2. Sterilization and Plant tissue culture media
3. Micro-propagation technique
4. Callus and suspension culture
5. Organogenesis and somatic embryogenesis – Techniques and applications
6. Protoplast Culture – Isolation, regeneration and viability test, somatic hybridization, methods of protoplast fusion – chemical methods, practical application of somatic hybridization
7. Somaclonal variation and their significance
8. Transgenic plants: Agro bacterium mediated transformation

### **BBT-312: Animal Biotechnology (3+0)**

1. Animal cell culture applications and products: Cell products - antibodies and immuno-regulators, recombinant products, viral vaccines, cell and tissue therapy.
2. **Cloning**
3. Production of Vaccines in animal Cells.
4. Production and Applications of monoclonal antibodies.
5. Transgenic animals

### **BTM-313: Biostatistics and Bioinformatics (3+0)**

1. Introduction and principles of statistical sampling from a population.
2. Random sampling.
3. Frequency distributions and associated statistical measures.
4. Probability measures and probability distributions and Random variable.
5. Correlation, and regression analysis,
6. Hypothesis testing: T, F, Chi-square distribution and tests.
7. Introduction to bioinformatics.
8. Application of different software in solving biological problems
9. Database management and data analysis – use of different databases e.g. Pubme, TIGR, PDB database, Gene bank.
10. Gene and protein sequence analysis
11. Genomics, transcriptomics and proteomics – computer applications

### **BBT- 314: Plant and Animal Biotechnology lab (0+2)**

1. Tissue culture laboratory general requirement, equipments, common media.
2. Preparation of Plant tissue culture media.
3. *In vitro* propagation through shoot tip and nodal culture.
4. Production of callus and culture.
5. Sub culture of carrot callus.
6. Hardening of plantlets.
7. Isolation of protoplast from plant leaves.
8. Isolation of lymphocytes.
9. Lymphocytes culture

### **BTM- 315: Biostatistics and Bioinformatics lab (0+2)**

1. Practical work of simple Statistical programmes.
2. Practical on Biostatistics: based on theory papers.

3. Introduction to Computer application.
4. Introduction to software of enzymes, DNA and Proteins.
5. Internet basics.
6. Introduction to NCBI Web sites.
7. Introduction to Data bases.

### **BTM-316: Basic Fermentation Technique (3+0)**

1. Principles of Microbial growth – introduction, the ways of growing microorganisms, ways to increase yield of microbes, Batch, fed-batch and continuous cultures (definition and kinetics).
2. Bioreactor / Fermenter – types & operation of Bioreactors, physico-chemical standards used in bioreactors, limitations of bioreactors, stages of fermentation processes, Media design for fermentation processes, Solid substrate fermentation, Fermenters (Stirred tank, bubble columns, airlift. Bioreactors, Static, Submerged and agitated fermentation), advantages & disadvantages of solid substrate & liquid fermentations.
3. Technology of Microbial cell maintenance – steps to maintain microbial culture in an aseptic & sterile environment (how to inoculate, preserve & maintain), Strain preservation, maintenance and strain improvement.
4. Downstream processing – extraction, separation, concentration, recovery & purification, operations (Insulin, Vitamins, Metabolites), Industrial production of Ethyl alcohol, Acetic Acid (Vinegar), Citric acid, lactic acid,  $\alpha$ -amylase, protease penicillin, tetracycline and vitamin B12, with reference to easily available raw materials, Production of herbal drugs.

### **BOOKS**

#### **PLANT BIOTECHNOLOGY**

1. Ravishankar G.A and Venkataraman L.V(1997) Biotechnology: Applications of Plant Tissue and Cell Culture. Oxford and IBH Publishing Co., Pvt Ltd.
2. Bhan (1998) Tissue Culture, Mittal Publications, New Delhi.
3. Islan A.C (1996) Plant Tissue Culture, Oxford and IBH Publishing Co., Pvt. Ltd.
4. Lydiane Kyte & John Kelvins (1996) Plants from test tubes. An introduction to Micropropagation (3<sup>rd</sup> Edition) Timber Press, Partland.
5. Kumar H.D (1991) A Text Book on Biotechnology (2<sup>nd</sup> Edition). Affiliated East West Press Private Ltd. New Delhi.
6. Chrispeel M.J. and Sdava D.E. (1994) Plants, Genes and Agriculture, Jones and Barlett Publishers, Boston.
7. Reinert J. and Bajaj Y.P.S (1997) Applied and Fundamental Aspects of Plant Cell, Tissue, and Organ Culture, Narosa Publishing House.

#### **ANIMAL BIOTECHNOLOGY**

1. Elements of Biotechnology- P.K. Gupta., Rastogi publishers, Meerut.
2. Biotechnology- B.D.Singh, Kalyani Publishers, Ludhiana
3. A Text Book of Biotechnology- R.C. Dubey, S. Chand & Company Ltd.

