

<b>Telangana State Council of Higher Education</b> <b>B.Sc. CBCS (Biotechnology) Common Core Syllabi for all Universities of</b> <b>Telangana (w.e.f.2019-20 batch)</b>				
<b>CODE</b>	<b>COURSE TITLE</b>	<b>COURSE TYPE</b>	<b>HPW</b>	<b>CREDITS</b>
<b>I YEAR</b>				
<b>SEMESTER - I</b>				
BS 104	Cell Biology & Genetics	DSC – 1A	4T+3P=7	4+1=5
<b>SEMESTER - II</b>				
BS 204	Microbiology & Biological Chemistry	DSC – 1B	4T+3P=7	4+1=5
<b>II YEAR</b>				
<b>SEMESTER - III</b>				
BS 301	Industrial Fermentation*	SEC - 1	2	2
BS 302	Immunological Techniques	SEC - 2	2	2
BS 305	Molecular Biology & r-DNA Technology	DSC – 1C	4T+3P=7	4+1=5
<b>SEMESTER - IV</b>				
BS 401	Molecular Markers in Plant Breeding	SEC - 3	2	2
BS 402	Drug Designing*	SEC - 4	2	2
BS 405	Bio Informatics & Biostatistics	DSC – 1D	4T+3P=7	4+1=5
<b>III YEAR</b>				
<b>SEMESTER - V</b>				
BS 503	Basics in Biotechnology	GE	4	4
BS 505	Optional-I A/B A. Plant Biotechnology B. Medical Biotechnology	DSE – 1E	4T+3P=7	4+1=5
<b>SEMESTER - VI</b>				
BS 601	Project in Biotechnology/Optional Paper: (IPR, Biosafety and Entrepreneurship)	Project Work/Opt. P	4	4
BS 605	Optional-I A/B A. Animal Biotechnology B. Environmental Biotechnology	DSE – 1F	4T+3P=7	4+1=5

\*Previously recommended SEC 1: **Enzyme Technology** and SEC 4: **Intellectual Property Rights** have been changed to two UGC recommended SEC courses. **SEC 1: Industrial Fermentation** and **SEC:4 Drug Designing**.

**SEC:** Skill Enhancement Course  
**DSC:** Discipline Specific Core

**GE:** Generic Elective  
**DSE:** Discipline Specific Elective

**B.Sc. Biotechnology, I year**  
**SEMESTER I**  
**DSC-1A**  
**BS104: CELL BIOLOGY AND GENETICS**

**CREDIT I: Cell structure and Functions**

- 1.1 Cell as basic unit of living organisms-bacterial, fungal, plant and animal cells
- 1.2 Ultrastructure of prokaryotic cell (cell membrane and plasmids, Nucleoid)
- 1.3 Ultrastructure of eukaryotic cell (cell wall, cell membrane, nucleus, mitochondria, chloroplast, endoplasmic reticulum, Golgi apparatus, vacuoles)
- 1.4 Fluid mosaic model, Sandwich model, Cell membrane permeability
- 1.5 Structure of chromosome-morphology, components of chromosomes (histones and non-histones), specialized chromosomes (Polytene, Lamp brush)
- 1.6 Chromosomal aberrations- structural and numerical

**CREDIT II: Cell Division and Cell cycle**

- 2.1 Bacterial cell division
- 2.2 Eukaryotic cell cycle –phases
- 2.3 Mitosis - Stages (spindle assembly)-significance
- 2.4 Meiosis- Stages (synaptonemal complex)-significance
- 2.5 Senescence and necrosis
- 2.6 Apoptosis

**CREDIT III: Principles and mechanism of inheritance**

- 3.1 Mendel's experiments- factors contributing to success of Mendel's experiments
- 3.2 Law of segregation- Monohybrid Ratio; Law of independent assortment- Dihybrid Ratio, Trihybrid Ratio
- 3.3 Deviation from Mendel's laws- partial or incomplete dominance (eg: Flower color in *Mirabilis jalapa*), Co-dominance (eg: MN Blood groups), Non allelic interactions-types of epistasis, modification of dihybrid ratios
- 3.4 Penetrance and Expressivity (eg: Polydactyly, Waardenburg syndrome), pleiotropism, phenocopy- microcephaly, cleft lip.
- 3.5 Multiple allelism (eg: Coat color in Rabbits, eye color in *Drosophila* and ABO Blood groups)
- 3.6 X-Y chromosomes - Sex determination in *Drosophila*, Man, X-linked inheritance– Hemophilia and Color blindness; X-inactivation.

**CREDIT IV: Linkage, Recombination and Extension to Mendel's Laws**

- 4.1 Linkage and recombination- Cytological proof of crossing over, phases of linkage, recombination frequency, gene mapping and map distance
- 4.2 Non-Mendelian Inheritance – Maternal effect (Shell coiling in snail), variegation in leaves of *Mirabilis jalapa*
- 4.3 Cytoplasmic male sterility in Maize.
- 4.4 Mitochondrial inheritance in human and poky in *Neurospora crassa*
- 4.5 Chloroplast inheritance in *Chlamydomonas*
- 4.6 Hardy-Weinberg Equilibrium.

## BS104: CELL BIOLOGY AND GENETICS

### PRACTICALS

1. Microscopic observation of cells: bacteria, fungi, plant and animal
2. Preparation of different stages of Mitosis (onion root tips)
3. Preparation of different stages of Meiosis (grasshopper testis)
4. Preparation of Polytene chromosome from *Drosophila* salivary gland
5. Monohybrid and dihybrid ratio in *Drosophila*
6. Monohybrid and dihybrid ratio in Maize
7. Problems on co-dominance, Epistasis, two point and three-point test cross, gene mapping.
8. Statistical applications of Hardy-Weinberg Equilibrium

### Spotters:

1. Prokaryotic Cell (Bacteria)
2. Mitochondria
3. Chloroplast
4. Polytene Chromosomes
5. Test Cross
6. Blood Grouping
7. Haemophilia Pedigree
8. Crossing Over
9. Synaptonemal Complex
10. Nucleosome Model

