### M. Sc. Biotechnology Second Year (Third Semester)

<table>
<thead>
<tr>
<th>Paper No.</th>
<th>Paper Title</th>
<th>External (ESE)</th>
<th>Internal (CA)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>BT-XI</td>
<td>Genetic Engineering</td>
<td>75 Marks</td>
<td>25 Marks</td>
<td>Credit :4 (100 Marks)</td>
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<tr>
<td>BT-XII</td>
<td>Industrial Biotechnology</td>
<td>75 Marks</td>
<td>25 Marks</td>
<td>Credit :4 (100 Marks)</td>
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<tr>
<td>BT-XIII</td>
<td>Animal Biotechnology</td>
<td>75 Marks</td>
<td>25 Marks</td>
<td>Credit :4 (100 Marks)</td>
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<tr>
<td>* BT-XIV</td>
<td>(Elective) Plant &amp; Agriculture Biotechnology</td>
<td>75 Marks</td>
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<td>Credit :4 (100 Marks)</td>
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<tr>
<td>BT-XV</td>
<td>Seminar</td>
<td>25 Marks</td>
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**Total for Sem.: III**

Credit:17

### M. Sc. Biotechnology Second Year (Fourth Semester)

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<th>Paper No.</th>
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</thead>
<tbody>
<tr>
<td>BT-XVI</td>
<td>Computational Biology &amp; Biostatistics</td>
<td>75 Marks</td>
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<tr>
<td>BT-XVII</td>
<td>Pharmaceutical Biotechnology</td>
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<td>BT-XVIII</td>
<td>Environmental Biotechnology</td>
<td>75 Marks</td>
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<td>* BT-XIV</td>
<td>(Elective) Applied Biotechnology</td>
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<td>BT-XX</td>
<td>Seminar</td>
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**Total for Semester IV**

Credit:17

### Lab Course Work (Annual Practical)

<table>
<thead>
<tr>
<th>Lab Course Work (Annual Practical)</th>
<th>Lab Course Work- V</th>
<th>75 Marks</th>
<th>25 Marks</th>
<th>Credit :4 (100 Marks)</th>
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<tbody>
<tr>
<td>Lab Course Work- VI</td>
<td>75 Marks</td>
<td>25 Marks</td>
<td>Credit :4 (100 Marks)</td>
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<tr>
<td>Lab Course Work-VII</td>
<td>75 Marks</td>
<td>25 Marks</td>
<td>Credit :4 (100 Marks)</td>
<td></td>
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<tr>
<td>Lab Course Project Work-VIII</td>
<td>75 Marks</td>
<td>25 Marks</td>
<td>Credit :4 (100 Marks)</td>
<td></td>
</tr>
</tbody>
</table>

**Total for Lab Course Work (Annual)**

Credit: 16

**Total for M.Sc. II Year: Sem. III +Sem. IV + Lab Course Work (Annual)**

Credit:50

**Total For M.Sc. (I Year + II Year)**

Credit:100

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Note: *Paper IV (Elective): Transfer of Credit as per Students Choice  
** The Evaluation of Seminar should be from Panel of Experts  
CA- Continuous Assessment  
ESE- End of Semester Examination
M.Sc. Biotechnology III Semester

BT -XI: Genetic Engineering
Marks: 100
Hours: 45

UNIT-I: Molecular Tools in Genetic Engineering

UNIT-II: Molecular cloning

UNIT-III: Techniques in Molecular cloning
Chemical synthesis and Sequencing of DNA. Polymerase chain reaction and its applications
Protein Engineering and Applications: Site-directed mutagenesis, PCR based methods of mutagenesis, DNA Shuffling. Strategies for production and purification of recombinant proteins

UNIT-IV: Strategies of Gene Expression

Unit V: Applications of Genetic Engineering
Bio safety regulation: Physical and Biological containments.

