

**BSC III YEAR  
SEMESTER V  
CORE THEORY- V  
MOLECULAR BIOLOGY AND RECOMBINANT DNA TECHNOLOGY**

**Credit 1: Gene expression and regulation in prokaryotes**

- 1.1 Structure of prokaryotic gene (promoter, initiator & terminator regions), Structure and functions of RNA polymerase
- 1.2 Transcription mechanism- initiation, elongation & proof reading, termination (rho independent & rho dependent); basic concept of reverse transcription
- 1.3 Genetic code- properties, deciphering of genetic code, wobble hypothesis, aminoacylation
- 1.4 Translation mechanism- initiation, elongation and termination
- 1.5 Gene regulation: Negative & Positive control
- 1.6 Operon concept Lac operon, CAP-cAMP system, Arabinose operon

**Credit 2: Gene expression and regulation in eukaryotes**

- 2.1 Structure of eukaryotic gene (promoter, exons, introns, terminator, enhancer & silencer)
- 2.2 Transcriptional machinery in eukaryotes (RNA polymerases), structures and transcriptional factors ( basic, upstream & regulatory)
- 2.3 Transcription- initiation (formation of transcriptome), elongation and termination
- 2.4 Post-transcriptional modifications- capping, polyadenylation, Splicing (self & protein mediated) and alternative splicing
- 2.5 Translation- initiation, elongation and termination
- 2.6 Regulation of gene expression in eukaryotes- mating types in yeast

**Credit 3: Recombinant DNA Technology**

- 3.1 Enzymes useful in molecular cloning: Restriction endonuclease, DNA ligases, polynucleotide kinase, klenow enzyme, DNA Polymerase- I, reverse transcriptase, alkaline phosphatase, terminal nucleotidyltransferase
- 3.2 Cloning Vectors: PBR 322, Bacteriophage, Cosmid, Phagemid, Shuttle vectors
- 3.3 Gene transfer techniques: Physical, Chemical and Biological methods
- 3.4 Labeling nucleic acids and blotting techniques (Southern, Northern, Western, Zooblot)
- 3.5 Polymerase Chain Reaction and its applications
- 3.6 Applications of recombinant DNA technologies- Agriculture, Medicine

## **CORE-V 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 (Selection of transformants with blue white selection)

## **REFERENCE BOOKS**

1. Molecular Biology of the cell. 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 (Pearson 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. Pasternak, 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, Genomics and Genetic Engineering - By Irfan Ali Khan and AtiyaKhanum (Ukaaz Publications).

**SEMESTER- V**  
**ELECTIVE THEORY**  
**(A) PLANT BIOTECHNOLOGY**

**Credit 1: Basics of Plant Biotechnology**

- 1.1 Introduction to plant tissue culture, totipotency of plant cells (Dedifferentiation, redifferentiation, regeneration of whole plant)
- 1.2 Nutritional requirements for plant tissue culture: nutrient media – macronutrients and micronutrients, media additives (carbon source, vitamins, amino acids)
- 1.3 Plant growth regulators (cytokinins, auxins, gibberellins).
- 1.4 Preparation of media, selection and surface sterilization of explants, inoculation, incubation (temperature and light regime), regeneration of plants.
- 1.5 Initiation of callus cultures and cell suspension cultures
- 1.6 Regeneration of plants (Organogenesis and embryogenesis)

**Credit 2: Applications of Plant Tissue Culture**

- 2.1 Meristem culture and production of disease free plants
- 2.2 Micropropagation of elite ornamental, horticultural plants via organogenesis and somatic embryogenesis, encapsulation and production of synthetic seeds
- 2.3 Cell suspension cultures (batch and continuous culture) for production of secondary metabolites
- 2.4 Embryo culture and embryo rescue; Protoplast culture and fusion, Development of somatic hybrids and cybrids and their applications
- 2.5 Somaclonal variation and their applications; production of haploids, Anther and pollen culture
- 2.6 Methods of cryopreservation for conservation of plant germplasm

**Credit 3: Transgenic plants and applications**

- 3.1 Herbicide resistant plants: production of glyphosate tolerant plants
- 3.2 Insect resistant plants: Bt corn, Bt cotton
- 3.3 Virus resistant plants: Transgenic plants with viral coat protein and viral nucleoprotein
- 3.4 Transgenic plants with enhanced nutritive values: Vitamin A, Vitamin E
- 3.5 Stress tolerant plants: Overview of Drought and Light stress
- 3.6 Transgenic plants as Bioreactor: Antibody production in plants, Biodegradable plastics

## **CORE-V (A) PRACTICALS**

1. Preparation of media for tissue culture
2. Surface sterilization methods of explants (seed leaf, inter node & root) and inoculation
3. Establishment of callus cultures –from carrot
4. Cell suspension cultures
5. Protoplast isolation and culture
6. Anther culture
7. Agrobacterium mediated transformation
8. Synthetic seeds production