### REFERENCE BOOKS

1. Cell & Molecular Biology. E.D.D De Robertis & E.M.F De Robertis, Waverly publication
2. An introduction to Genetic Analysis by Anthony, J.F. J.A. Miller, D.T. Suzuki, R.C. Richard Lewontin, W.M-Gilbert, W.H. Freeman publication
3. Principles of Genetics by E.J.Gardner and D.P. Snusted. John Wiley & Sons, New York
4. The science of Genetics, by A.G. Atherly J.R. Girton, J.F. Mcdonald, Saundern College publication
5. Principles of Genetics by R.H. Tamarin McGrawhill
6. Theory & problems in Genetics by Stansfield, Schaum out line series McGrawhill
7. Molecular Cell Biology Lodish, H., Baltimore, D; fesk, A., Zipursky S.L., Matsudaride, P. and Darnel. American Scientific Books. W.H. Freeman, New York
8. The cell: A molecular approach. Geoffrey M Cooper, Robert E Hausman, ASM press
9. Cell and Molecular Biology, Concepts and Experiments – Gerald Karp, John Wiley & Sons, Inc.
10. Cell Biology and Genetics by P.K. GUPTA

**B.Sc. Biotechnology, I year  
SEMESTER II  
DSC-1B**

**BS204: BIOLOGICAL CHEMISTRY AND MICROBIOLOGY**

**CREDIT I: Biomolecules**

- 1.1. Carbohydrates- importance, classification; structure and functions of monosaccharides (glucose & fructose), disaccharides (sucrose, lactose & maltose) and polysaccharides (starch, glycogen & insulin)
- 1.2. Amino acids- importance, classification, structure, physical and chemical properties of amino acids; peptide bond formation
- 1.3. Proteins- importance, structure of proteins- primary, secondary, tertiary and quaternary
- 1.4. Lipids- importance, classification- simple lipids (triacyl glycerides & waxes), complex lipids (phospholipids & glycolipids), derived lipids (steroids, terpenes & carotenoids)
- 1.5. Nucleic acids: structure and chemistry of DNA (Watson and crick) and RNA(TMV) Structure and forms of DNA (A, B and Z)
- 1.6. Enzymes- importance, classification and nomenclature; Michaelis-Menton Equation, factors influencing the enzyme reactions; enzyme inhibition (competitive, uncompetitive & mixed), co-enzymes

**CREDIT II: Bioenergetics**

- 2.1 Glycolysis, Tricarboxylic Acid (TCA) Cycle,
- 2.2 Electron Transport, Oxidative Phosphorylation
- 2.3 Gluconeogenesis and its significance
- 2.4 Transamination and Oxidative deamination reactions of amino acids
- 2.5 B-Oxidation of Fatty acids
- 2.6 Glyoxalate cycle.

**CREDIT III: Fundamentals of Microbiology**

- 3.1 Historical development of microbiology and contributors of microbiology
- 3.2 Microscopy: Bright field microscopy, Dark field microscopy, Phase contrast microscopy, Fluorescent microscopy, Scanning and Transmission electron microscopy
- 3.3 Outlines of classification of microorganisms
- 3.4 Structure and general characteristics of bacteria and virus
- 3.5 Disease causing pathogens and symptoms (Eg: *Mycobacterium*, *Hepatitis*)
- 3.6 Structure and general characteristics of micro-algae and fungi

**CREDIT IV: Culture and identification of microorganisms**

- 4.1 Methods of sterilization- physical and chemical methods
- 4.2 Bacterial nutrition nutritional types of bacteria, essential macro micro nutrients and growth factors.
- 4.3 Bacterial growth curve-batch and continuous cultures, synchronous cultures measurement of bacterial growth-measurement of cell number and cell mass.
- 4.4 Factors affecting bacterial growth
- 4.5 Culturing of anaerobic bacteria and viruses
- 4.6 Pure cultures and its characteristics

## BS204: BIOLOGICAL CHEMISTRY AND MICROBIOLOGY

### PRACTICALS

1. Preparation of normal molar, molal solutions.
2. Preparation of buffers (acidic, basic, neutral)
3. Qualitative tests of sugars, amino acids and lipids
4. Estimation of total sugars by Anthrone method
5. Separation of amino acids by paper chromatography
6. Estimation of proteins by biuret method
7. Sterilization methods
8. Preparation of microbiological media (bacterial, algal & fungal)
9. Isolation of bacteria by streak, spread and pour plate methods
10. Isolation of bacteria from soil
11. Simple staining and differential staining (gram's staining)
12. Bacterial growth curve
13. Technique of micrometry (ocular and stage)

### Spotters:

1. Osazone
2. Globular protein
3. Lock and key model
4. Competitive inhibition
5. RUBISCO
6. ATP synthase
7. Autoclave
8. Laminar air flow
9. Tyndalization
10. Bacterial growth curve
11. Hot air oven
12. Serial dilution technique

### REFERENCE BOOKS

1. Lehninger Principles of Biochemistry By: David L. Nelson and Cox
2. Biochemistry By: Rex Montgomery
3. Harper's Biochemistry By: Robert K. Murray
4. Enzymes By: Trevor Palmer
5. Enzyme structure and mechanism by: AlanFersht
6. Principles of Biochemistry By: Donald J. Voet, Judith G.Voet, Charlotte W.Pratt
7. Analytical Biochemistry By: Cooper
8. Principles and techniques of Biochemistry and Molecular Biology Edited By: Keith Wilson and John Walker
9. Practical Biochemistry By: Plummer
10. Biology of Microorganisms by: Brock, T.D. and Madigan, M.T.
11. Microbiology by: Prescott, L.M., Harley, J.P. Klein,D.A.
12. Microbiology by: Pelczar, M.J, Chan, E.C.S., Ereig, N.R.
13. Microbiological applications by: Benson

**B.Sc. Biotechnology, II year  
SEMESTER III  
SEC-1  
BS 301: INDUSTRIAL FERMENTATION**

**CREDIT I: Fermentative Production of Industrial Bioproducts**

- 1.1 Propionic acid, butyric acid, gluconic acid.
- 1.2 Biofuels: biogas, ethanol, butanol, hydrogen, biodiesel.
- 1.3 Microbial insecticides, newer antibiotics.
- 1.4 Anticancer agents, amino acids.
- 1.5 Upstream and downstream processing.
- 1.6 Centrifugation, filtration of fermentation broth and anaerobic fermentation.