Text & Reference:
1. Nicoll D.S.T. - An Introduction to Genetic Engineering.- Cambridge University Press,
2. Watson J.D. -Recombinant DNA. Scientific American Books, USA.
7. D.M. Glover Genetic Engineering, Cloning DNA. Chapman and Hall, New York,
9. Winnacker- From Genes to Clones- Panima

PRACTICALS: (Lab Course work V)
1. Bacterial culture and antibiotic selection media. Preparation of competent cells
2. Isolation of plasmid DNA, Lambda phage DNA.
3. Quantitation of nucleic acids.
4. Agarose gel electrophoresis and restriction mapping of DNA.
5. Construction of restriction map of plasmid DNA
7. Preparation of helper phage and its titration
8. Preparation of single stranded DNA template.
9. Oligonucleotide synthesis and DNA sequencing.
10. Gene expression in E coli and analysis of gene products
11. Study of PCR and PCR based markers AFLP/RAPD/SNP
M.Sc. Biotechnology III Semester

BT -XII: Industrial Biotechnology  Marks: 100  Hours: 45

Unit I  Down Stream Processing.
Removal and Recovery of cell mass: Precipitation, Filtration and Centrifugation
Membrane processes: Ultrafiltration and Reverse Osmosis. Drying and Crystallization.

Unit -II : Microbial Productions
Microbial production of Organic Acids and Solvents, alcohol by fermentation
Production, recovery and applications: Glycerol, Acetone, Citric acid, Lactic acid
Microbial Production of Amino Acids and Vitamins: Vitamin-B12 and Riboflavin
Production, recovery and applications of amino acids: L-Glutamic acid, L-Tryptophan
Production, recovery and applications of antibiotics: Penicillin, Erythromycin.

Unit III Microbial Productions
Production, recovery and applications of polysaccharides: Xanthan, Dextran and Alginate
Polyhydroxyalkanoates: Chemistry and properties, Polyhydroxybutyrate (PHB), biodegradable plastic. Microbial recovery of petroleum.
Production and applications of: Proteases, Pectinases, Cellulase.

Unit IV Microbial transformations
Basic concept involved. Types of bioconversion reactions: Oxidation, Reduction, Hydrolytic reactions, Condensations. Transformation of steroids and sterols,
Transformation of nonsteroid compounds: L-Ascorbic acid, Prostaglandins, Antibiotics

UNIT -V: QC QA and GLP.
Concept of QC, QA, Good Laboratory Practices, cGMP
QC testing of products: Purity, Sterility, Toxicity, Carcinogenicity. Pyrogen testing.

Text & Reference:
3. Casida L.E - Industrial Microbiology- New Age
5. Patel A.H. - Industrial Microbiology, Macmillan India
6. Prescott and Dunn's- Industrial Microbiology-CBS
9. Lar Schuger- Solvent Extraction in Biotechnology - Spinger

Practical (Lab course work V)
1. Production and isolation of bacterial exo-polysaccharides
2. Production and estimation of alkaline protease from bacterial source
3. Production and estimation of Bacterial enzymes lipase, Pectinase/ Cellulase/ Amylase
4. Production of sauerkraut by microorganisms
5. Production and estimation of lactic acid by Lactobacillus Sp.
7. Microbial transformations of steroids/antibiotics
8. Comparison of ethanol production using various Organic wastes /raw Material
9. Production and purification of fungal enzymes Amylase /Pectinase
10. Production of kojic acid.
11. Visit to fermentation industry
UNIT- I Animal Cell Culture
Structure and organization of Animal cells - Culture media; Balanced salt solutions and simple growth medium. Physical, chemical and metabolic functions of different constituents of culture medium; Role of carbon dioxide, serum, growth factors, glutamine in cell culture; Serum and protein free defined media and their applications.

UNIT- II Animal Cell Culture
Types of cell culture: primary and established culture; organ culture; tissue culture; three dimensional culture and tissue engineering; feeder layers; disaggregation of tissue and primary cell culture; cell separation; cell synchronization. Cryopreservation. Biology and characterization of cultured cells: tissue typing; cell-cell interaction; measuring parameters of growth; measurement of cell death; Apoptosis and its determination; cytotoxicity assays -

UNIT- III Molecular techniques in cell culture
Cell transformation; physical, chemical and biological methods; Viral gene delivery systems: Adenoviruses, ALVs, Baculoviruses; manipulation of genes; cell cloning and micro manipulation; hybridoma technology and its applications; cell fusion methods; gene mapping; vaccine production; gene therapy, targeting, silencing and knockout. Selectable markers like pSV and pRSV plasmids -reporter genes. Application of animal cell culture - Engineered cell culture as source of valuable products and protein production

UNIT- IV Embryology
Collection and preservation of embryos; culturing of embryos; Gametogenesis and fertilization in animals; types of cleavage pattern; role of maternal contributions in early embryonic development; genetic regulation of embryonic development in Drosophila; homeotic genes in development; stem cell culture, embryonic stem cell and their applications.