### **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. Sopory, 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

**SEMESTER-V**  
**ELECTIVE THEORY**  
**(B) MEDICAL BIOTECHNOLOGY**

**Credit 1: Methods for diagnosis of human diseases**

- 1.1 Karyotyping of human chromosomes
- 1.2 Chromosome banding – G-banding and R-banding technique
- 1.3 Inheritance patterns in Man – Pedigree analysis
- 1.4 Prenatal diagnosis - Invasive techniques – Amniocentesis, Chorionic Villi Sampling (CVS); Non-invasive techniques – Ultrasonography
- 1.5 Diagnosis using monoclonal antibodies – ELISA
- 1.6 DNA/RNA based diagnosis – HBV, HIV

**Credit 2: Inherited disorders**

- 2.1 Chromosomal disorders caused due to structural chromosomal abnormalities (Deletions, duplications, Translocations)
- 2.2 Chromosomal disorders caused due to numerical chromosomal abnormalities (autosomal and allosomal)
- 2.3 Monogenic disorders (autosomal and X-linked diseases)
- 2.4 Mitochondrial diseases – LHON, MERRF
- 2.5 Multifactorial conditions – Diabetes & Hypertension; Single Nucleotide Polymorphisms in common diseases: hypertension (Angiotensin Converting Enzyme gene)
- 2.6 Cancer – types, molecular basis of colon cancer and breast cancer

**Credit 3: Therapeutic approaches for human diseases**

- 3.1 Gene therapy – ex vivo and in vivo gene therapy; somatic and germline gene therapy
- 3.2 Strategies of gene therapy: gene augmentation – ADA deficiency; Cystic Fibrosis & Familial hyper cholesterolemia
- 3.3 Stem cells – potency definitions; embryonic and adult stem cells; applications of stem cells – cell based therapies and regenerative medicine
- 3.4 Encapsulation technology and therapeutics-Diabetes
- 3.5 DNA based vaccines, subunit vaccines – Herpes Simplex Virus, Recombinant attenuated vaccines– Cholera
- 3.6 Basic concept of Nutrigenomics and Pharmacogenomics

## **ELECTIVE (B) PRACTICALS**

1. Karyotyping of normal & abnormal human chromosome sets
2. Human pedigree analysis
3. Estimation of C-reactive protein
4. Dot ELISA
5. Genotyping of candidate genes for diseases by RFLP
6. Detection of DNA damage by comet assay
7. Stem cell isolation
8. Cell culture technique

## **REFERENCE BOOKS**

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

**BSc III YEAR  
SEMESTER-VI  
CORE THEORY  
VI MICROBIAL TECHNOLOGY**

**Credit 1: Introduction to Microbial technology**

- 1.1. Introduction to industrial biotechnology, scope and applications
- 1.2. Exploitation of microorganisms and their products
- 1.3. Isolation and screening of microorganisms for industrial products
- 1.4. Strategies for Strain improvement (mutation, selection, recombination)
- 1.5. Preservation of industrial microorganisms
- 1.6. Good manufacturing practices, Intellectual Property Rights and Patenting issues

**Credit 2: Microbial fermentation**

- 2.1 Principles of Fermentation technology
- 2.2 Fermentation concept and design
- 2.3 Types of fermentation
- 2.4 Formulation and design of fermentation media
- 2.5 Substrates used as Carbon and Nitrogen Inoculum development.
- 2.6 Factors affecting fermentation process

**Credit 3: Microbial technology products and applications**

- 3.1 Microbial production of Organic acids (Lactic acid, citric acid), Amino acids (Glutamic acid, Aspartic acid, Lysine)
- 3.2 Fermentation by microbes for food additives: dairy products (Cheese, Yogurt), beverages (Beer, Wine) and antibiotics (Streptomycin, Erythromycin)
- 3.3 Basic concepts of Food quality and Control
- 3.4 Therapeutic drugs: Recombinant vaccines, monoclonal antibodies, insulin, vitamins
- 3.5 Biofuel: Hydrogen, Alcohol, Methane
- 3.6 Biomining (Extraction of Copper, Aluminum, Uranium and Bioremediation)

## **CORE-VI PRACTICALS**

1. Screening of Microorganisms (Primary selection, secondary selection)
2. Screening of amylase producing microorganisms
3. Production of wine using common yeast
4. Production of alcohol by fermentation and Estimation of alcohol by colorimetry
5. Production of Penicillin/Ampicillin
6. Estimation of Dissolved oxygen in water samples
7. Isolation of microbes from soil or industrial effluents
8. Quality testing of milk by MBRT

## **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)
11. Bioprocess Engineering - By Shuler (Pearson Education)
12. Essentials of Biotechnology - By Irfan Ali Khan and AtiyaKhanum (Ukaaz Publications)
13. Gene, Genomics and Genetic Engineering - By Irfan Ali Khan and AtiyaKhanum (Ukaaz Publications)