**CREDIT II: Microbial Production Process**

- 2.1 Steroid fermentations and transformations.
- 2.2 Metabolic engineering of secondary metabolites for highest productivity.
- 2.3 Enzyme and cell immobilization techniques in industrial processing.
- 2.4 Rate equations for enzyme kinetics – simple and complex reactions.
- 2.5 Enzymes in organic synthesis, proteolytic enzymes, hydrolytic enzymes.
- 2.6 Enzymes in food technology/organic synthesis.

**REFERENCE BOOKS**

1. Patel, A.H. (1984). Industrial Microbiology, Mac Milan India Ltd., Hyderabad.
2. Cassida, L.E. (1968). Industrial Microbiology, Wiley Eastern Ltd. & New Age International Ltd., New Delhi.
3. Crueger, W. and Crueger, A. (2000). Biotechnology – A Text Book of Industrial Microbiology, Panima Publishing Corporation, New Delhi.
4. Reedy, G. (Ed.) (1987). Prescott & Dunn's Industrial Microbiology, 4<sup>th</sup> Edition, CBS Publishers & Distributors, New Delhi.
5. Reddy, S.R. and Singara Charya, M.A. (2007). A Text Book of Microbiology – Applied Microbiology. Himalaya Publishing House, Mumbai.
6. Singh, R.P. (2007). Applied Microbiology. Kalyani Publishers, New Delhi.
7. Demain, A.L. and Davies, J.E. (1999). Manual of Industrial Microbiology and Biotechnology, ASM Press, Washington, D.C., USA.

**B.Sc. Biotechnology, II year**

**SEMESTER III**

**SEC-2**

**BS 302: IMMUNOLOGICAL TECHNIQUES**

**CREDIT I: Antibody Assays – Principle, Methodology and Applications**

- 1.1 Antigen – Antibody reactions: opsonization, neutralization, precipitation & agglutination
- 1.2 Immunodiffusion and radial diffusion
- 1.3 Immuno electrophoresis-rocket and counter current
- 1.4 ELISA and western blotting
- 1.5 Radioimmunity assay and immunofluorescent assay
- 1.6 Immunohistochemistry

**CREDIT II: Cellular Assays – Principle, Methodology and Applications**

- 2.1 Total and differential count in human peripheral blood
- 2.2 Separation of mononuclear cells from human peripheral blood
- 2.3 Cell viability assay using trypan blue
- 2.4 Lymphocyte transformation assay
- 2.5 Enumeration of T & B cells from human peripheral blood
- 2.6 Micro cytotoxicity assay for HLA typing

**REFERENCE BOOKS**

1. Essential Immunology by I. Roitt, Publ: Blackwell
2. Immunology by G. Reeve & I. Todd, Publ: Blackwell
3. Cellular and Molecular Immunology by Abbas AK, Lichtman AH, Pillai S. Saunders publication, Philadelphia.
4. Kuby's Immunology by Golds RA, Kindi TJ, Osborne BA. W.H. Freeman and company, New York.

**B.Sc. Biotechnology, II year  
SEMESTER III  
DSC-1C**

**BS 305: MOLECULAR BIOLOGY AND RECOMBINANT DNA TECHNOLOGY**

**CREDIT I: Genome Organization and DNA Replication**

- 1.1 DNA as genetic material – Griffith's transformation experiment, Avery McLeod and McCarty's experiments, Hershey and Chase experiment, RNA as genetic material- TMV.
- 1.2 Prokaryotic genome organization.
- 1.3 Eukaryotic genome organization, mitochondrial and chloroplast genome.
- 1.4 DNA replication: enzymes involved, replication fork.
- 1.5 Prokaryotic and eukaryotic (nuclear) replication.
- 1.6 Mutations: types (spontaneous, induced), mutagens.

**CREDIT II: Gene Expression in Prokaryotes and Eukaryotes**

- 2.1 Structure of prokaryotic gene (promoter, initiator & terminator regions), prokaryotic RNA polymerase
- 2.2 Structure of eukaryotic gene ((promoter, exons, introns, terminator, enhancer & silencer), eukaryotic RNA polymerase and transcriptional machinery
- 2.3 Genetic code and its properties, Wobble Hypothesis
- 2.4 Mechanism of transcription in prokaryotes
- 2.5 Mechanism of transcription in eukaryotes
- 2.6 Translation mechanism

**CREDIT III: Gene Regulation in Prokaryotes and Eukaryotes**

- 3.1 Prokaryotic transcriptional regulation (inducible system)- operon concept, lac operon and glucose effect.
- 3.2 Prokaryotic transcriptional regulation (repressible system)- tryptophan operon.
- 3.3 Post transcriptional modifications – capping, polyadenylation
- 3.4 Post transcriptional modifications – splicing and its types
- 3.5 Post translational modifications – glycosylation, acetylation and ubiquitination
- 3.6 Gal regulation in Yeast – mating type gene switching.

**CREDIT IV: Recombinant DNA Technology**

- 4.1 Enzymes used in molecular cloning: restriction endonucleases, ligases, polynucleotide kinases, klenow enzyme and DNA polymerase.
- 4.2 Cloning Vectors: PBR 322, bacteriophage, cosmid, phagemid, shuttle vectors; Vectors for library preparation: lambda phage vectors, cosmids, BAC & YAC.
- 4.3 Gene transfer techniques: physical, chemical and biological methods.
- 4.4 Selection of recombinant clones – colony hybridization, library screening.
- 4.5 PCR and its applications; blotting techniques.
- 4.6 Applications of r-DNA technology in agriculture, diagnostics, industrial, pharmaceuticals and medicine.