Unit V -Transgenics
Transgenic animal: production and application; transgenic animals as models for human diseases; transgenic animals in live-stock improvement; expression of the bovine growth hormone; transgenics in industry; chimera production; Ethical issues in animal biotechnology.

Text & References
2. Mammalian cell biotechnology; A practical approach, Ed. M. Butler, Oxford
4. Principles of genetic manipulation; - Old and Primrose- Blackwell science
5. Biotechnological innovations in Animal productivity- BIOTOL - Elsevier
6. An introduction to embryology. WB Sounders company, Philadelphia, Balinsky. BI,
8. Gangal Sudha- Principles and Practice of Animal Tissue Culture-Universities
10. In Vitro Cultivation of Animal cells- Butterworth- Heinemann, BIOTOL, Elsevier

Practical (Lab course work I)
1. Packing and sterilization of glass and plastic wares for cell culture.
2. Preparation of reagents and media for cell culture.
3. Primary culture technique for chicken embryo fibroblast.
4. Secondary culture of chicken embryo fibroblast.
5. Cultivation of continuous cell lines.
6. Quantification of cells by trypan blue exclusion dye.
7. Isolation of lymphocytes and cultivation of lymphocytes
8. Study of effect of toxic chemicals on cultured mammalian cells
10. Suspension culture technique
11. Cryopreservation of cell primary cultures and cell lines.
M.Sc. Biotechnology III Semester

BT -XIV: Plant & Agriculture Biotechnology  Marks: 100  Hours: 45

Unit-I: Plant Tissue Culture
Structure and organization of Plant tissue culture laboratory. Tissue culture media: Types, Composition and preparation. Initiation and maintenance of callus and suspension culture. Somatic embryogenesis Shoot tip culture, Protoplast culture, Embryo culture and embryo rescue. Anther, Pollen and Ovary culture for production of haploid plants and homozygous lines. Cryopreservation, slow growth and DNA banking for germ plasm conservation Commercial application of tissue culture technology, examples: banana and Sugarcane.

Unit-II: Transgenic Crops
Crops with resistance to biotic stresses, viruses, fungal and bacterial diseases: strategy and examples Crops with resistance to abiotic stresses (Herbicides and drought conditions): strategy and examples. Terminator technology. Ecological risk assessment of genetically modified crops

Unit-III: Microbes for Sustainable Agriculture
N2 fixing bacteria as microbial biofertilizers: Symbiotic and nonsymbiotic bacteria. Microbial inoculants for sustainable agriculture: Microorganisms, Physiology and Production technology of (i) Cyanobacteria (ii) Plant growth promoting rhizobacteria (iii) Phosphate solubilizing microorganisms (iv) Mycorrhizae. Plant hormones by bacteria

Unit IV Plant Pathology.
Concept of Plant Pathology. Host Pathogen Relationship. Pathogenesis mechanism- Enzymes, Toxins, Nutrition etc. Mechanism of Plant defense, resistance to disease. Classification of Plant Diseases based on Symptoms. Plant Diseases: Causative agent, Symptoms, Mechanism of Action and Control Measures against plant diseases (Chemical and Biological)

Unit-IV: Biopesticides and Integrated Pest Management
Biological control. Plant biopesticides and botanicals and microorganisms pest control Biopesticides v/s chemical pesticides: advantages and disadvantages. Examples of biopesticides: Bt-based biopesticides, Baculoviruses, Trichoderma Integrated Pest Management (IPM): Use of insect resistant crops, Refugia and Ecological approach of IPM. Present status and future needs for making biopesticides and IPM popular

Text & References:
1. Introduction to plant tissue culture – M.K. Razdan-Oxford and IBH
2. Biotechnological innovations in crop improvement- BIOTOL- Elsevier
4. Plant Tissue Culture-Bhojwani and Razdan-Elsevier
5. Methods in Plant Tissue culture- U Kumar- Agrobios India
8. N.S. Subbarao - Soil Microbiology – Oxford
10. Gupta P.K. - Genetics and Biotechnology in Crop Improvement, Rastogi Publications