**SEMESTER- VI**  
**ELECTIVE THEORY**  
**(A) ANIMAL BIOTECHNOLOGY**

**Credit 1: Animal tissue culture: principles and applications**

- 1.1 Cell culture technique: cell culture media, sterilization techniques
- 1.2 Cell lines, characteristic feature of cell lines and maintenance
- 1.3 Methods of separation of various cell types (physical and enzymatic methods)
- 1.4 Stem cell: Features, culture, embryonic stem cells and adult stem culture methods
- 1.5 Genetic manipulation of cells – Physical (microinjection) and Chemical methods
- 1.6 Commercial applications of cell culture: Cell based manufacturing (vaccines), toxicity testing and tissue engineering

**Credit II: Animal improvement for desired traits by biotechnology interventions**

- 2.1 Scope for biotechnological interventions (Buffalo as multipurpose livestock)
- 2.2 Model organisms and their significance (Cattle, Fish)
- 2.3 DNA micromanipulation
- 2.4 Somatic cell nuclear transfer
- 2.5 Embryo sexing
- 2.6 Gene mapping and identification of genes of economic importance in farm animals

**Credit III: Developments in Molecular markers in Livestock and Transgenic Animals**

- 3.1 Developments in Livestock Genomics (Estimated Breeding Value -EBV)
- 3.2 Molecular markers (RFLP, RAPD and SNP) and applications
- 3.3 Animal transgenesis- methods and applications
- 3.4 Animal cloning – Case study-Dolly
- 3.5 Applications of animal biotechnology: Gene therapy, milk production, meat production and aquaculture production
- 3.6 Ethical consideration of transgenic animals

## **ELECTIVE (A) PRACTICALS**

1. Preparation of Animal cell culture media
2. Isolation of cells from Chicken Liver
3. Isolation of cells from Chick Embryo
4. Establishment of primary cell culture: Liver/Spleen
5. In vitro and in vivo preparation of somatic metaphase chromosomes;
6. Protocol of Animal cloning procedure
7. Molecular marker application
8. Gene transfer technique

## **REFERENCE BOOKS**

1. Lasley JF. 1987. Genetics of Livestock Improvement. 3rd Ed. IBH.
2. Text book of Animal Biotechnology by B Singh. The Energy and Resources Institute (teri)
3. Ross CV. 1989. Sheep Production and Management. Prentice Hall.
4. Schmidt GM & Van Vleck LD. 1974. Principles of Dairy Science. WH Freeman.
5. Turner HN & Young SSY. 1969. Quantitative Genetics in Sheep Breeding. MacMillan.
6. Van Vleck LD, Pollak EJ & Bltenacu EAB. 1987. Genetics for Animal Sciences. WH Freeman.
7. Crawford RD. 1990. Poultry Breeding and Genetics. Elsevier.
8. Singh RP & Kumar J. 1994. Biometrical Methods in Poultry Breeding. Kaly

**SEMESTER-VI**  
**ELECTIVE THEORY**  
**(B) ENVIRONMENTAL BIOTECHNOLOGY**

**Credit I: Environmental Pollution**

- 1.1 Introduction to environment and pollution
- 1.2 Types of pollution - air, water and land pollution
- 1.3 Types of pollutants–inorganic, organic and biotic sources
- 1.4 Sources of pollution – domestic waste, agricultural waste, industrial effluents and municipal waste
- 1.5 Climate change, greenhouse gases and global warming
- 1.6 Impact of pollution on environment and measurement methods

**Credit II: Bioenergy and Bio-fuels**

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

**Credit III: Bioremediation and Restoration of Environment**

- 3.1 Microbial treatment of waste water (sewage of industrial effluent) - aerobic and anaerobic methods
- 3.2 Solid waste and management; Bioremediation – concepts and types (in-situ and ex-situ); Bioremediation of toxic metal ions – biosorption and bioaccumulation
- 3.3 Composting of organic wastes
- 3.4 Microbial bioremediation of pesticides and Xenobiotic compounds
- 3.5 Phytoremediation- concepts and application 3.6 Conservation of biodiversity

## **ELECTIVE (B) –PRACTICALS**

1. Estimation of BOD in water samples
2. Estimation of COD in water samples
3. Estimation of Total dissolved solid
4. Isolation of microorganisms from soil/industrial effluents
5. Production of hydrogen or biogas using cow/cattle dung
6. Identification and characterization of bioremediation microorganisms
7. Conservation of useful microorganisms
8. Production of ethanol from waste byproducts

### **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)
11. Bioprocess Engineering - By Shuler (Pearson Education)
12. Essentials of Biotechnology - By Irfan Ali Khan and AtiyaKhanum (Ukaaz Publications)