## **BS 305: MOLECULAR BIOLOGY AND RECOMBINANT DNA TECHNOLOGY**

### **PRACTICALS**

1. Isolation of DNA from bacterial cells.
2. Isolation of plasmid DNA.
3. Agarose gel electrophoresis of DNA.
4. Quantification of DNA by spectrophotometer.
5. Separation of proteins by SDS PAGE.
6. Polymerase chain reaction.
7. Restriction digestion of DNA.
8. Bacterial transformation.

### **SPOTTERS:**

1. PCR
2. RNA Polymerase
3. Okazaki fragments
4. Plasmid vector map
5. Prokaryotic gene
6. Eukaryotic gene
7. Splicing
8. Capping
9. Polyadenylation
10. Point mutations
11. Lac operon
12. Tryptophan operon

### **REFERENCE BOOKS**

1. Molecular Biology of the cell by Alberts, B; Bray, D, Lewis, J, Raff, M, Roberts, K and Watson, J.D. Garland publishers, Oxford.
2. Molecular Biology of the Gene by Watson, Hopkins, Goberts, Steitz and Weiner (Person Education)
3. Text Book of Biotechnology by H.K. Das (Wiley Publications)
4. Gene Structure & Expression by J.D. Howkins, Publ: Cambridge.
5. Test Book of Molecular Biology by K.S. Sastry, G. Padmanabhan & C. Subramanyan, Publ: Macmillan India.
6. Principles of Gene Manipulation by R.W. Old & S.B. Primrose, Publ: Blackwell.
7. Genes by B. Lewin – Oxford Univ. Press
8. Molecular Biology & Biotechnol. by H.D. Kumar, Publ: Vikas
9. Methods for General & Molecular Bacteriology by P. Gerhardt et al., Publ: ASM
10. Molecular Biotechnology by G.R. Click and J.J. Pastemak, Publ: Panima
11. Genes and Genomes by Maxine Singer and Paul Berg
12. Molecular Biology by D. Freifelder, Publ: Narosa
13. Molecular Biology by F. Weaver. WCB/McGraw Hill.
14. Gene, Geonomics and Genetic Engineering by Irfan Ali Khan and AtiyaKhanum (Ukaaz Publications).

**B.Sc. Biotechnology, II year**

**SEMESTER IV**

**SEC-3**

**BS 401: MOLECULAR MARKERS IN PLANT BREEDING**

**CREDIT I: Molecular Markers in Plant Breeding**

- 1.1 Types of markers: morphological, cytological, biochemical and genetic.
- 1.2 Development of molecular markers: criteria for ideal molecular markers.
- 1.3 Types of molecular markers and their scope in plant breeding.
- 1.4 Hybridization based molecular markers – RFLP.
- 1.5 PCR based molecular markers – RAPD, SSRs, AFLP.
- 1.6 Sequence based molecular markers – SNP, DArTs.

**CREDIT II: Applications of Molecular Markers in Plant Breeding**

- 2.1 Segregating populations: backcross, double haploid, F<sub>2</sub> & F<sub>3</sub> families, RILs.
- 2.2 Linkage mapping
- 2.3 QTL mapping.
- 2.4 Marker Assisted Selection.
- 2.5 Fingerprinting- fingerprinting genotypes, assessment of genetic similarity among genotypes, conservation and evaluation.
- 2.6 hybrid testing.

**REFERENCE BOOKS**

1. Gupta PK. 2010. Plant Biotechnology. Rastogi Publications.
2. Chawla HS. 2011. Introduction to Plant Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd.
3. Chittaranjan K. 2006-07. Genome Mapping and Molecular Breeding in Plants. Vols. I-VII. Springer.16
4. Newbury HJ. 2003. Plant Molecular Breeding. Blackwell Publ. Weising K, Nybom H, Wolff K & Kahl G. 2005. DNA Fingerprinting in Plants: Principles, Methods and Applications. Taylor & Francis.

**B.Sc. Biotechnology, II year  
SEMESTER IV  
SEC-4  
BS 402: DRUG DESIGNING**

**CREDIT I: Introduction to Drug Discovery**

- 1.1 Drug discovery: process, historical perspective and challenges.
- 1.2 Drug targets: proteins- receptors, ion channels and transporters; DNA-gene specific inhibitors of transcription.
- 1.3 Drug target identification and validation: genetic (mapping disease loci) approaches.
- 1.4 Drug target identification and validation: bioinformatics (sequence- DNA, protein /structural analysis- protein) approaches.
- 1.5 Structure based drug design: active site detection, docking.
- 1.6 Ligand based drug design: computational methods.

**CREDIT II: Applications of Molecular Markers in Plant Breeding**

- 2.1 Strategies of drug designing: lead generation.
- 2.2 Preparation of active compounds: natural products, synthetic, semi synthetic compounds.
- 2.3 Lead Identification: high throughput screening and hit generation-small molecule drugs, large molecule drugs.
- 2.4 Lead Optimization: properties of druggable compounds (Lipinski Rule), pharmacokinetics and pharmacodynamics.
- 2.5 Screening of lead molecules from phase I-IV to final drug molecules.
- 2.6 Pharmacogenomics: its role in drug development and optimization.

**REFERENCE BOOKS**

1. Textbook of Drug Design Krogsgaard-Larsen, Liljefors and Madsen (Editors), Taylor and Francis, London UK, 2002.
2. Drug Discovery Handbook S.C. Gad (Editor) Wiley-Interscience Hoboken USA. 2005.
3. Advanced Computer – Assisted Techniques in Drug Discovery in Methods and Principles in Medicinal Chemistry by Han van de Waterbeemd (ed.) Volume 3, 1994, Publishers, New York, NY (USA).
4. Virtual Screening for Bioactive Molecules by in Methods and Principles in Medicinal Chemistry, Edited by Hans-Joachim Bohm and Gisbert Schneider, Volume 10, 2000
5. Burger's Medicinal Chemistry and Drug Discovery, 6<sup>th</sup> Edition, Vol. 1. Principles and Practice, edited by M.E. Wolff, John Wiley & Sons: New York, 2003
6. Real world drug discovery: A chemist's guide to biotech and pharmaceutical research by Robert M. Rydzewski, Elsevier Science, 1 edition (2008)
7. Drug discovery and development: Technology in transition by Raymond G Hill, Churchill Livingstone, 2 edition (2012)