Practical (Lab course work VI)
1. Preparation of Tissue culture Media.
2. Callus Culture, Organ Culture, organogenesis.
3. In vitro rooting and acclimatization.
4. Protoplast isolation and culture.
5. Anther Culture/ Production of haploids.
6. Agrobacterium culture, selection of transformants, GUS assay.
7. Somatic embryogenesis
8. Isolation of nitrogen fixing rhizobia, Azotobacter
9. Isolation of phosphate solubilizing bacteria and determination of efficiency
10. Estimation of leg haemoglobin from root nodule of leguminous plant
11. Study of Bio pesticides: Trichoderma
12. Visit to commercial plant tissue culture laboratory
UNIT-I: Biological Data Bases
The need for computation in Biology: An introduction to Bioinformatics, Historical overview, the principles involved, development of tools, internet based access. Introduction to Biological Databases, Database Browsing and Data Retrieval - Sequence databases, Structural databases, Literature and other databases

UNIT-II: Applications of Bioinformatics
Application of Bioinformatics Approaches for analysis and interpretation of Sequence Data and using: Homology Searches, Sequence Alignments, Pattern Searching. Application of Bioinformatics Approaches for analysis and interpretation of Genome data such as - Gene prediction, Full Genome comparison etc. Introduction to computational structural biology: Protein structure prediction using computational methods, Structure analysis, Classification of Proteins etc.

UNIT-III : Proteomics
Protein-Ligand Docking: Introduction; Docking problems, methods for protein- ligand docking, validation studies and applications

UNIT-IV: Genomics
Introduction sequencing strategies for whole genome analysis, sequence data analysis. Comparative Genomics: Protein evolution from exon shuffling, Protein structural genomics. Gene function by sequence comparison, Comparative Genomics: Protein evolution from exon shuffling, Protein structural genomics. Gene function by sequence comparison, Global expression profiling: whole genome analysis of mRNA and protein expression, microarray analysis, types of microarrays and their applications Functional genomics, Toxicogenomics, Pharmacogenomics, Metagenomics. Metabolic engineering

UNIT V: Biostatistics
Brief description and tabulation of data and its graphical representation Measurement of central tendency and dispersion Mean, mode, median, range Mean deviation, standard deviation, variance . Idea of two types of errors and level of significance. Tests of significance-F-Test and chi-square test. Linear regression and correlation.

Text & Reference:
1. Teresa Attwood, David Parry-Smith - Introduction to Bioinformatics Prentice Hall
2. Jin Xiong- Essentials of Bioinformatics- Cambridge
4. Rashidi H.H and Buahler L.K - Bioinformatics : Applications in Biological Science and Medicine-CRC
6. Philip E. Bourne, Helge Weissig - Structural Bioinformatics Wiley,
10. Arthur M Lesk - Introduction to Bioinformatics, Oxford University Press
14. Statistical Method S. P. Gupta
15. Mathematical Statistics- S.C. Gupta & Kapoor

Practical (Lab course work VII)
1. NCBI/EBI: Data access – standard search engines : data retrievals tools – Entrez, DBGET and SRS, Pubmed etc
2. Software for data building. Submission of sequence to databases.
3. Sequence homology as product of molecular evolution, sequence similarity searches,
4. Sequence alignment-global, local. end free-space; measurement of sequence similarity
5. Homology Modeling
6. Phylogeny reconstruction by using biological data
7. Getting an amino acid sequence, nucleotide sequence by BLAST
8. Protein identification & characterization with peptide mass fingerprinting data.
10. Tertiary structure analysis of proteins (3D structure prediction)
11. Experiments based of biostatistics and assumed data sets
12. Measures of central tendency and dispersion mean, median, mode, range, standard deviation variance ,standard error
M.Sc. Biotechnology IV Semester
BT - XVII: Pharmaceutical Biotechnology  Marks: 100  Hours: 45

UNIT - I : Chemotherapy
Antimicrobial Drug. Mechanism of action of antimicrobial agents. Microbial Resistance to antibiotics and antimicrobial agents (Types and Mechanism). Types of Antibiotics: Classification of antibiotics with example. General characteristics of an Secondary Metabolites: Types and Medicinal Applications

UNIT-II : Chemotherapeutics Agents

UNIT-III: Protein Engineering
Methods of protein sequencing: mass spectrometry, Edman degradation, Tryptic and/or Chymotryptic Peptide Mapping. Isolation and purification of proteins, Stability and activity based approaches of protein engineering, Chemical and Physical Considerations in Protein and Peptide Stability, Different methods for protein engineering, Site-directed mutagenesis, gene shuffling, and direct evolution. Mapping of protein interactions: Two hybrid, phage display etc

UNIT IV: Discovery and Development

Unit V: Clinical Trials
Phases of Clinical trials of drugs, Preclinical drug evaluation of its biological activity, potency and toxicity-Toxicity test in animals including acute, sub-acute and chronic toxicity, ED50 and LD50 determination, special toxicity test like teratogenicity and mutagenecity. Introduction to Indian, International Pharmacopoeia and global regulatory guidelines.