## **BIOSTATISTICS**

1. Bliss, C.J.K. (1967) *Statistics in Biology*, Vol. I Mc Graw Hill, New York.
2. Campbell R.C.(1974) *Statistics for Biologists*, Cambridge Univ. Press, Cambridge.
3. Daniel (1999) *Biostatistics (3rd Edition)* Panima Publications Corporation.
4. Swardlaw, A.C. (1985) *Practical Statistics for Experimental Biologists*, John Wiley and sons, Inc, NY
5. Khan (1999) *Fundamentals of Biostatistics*.

## **BIOINFROMATICS**

1. *Introduction to Bioinformatics* - T.K. Attwood, D.J.P. Smith and S. Phukan, Pearson Education
2. *Bioinformatics of genome regulation and structure* - Kolchanov
3. *Trends in Bioinformatics* – P. Shanmughavel, Scientific Book Center.

## **SEMESTER VI**

### **BBT-321: Food and Industrial Biotechnology (3+0)**

1. Definition and scope for application of biotechnology in food industry.
2. Basic food chemistry and microbiology.
3. Food spoilage and preservation, preservation methods- physical, chemical, biological and irradiation.
4. Application of microorganisms in food fermentation; solid state fermentation (SSF); Types of fermented foods and beverages; traditional fermented foods of the Orient, Advantages of fermented foods. Technologies for production of Sauerkraut, Soya, bamboo shoot, cheese, and grape wine. Concept of starter cultures.
5. Enzymes and their application in food industries.
6. SCP; SCP producing microorganism and substrates used; advantage of using SCP.
7. Fermenters and their types; structure of an ideal Fermenters.
8. Microbes used in industrial fermentation; Industrial production process (Fermentations) for ethanol, vinegar and penicillin. Media for industrial fermentation
9. Microbial enhanced oil recovery.

### **BBT -322 Environmental biotechnology (3+0)**

1. Overview of the global environmental problems: Climate change, Energy crisis, use and abuse of plastics
2. Renewable and Non-Renewable resources of energy
3. Biofuels: Scope, source and production process
4. Bioremediation: Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents.
5. Treatment of municipal and Industrial waste water
6. Biofertilizers and Biopesticides- Scope, production and uses.
7. Environmental significance of Genetically Modified organisms (GMOs), plants and animals

### **BBT-323: Food and Industrial Biotechnology lab (0+3)**

1. Isolation of different types (bacteria, mould and yeast) for food.
2. Detection of amylase producing bacteria/ fungi from food sample.
3. Detection of coli forms and E-coli in food.
4. Estimation of BOD.
5. Determination of dissolved oxygen concentration of water sample.
6. Estimation of nitrate in drinking water.
7. Vermiculture and solid waste treatment
8. Testing of chlorine demand of water.
9. Estimation of hardness in drinking water.
10. Estimation of TDS in water
11. Testing of sulfate in water
12. Testing of fluoride in water
13. Testing of iron in water.



### **BBT-324 Bioethics, legal issues and patenting (2+0)**

1. Social, legal and ethical issues – Basic principles of Biosafety and Bioethics .
2. IBSC, RCGM
3. Institutional animal ethics committee
4. GEAC
5. CPCSEA
6. Bioethics – Necessity of Bioethics, different paradigms of Bioethics – National & International.
7. Intellectual Property Rights – Why IPR is necessary, TRIPS & IPR, IPR – national & international scenario, IPR protection of life forms.

### **BBT-325: Project work (0+6)**

1. Project report.
2. Seminar and viva –voce on Project work.

## **BOOKS**

### **FOOD AND INDUSTRIAL BIOTECHNOLOGY**

1. Bisen P.S (1994) Frontiers in Microbial Technology, 1<sup>st</sup> Edition, CBS Publishers.
2. Glaser A.N and Nilaido.H (1995) Microbial Biotechnology, W.H Freeman and Co.
3. Prescott and Dunn (1987) Industrial Microbiology 4<sup>th</sup> Edition, CBS Publishers & Distributors.
4. Prescott and Dunn (2002) Industrial Microbiology, Agrobios (India) Publishers.
5. Crueger W. and Crueger A. (2000) A Text of Industrial Microbiology, 2<sup>nd</sup> Edition, Panima Publishing Corp.
6. Stanbury P.F, Ehitaker H, Hall S.J (1997) Principles of Fermentation Technology, Aditya Books (P) Ltd.
7. Food Microbiology – Adams and Moss
8. Food Microbiology – Fraizer and Werthoff
9. Food Fermentation – Microbiology, Biochemistry & Technology, Vol. I & II , Joshi and Pandey.

### **ENVIRONMENTAL BIOTECHNOLOGY**

1. Biosafety and Bioethics – Joshi, R.M.: Eastern Book House.
2. Biotechnology in Environmental Management- Pathade, G.R., Eastern Book House.
3. Biodiversity and Environmental Biotechnology- Dwivedi, P and Kalita, M.C.