**B.Sc. Biotechnology, II year  
SEMESTER-IV  
DSC-1D  
BS 405: BIOINFORMATICS AND BIOSTATISTICS**

**CREDIT I: Introduction to bioinformatics and biological databases**

- 1.1 Bioinformatics: definition, scope and applications.
- 1.2 Bioinformatics tools and resources-internet basics, role of internet, free online tools, downloadable free tools.
- 1.3 Bioinformatics web portals-NCBI, EBI, ExPASy
- 1.4 Biological databases: Classification of databases – primary (Genbank), Secondary (PIR) and tertiary or composite (KEGG) databases.
- 1.5 Sequence databases – DNA sequence databases (DDBJ)
- 1.6 Protein sequence databases (Swissprot & PROSITE)

**CREDIT II: Sequence Alignment**

- 2.1 Basics of sequence alignment – match, mismatch, gaps, gap penalties, scoring alignment.
- 2.2 Types of sequence alignment – pairwise and multiple alignment, local and global alignment.
- 2.3 Dot matrix comparison of sequences
- 2.4 Scoring matrices – PAM and BLOSUM
- 2.5 Pairwise sequence similarity search by BLAST and FASTA
- 2.6 Concepts of phylogeny – distance based (NJ method) and character based (ML method) tree construction methods.

**CREDIT III: Descriptive Biostatistics and Probability**

- 3.1 Introduction to biostatistics, kinds of data and variables – based on nature (numerical – discrete and continuous, categorical – ordinal and nominal) – based on source (primary and secondary data), sample size, sampling methods and sampling errors.
- 3.2 Data tabulation and representation methods: graphical methods – stem and leaf plot, line diagram, bar graphs, histogram, frequency polygon, frequency curves, diagrammatic method – pie diagram.
- 3.3 Measures of central tendency – mean, median, mode, merits and demerits.
- 3.4 Measures of dispersion – range, variance, standard deviation, standard error and coefficient of variation, merits and demerits.
- 3.5 Concepts of probability – random experiment, events probability of an event, probability rules (addition and multiplication), uses of permutations and combinations, random variables (discrete and continuous).
- 3.6 Probability distributions: Binomial & Poisson distributions for discrete variables, Normal distribution for continuous variables.

**CREDIT IV: Applications of Biostatistics**

- 4.1 Hypothesis testing – steps in testing for statistical hypothesis, null and alternative hypothesis, level of significance – type-1 and type-2 errors.
- 4.2 Test of significance for small samples – Student's t-test (one sample and two samples)
- 4.3 Test of significance for large samples – Z-test for means and proportions.
- 4.4 Chi-square test and its applications – goodness of fit, test of independence.
- 4.5 Analysis of Variance (ANOVA) – one-way analysis.
- 4.6 Correlation – definition, simple and linear analysis, Karl Pearson's correlation coefficient.

**BS 405: BIOINFORMATICS AND BIOSTATISTICS  
PRACTICALS**

1. Exploring web portals – NCBI, EBI & ExPASy
2. Literature search through Pubmed and Pubmed Central
3. Sequence retrieval from Genbank, ENA, Swissprot
4. Pairwise homology search by BLAST and FASTA
5. Calculation of mean, median, mode, standard deviation, variance, standard error and coefficient of variation.
6. Construction of bar diagram, pie-diagram, line diagram, histogram
7. Problems on hypothesis testing using Z-test, t-test and Chi-square test
8. Problems on probability and probability distributions

**Spotters**

1. Line diagram, bar diagram & pie-diagrams
2. Histogram, frequency polygon & frequency curve
3. Normal probable curve
4. GenBank
5. DDBJ
6. SWISS-PORT
7. PROSITE
8. PIR
9. BLAST
10. Pairwise alignment
11. Multiple sequence alignment
12. PAM and BLOSUM
13. Phylogenetic tree

**RECOMMENDED BOOKS**

1. Khan & Khanum (2004), Fundamentals of Biostatistics, II Revised Edition, Ukaaz Publication.
2. Bailey, N.T.J., Statistical methods in Biology, Cambridge Univ. Press
3. Fundamentals of Biostatistics, P. Hanmanth Rao and K. Janardhan
4. Danial, W.W., Biostatistics, Wiley
5. Introduction to Bioinformatics by Aurther M lesk
6. Developing Bioinformatics Computer Skills by: Cynthia Gibas, Per Jambeck
7. Bioinformatics second edition by David M mount
8. Essential Bioinformatics by Jin Xiong
9. Bioinformatics Computing by Bryan Bergeron
10. Bioinformatics: Concepts, Skills & Applications by R.S. Rastogi
11. Queen, J.P., Quinn, G.P., & Keough, M.J. (2002). *Experimental design and data analysis for biologists*, Cambridge University Press.
12. Mahajan, B.K. (2002). Methods in biostatistics. Jaypee Brothers Publishers.

**B.Sc. BIOTECHNOLOGY III YEAR  
SEMESTER-V  
GENERIC ELECTIVE (GE)  
BS 503: BASICS IN BIOTECHNOLOGY**

**CREDIT I: Agricultural Biotechnology**

- 1.1. Plant tissue culture – media, sterilization, culture types
- 1.2. Micro-propagation, Synthetic seeds, Somatic hybrids and haploid plants
- 1.3. Transgenic plants – direct & indirect methods of gene transfer
- 1.4. Applications of transgenic plants – improving productivity & nutritional quality
- 1.5. Applications of transgenic plants – stress tolerant plants & molecular farming
- 1.6. Biofertilizers and biopesticides

**CREDIT II: Microbial and Industrial Biotechnology**

- 2.1 Exploitation of micro-organisms and their products
- 2.2 Isolation, screening and selection of microorganisms for industrial products
- 2.3 Preservation of micro organisms
- 2.4 Strain development and improvement, strategies of strain improvement selection and recombination
- 2.5 Production of recombinant DNA vaccine, amino acids, vitamins
- 2.6 Single cell protein, dairy products, penicillin and streptomycin production