Text & References:
1. Hugo W. B. and Russell A. D. - Pharmaceutical Microbiology -Wiley India
2. Ashutosh Kar-Pharmacology and Pharmacobiototechnology-New Age
3. FSK Barar- Pharmaceutical- Essentials of Pharmaceuticals- S.Chand
6. S.P. Vyas, Dixit- Pharmaceutical Biotechnology-CBS
7. B.Razdan-Medicinal Chemistry-CBS
8. Satoskar, Bhandarkar- Pharmacology and Pharmacotheapeutics- Popular
9. Purohit, Saluja- Pharmaceutical Biotechnology-Student Edition
11. Ed. R.H. Thomson-Chemistry of Natural Products-Springer
12. Jogdand S.N - Biopharmaceuticals, Himalaya Publishing

Practical: (Lab course work VII)
1. Estimation of penicillin/streptomycin by biological assay.
2. Estimation of penicillin/streptomycin by chemical assay.
3. Assay of antimicrobial activity of Penicillin, Chloramphenicol, streptomycin
4. Determination of Minimum Inhibitory Concentration (MIC) of Antibiotic
5. Determination of shelf life of antibiotics (Expired drugs)
6. Sterility testing of commercial pharmaceuticals.
7. Study of microbial spoilage of pharmaceuticals.
8. Sterility testing of injectable as per IP.
9. Effect of chemical disinfectant on growth of bacteria
10. Study of Pharmacopoeia and global regulatory guidelines in pharma industry
11. Study of drug action by using Zebra fish (Danio rerio) as model organism
12. Visit to Pharmaceutical industry
M.Sc. Biotechnology IV Semester

BT - XVIII: Environmental Biotechnology Marks: 100 Hours: 45

UNIT - I: Ecology & Environment: Interactions between environment and biota; Concept of habitat and ecological niches; Limiting factor; Energy flow, food chain, food web and trophic levels; Ecological pyramids and recycling, biotic community-concept, structure, dominance, fluctuation and succession; N.P.C and S cycles in nature. Concepts and theories of evolution - Population ecology - community structure.

UNIT - II: Ecology and Environment: Ecosystem dynamics and management: Stability and complexity of ecosystems; Speciation and extinctions; environmental impact assessment; Principles of conservation; Conservation strategies; sustainable development. Global environmental problems: ozone depletion, UV-B green house effect and acid rain, their impact in biotechnological approaches for management.


Text & References
2. Cell biology, genetics, Molecular Biology Evolution, Ecology-Verma, Agarwal- S.Chand
3. Environmental Biology -Principles of Ecology- Verma and Agarwal- S.Chand
4. Environmental Biotechnology by Alan Scragg. Pearson Education Limited
5. Environmental biotechnology by S.N. Jogdand. Himalaya Publishing House
8. Introduction to Biodeterioration by D. Alsopp and K.J. Seal, ELBS/Edward Arnold.
10. Introduction to Environmental Biotechnology Chatterji A.K., , Prentice Hall of India
11. Environmental Biotechnology Indushekar Thakur- I K International

Practical (Lab course work VII)
1. Measurement of sounds by DB meter in silent, industrial, residential,commercial zones.
3. Estimation of Hardness, Ca and Mg from given water and soil sample.
5. Estimation of Na and K from given water and soil sample by flame photometrically.
6. Estimation of Sulphate/ Phosphates from given water and soil
7. Determination of Dissolved Oxygen and Biological Oxygen Demand of polluted water.
8. Determination of Chemical Oxygen Demand of polluted water.
10. Field Visit to MSW management/ STP Sewage treatment plant (one day)
SY M.Sc. Biotechnology Syllabus – (CBCS) - 2014 Pattern
Lab Course Project Work-VIII
(Dissertation/ Elective Lab Course Work)

Guidelines for Dissertation work
1. The dissertation will be allotted during III semester
2. Students will design experiment of dissertation under guidance of supervisor
3. Selection of topic relevant to priority to areas of biotechnology
4. Collection of literature from various sources
5. Planning of research experiments
6. Performing the experiments with scientific and statistical analysis
7. Writing and compilation of dissertation report
8. Presentation of experimental data in schedule of practical examination
9. Dissertation to be carried out individually by each student