**CREDIT III: Animal and Medical Biotechnology**

- 3.1 Cell culture technique and its applications
- 3.2 Animal breeding (selective breeding and cross breeding) and its limitations
- 3.3 *In vitro* techniques in animal improvement *in vitro* fertilization & microinjection
- 3.4 Genetically modified animals: transgenic & knock-outs
- 3.5 Mouse models of disease: cancer and diabetes
- 3.6 Bio techniques: gel electrophoresis and PCR

**CREDIT IV: Computer applications in Biotechnology**

- 4.1 Scope of computer applications in Biotechnology
- 4.2 Biotechnology tools and resources – role of the internet, free online tools, downloadable free software
- 4.3 Biotechnology web portals – NCBI, EBI, ExPASy
- 4.4 Biological databases: classification of databases – the primary (Genbank), Secondary (PIR) databases
- 4.5 Sequence databases – DNA sequence databases (ENA & DDBJ)
- 4.6 Protein sequence databases (Swissprot & PROSITE)

**B.Sc. BIOTECHNOLOGY III YEAR  
SEMESTER-V  
OPTIONAL-I (A) (DSE-1E)  
BS 504(A): PLANT BIOTECHNOLOGY**

**CREDIT I: Fundamentals of Plant Tissue Culture**

- 1.1 Introduction to Plant tissue culture, totipotency of plant cells (dedifferentiation, redifferentiation and regeneration)
- 1.2 Nutritional requirements for plant tissue culture: nutrient media – macronutrients and micronutrients, media additives (carbon source, vitamins, amino acids), types of media
- 1.3 Plant growth regulators – auxins, cytokinins and gibberellins
- 1.4 Preparation of media, sterilization, selection & surface sterilization of explants, inoculation, incubation and culture of plant tissue *in vitro*
- 1.5 Induction of callus cultures and cell suspension cultures
- 1.6 Organogenesis and somatic embryogenesis

**CREDIT II: Applications of Plant Tissue Culture**

- 2.1 Meristem culture, micro propagation and their applications
- 2.2 Encapsulation and production of synthetic seeds and their applications
- 2.3 Cell suspension cultures (batch and continuous cultures) and applications
- 2.4 Protoplast isolation, culture and fusion – development of somatic hybrids & cybrids and their applications
- 2.5 Somaclonal variation and its applications, Cryopreservation – conservation of plant germplasm
- 2.6 Anther and pollen culture for production of haploids & their applications

**CREDIT III: Production of Transgenic Plants**

- 3.1 Direct gene transfer techniques – physical methods, micro injection, particle bombardment (gene gun) and electroporation & chemical methods.
- 3.2 Molecular mechanism of *Agrobacterium* infection and features of Ti Plasmid
- 3.3 *Agrobacterium* mediated gene transfer using binary and co-integrate vectors
- 3.4 Viral vectors for gene transfer into plants
- 3.5 Selection of transgenic plants using reporter and selection marker genes
- 3.6 Genome editing – CRISPR CAS 9 Technology

**CREDIT IV: Applications of Transgenic Plants**

- 4.1 Herbicide resistance in transgenic plants – glyphosate tolerance
- 4.2 Insect resistant transgenic plants: Bt cotton, proteinase inhibitors, Ictins
- 4.3 Virus, bacterial and fungal resistant transgenic plants
- 4.4 Abiotic Stress tolerance: drought, heat and salinity stress tolerant plants
- 4.5 Transgenic plants with enhanced nutritional value: vitamin A, oil, amino acids
- 4.6 Transgenic plants as bioreactors: edible vaccines, antibody production, biodegradable plastics

**OPTIONAL-I (A): PRACTICALS**  
**PLANT BIOTECHNOLOGY**

1. Preparation of media for plant tissue culture
2. Sterilization methods of explants (seed, leaf, inter node & root) and inoculation
3. Establishment of callus cultures from carrot/rice
4. Preparation of synthetic seeds
5. Meristem culture
6. Cell suspension cultures
7. Protoplast isolation and culture
8. *Agrobacterium* mediated transformation

**Spotters**

1. Callus cultures
2. Sterilization techniques: autoclave and hot air oven
3. Somatic embryos
4. Synthetic seeds
5. Meristem culture
6. Plant regeneration
7. Cell suspension cultures
8. Isolation of protoplasts
9. Particle bombardment (Gene gun)
10. Binary or co-integrate vectors
11. Gus gene expression in transgenic plant tissue
12. Golden Rice

**REFERENCE BOOKS**

1. Plant Tissue Culture and its Biotechnological Applications by W. Barz, E. Reinhard, M.H. Zenk
2. Plant Tissue Culture by Akio Fujiwara
3. Frontiers of Plant Tissue Culture by Trevor A Thorpe
4. In vitro Haploid Production in Higher Plants by S. Mohan Jain, S.K. Sapory, R.E. Veilleux
5. Plant Tissue Culture: Theory and Practice by S.S. Bhojwani and A. Razdan
6. Plant Cell, Tissue and Organ Culture, Applied and Fundamental Aspects by Y.P.S. Bajaj and A. Reinhard



**B.Sc. BIOTECHNOLOGY III YEAR  
SEMISTER-V  
OPTIONAL-I (B) (DSE-1E)  
BS 504(B): MEDICAL BIOTECHNOLOGY**

**CREDIT I: Inheritance of human diseases and karyotyping**

- 1.1 Inheritance patterns – pedigree analysis of autosomal traits
- 1.2 Inheritance patterns – pedigree analysis of allosomal traits
- 1.3 Factors affecting pedigree pattern – penetrance, expressivity
- 1.4 Genetic heterogeneity – allele and locus heterogeneity
- 1.5 Karyotyping of human chromosomes
- 1.6 Chromosome staining G, Q, R and C banding techniques

**CREDIT II: Genetic basis of human disorders**

- 2.1 Chromosomal disorders caused due to structural chromosomal abnormalities (deletions, duplications, translocations and inversions)
- 2.2 Chromosomal disorders caused due to numerical chromosomal abnormalities (euploidy, aneuploidy, autosomal and allosomal)
- 2.3 Monogenic disorders (autosomal and X-linked diseases)
- 2.4 Mitochondrial diseases – LHON, MERRF
- 2.5 Multi factorial disorders – diabetes and hypertension
- 2.6 Cancer – types of cancer, genetic basis of cancer (oncogenes, tumour suppressor genes)

**CREDIT III: Techniques for diagnosis of human diseases**

- 3.1 Prenatal diagnosis – invasive techniques – amniocentesis, chorionic villi sampling (Down's syndrome): non-invasive techniques – ultrasonography (neural tube defects)
- 3.2 Diagnosis using enzyme markers – Guthrie test (phenylketoneuria)
- 3.3 Diagnosis using monoclonal antibodies – ELISA (HIV)
- 3.4 DNA / RNA based diagnosis – HBV
- 3.5 PCR based genotyping techniques for diagnosis – RFLP (MTHFR C677T mutation)
- 3.6 Chip based diagnosis and applications – colon cancer

**CREDIT IV: Therapeutic approaches for human diseases**

- 4.1 Recombinant proteins – human growth hormone, insulin
- 4.2 Gene therapy – *ex vivo* and *in vivo* gene therapy
- 4.3 Stem cells – potency definitions, embryonic and adult stem cells
- 4.4 Applications of stem cell-based therapies and regenerative medicine
- 4.5 DNA based vaccines, subunit vaccines – herpes simplex virus, recombinant attenuated vaccines – cholera vaccine
- 4.6 Applications of monoclonal antibodies

**OPTIONAL-I (B): PRACTICALS**  
**MEDICAL BIOTECHNOLOGY**

1. Karyotyping of normal human chromosome set
2. Karyotyping of autosomal abnormality (Down's syndrome)
3. Karyotyping of autosomal abnormality (Klinefelter syndrome)
4. Chromosome banding – G banding
5. Human pedigree analysis of autosomal disorder
6. Human pedigree analysis of allosomal disorder
7. Estimation of C-reactive protein
8. DOT ELISA

**Spotters**

1. Identify the karyotype (Down's syndrome)
2. Identify the karyotype (Klinefelter syndrome)
3. Chromosomal banding technique
4. Identify the inheritance pattern of pedigree (autosomal disorder)
5. Identify the inheritance pattern of pedigree (allosomal disorder)
6. Prenatal diagnosis – invasive technique
7. Prenatal diagnosis – non invasive technique
8. Identify the type of gene therapy – *ex vivo* / *in vivo*
9. Recombinant vaccine
10. ELISA technique
11. Identify the SNP genotypes of different samples after performing PCR-RFLP
12. Count the viable cells on neubauer chamber (hemocytometer)

**REFERENCE BOOKS**

1. Medical Biotechnology by Pratibha Nallari, V. Venugopalrao – Oxford Press
2. Introduction to Human Molecular Genetics by J.J. Pasternak – John Wiley Publishers
3. Human Molecular Genetics by Tom Strachen and A.P. Read – Bios Scientific Publishers
4. Human Genetics Molecular Evolution by McConkey
5. Recombinant DNA Technology by AEH Emery
6. Principles and Practice of Medical Genetics – I, II, III Volumes by AEH Emery
7. Molecular Biotechnology by Glick and Pasternak

**B.Sc. BIOTECHNOLOGY III YEAR  
SEMESTER-VI  
OPTIONAL PAPER-I  
BS 601: IPR, BIOSAFETY AND ENTREPRENEURSHIP**

**CREDIT I: Intellectual Property rights**

- 1.1 Intellectual Property – meaning, nature
- 1.2 Significance and need of protection of intellectual property
- 1.3 Types of intellectual property rights: patent, trademarks, copyright, design registration, trade secret, geographical indicators, plant variety protection
- 1.4 Copyright: meaning, nature, historical evolution and significance
- 1.5 Ownership of copyright – rights of authors and owners, trademarks
- 1.6 Plant varieties protection and plant breeding rights

**CREDIT II: Patent laws**

- 2.1 Patents – concept of patent – historical overview of the patent law in India
- 2.2 Kinds of patents – procedure for obtaining patent in India and in other countries
- 2.3 Patenting microbes and organisms – novelty – international Depository Authorities (IDAs), submitting details of the deposit
- 2.4 Patenting genes – pros and cons, ethics, examples
- 2.5 Patenting markers and variants – examples
- 2.6 Product v/s process patent – product life cycle and process design

**CREDIT III: Laboratory Management and Safety**

- 3.1 Administration of laboratories, laboratory design, laboratory information management system
- 3.2 Laboratory safety – good laboratory practice (GLP), bio safety levels
- 3.3 Basic principles of quality control (QC) and quality assurance (QA)
- 3.4 Handling of hazardous compounds – chemicals, solvents, poisons, isotopes, explosives and biological strains
- 3.5 Storage of hazardous material
- 3.6 Disposal of biological and radioisotope wastes

**CREDIT IV: Entrepreneurship**

- 4.1 Concept, definition, structure and theories of entrepreneurship
- 4.2 Types of start-ups with examples
- 4.3 Types of entrepreneurship, environment, process of entrepreneurial development
- 4.4 Entrepreneurial culture, entrepreneurial leadership
- 4.5 Product planning and development – project management, search for business idea, concept of projects, project identification
- 4.6 Promoting bio-entrepreneurship

**B.Sc. BIOTECHNOLOGY III YEAR  
SEMESTER-VI  
OPTIONAL-II (A) (DSE-1F)  
BS 604(A): ANIMAL BIOTECHNOLOGY**

**CREDIT I: Animal cell culture: principles and applications**

- 1.1 Cell culture technique: cell culture media, sterilization techniques.
- 1.2 Characteristic features of cell lines and cell line maintenance.
- 1.3 Methods of isolation and separation of various cell types and establishment of cell lines
- 1.4 Properties and types of stem cells, culturing of embryonic stem cells and adult stem cells.
- 1.5 Manipulation of cells: electroporation, transfection, transduction and microinjection.
- 1.6 Applications of cell culture: manufacturing, toxicity testing and tissue engineering.

**CREDIT II: *In vitro* techniques in animal improvement**

- 2.1 Principles of animal breeding: selective breeding, cross breeding and their limitations.
- 2.2 Superovulation, collection of semen and ova.
- 2.3 *In vitro* maturation of oocytes, artificial insemination.
- 2.4 *In vitro* fertilization, embryo collection and embryo sexing.
- 2.5 Somatic cell nuclear transfer, cloning of animals (Dolly)
- 2.6 Applications of *in vitro* techniques in animal improvement.

**CREDIT III: Molecular markers in animal genetics**

- 3.1 Developments on live stock genomics (estimated breeding value-EBV).
- 3.2 Molecular markers: types and characteristics.
- 3.3 RFLP and RAPD.
- 3.4 SNPs and their applications in genotyping.
- 3.5 Identification and isolation of desired gene of interest.
- 3.6 Marker assisted selection.

**CREDIT IV: Genetically modified organisms**

- 4.1 Animal models and their significance in scientific research
- 4.2 Mouse model for cancer.
- 4.3 Generation of transgenic mouse.
- 4.4 Generation of gene knock-out mouse.
- 4.5 Genetically modified mice as disease models.
- 4.6 Applications of genetically modified animals in understanding disease biology and drug development.

**BS 604(A): ANIMAL BIOTECHNOLOGY**

**PRACTICALS**

1. Preparation of animal cell culture media
2. Sterilization of cell culture media
3. Cell counting by microscopy
4. Isolation of cells from chicken liver
5. Establishment of primary cell culture (liver/spleen)
6. Preparation of metaphase chromosomes
7. Culturing adherent cells

**SPOTTERS:**

1. Microscope
2. CO<sub>2</sub> incubator
3. Biosafety cabinet/ laminar air flow
4. Trypan blue stained cells
5. Cell culture flasks and dishes
6. Metaphase slide
7. Autoclave
8. Centrifuge
9. Example of an RFLP
10. Microinjection into an egg cell

**REFERENCE BOOKS:**

1. Text book of Animal Biotechnology by B.Singh, The Energy and Resource Institute.
2. Genetics for Animal Sciences by WH Freeman, Van Vleck LD, Pollak EJ & Blteneau EAB 1987.
3. Cancer Cell Culture: Methods and Protocols 731 (methods in molecular biology) Humana, 2<sup>nd</sup> edition 2011.
4. Genetic engineering by VK Agarwal and PS Varma, S Chand & Company Ltd,2009.

**B.Sc. BIOTECHNOLOGY III YEAR  
SEMESTER-VI  
OPTIONAL-II (B) (DSE-1F)  
BS 604(B): ENVIRONMENTAL BIOTECHNOLOGY**

**CREDIT I: Environmental Pollution**

- 1.1 Introduction to environmental and pollution
- 1.2 Types of pollution – air, water and soil pollutions
- 1.3 Types of pollutions – inorganic, organic and biotic
- 1.4 Sources of pollution – domestic waste, agricultural waste, industrial effluents and municipal waste.
- 1.5 Greenhouse gases, global warming and climate change
- 1.6 Measurement methods of environmental pollution – BOD & COD

**CREDIT II: Biomass and Biofuels**

- 2.1 Renewable and non-renewable energy resources
- 2.2 Fossil fuels as energy source and their impact on environment
- 2.3 Biomass as source of energy (bioenergy)
- 2.4 Types of biomass – plant, animal and microbial biomass
- 2.5 Production of biofuels: bioethanol and biodiesel
- 2.6 Production of biohydrogen and biomethane

**CREDIT III: Biofertilizers and Biopesticides**

- 3.1 Chemical fertilizers and their impact on environment (Eutrophication)
- 3.2 Concepts of Biofertilizers
- 3.3 Types of Biofertilizers – bacterial, fungal and algal Biofertilizers
- 3.4 Pesticides and their impact on environment
- 3.5 Concepts of biopesticides, types of biopesticides
- 3.6 Uses of Biofertilizers and biopesticides

**CREDIT IV: Bioremediation of Environmental Pollutants**

- 4.1 Waste water treatment – sewage and industrial effluents (aerobic and anaerobic methods)
- 4.2 Bioremediation – concepts and types (*in-situ* and *ex-situ* bioremediation)
- 4.3 Bioremediation of toxic metal ions – biosorption and bioaccumulation
- 4.4 Composting of organic wastes
- 4.5 Microbial remediation of pesticides and xenobiotic compounds
- 4.6 Phytoremediation – concepts and applications

**BS 604(B): ENVIRONMENTAL BIOTECHNOLOGY  
PRACTICALS**

1. Estimation of BOD in polluted water samples
2. Estimation of COD in polluted water samples
3. Estimation of total dissolved solid in waste water samples
4. Determination of quality of water sample (Coli form test)
5. Isolation of microorganisms from polluted soil/industrial effluents
6. Production of hydrogen or biogas
7. Identification and characterization of bioremediation micro organisms
8. Production of microbial Biofertilizers

**Spotters**

1. Air/water/soil pollution
2. Municipal waste
3. Industrial effluents
4. Algal blooms
5. Greenhouse effect
6. Plant biomass
7. Waste water treatment plant
8. Organic composting
9. Biogas plant
10. Xenobiotic degrading bacteria
11. Phytoremediation
12. Microbial biofertilizers

**REFERENCE BOOKS**

1. Text Book of Biotechnology by H.K. Das (Wiley Publications)
2. Biotechnology by H.J. Rehm and G. Reed. VIH Publications, Germany
3. Biogas Technology by b.T. Nijaguna
4. Biotechnology by K. Trehan
5. Industrial Microbiology by L.E. Casida
6. Food Microbiology by M.R. Adams and M.O. Moss
7. Introduction to Biotechnology by P.K. Gupta
8. Essentials of Biotechnology for Students by Satya N. Das
9. Bioethics – Readings and Cases by B.A. Brody and H. T. Engelhardt Jr. (Pearson Education)
10. Biotechnology, IPRs and Biodiversity by M.B. Rao and Manjula Guru (Pearson Education)