

**INDIRA GANDHI NATIONAL TRIBAL UNIVERSITY, AMARKANTAK**  
**B.Sc. BIOTECHNOLOGY HONOURS SYLLABUS**

<b>COURSE NO.</b>	<b>PAPERS</b>	<b>MARKS</b>
	<b>SEMESTER I</b>	
<b>BIOT 01</b>	BIOMOLECULES: STRUCTURE AND FUNCTION:	50
<b>BIOT02</b>	CELL BIOLOGY	50
<b>BIOP 01</b>	PRACTICAL	50
	<b>SEMESTER II</b>	
<b>BIOT 03</b>	BIOCHEMICAL TECHNIQUES	50
<b>BIOT 04</b>	MICROBIOLOGY.	50
<b>BIOP 02</b>	PRACTICAL	50
	<b>SEMESTER III</b>	
<b>BIOT 05</b>	GENETICS	50
<b>BIOT 06</b>	IMMUNOLOGY	50
<b>BIOP 03</b>	PRACTICAL	50
	<b>SEMESTER IV</b>	
<b>BIOT 07</b>	MOLECULAR BIOLOGY	50
<b>BIOT 08</b>	ANIMAL BIOTECHNOLOGY	50
<b>BIOP 04</b>	PRACTICAL	50
	<b>SEMESTER V</b>	
<b>BIOT 09</b>	GENETIC ENGINEERING	50
<b>BIOT 10</b>	FERMENTATION TECHNOLOGY	50
<b>BIOT 11</b>	ENVIRONMENTAL BIOTECHNOLOGY	50
<b>BIOT 12</b>	MEDICAL BIOTECHNOLOGY	50
<b>BIOT 13</b>	PROTEOMICS AND GENOMICS	50

<b>BIOT 14</b>	BIODIVERSITY	50
<b>BIOP 05</b>	PRACTICAL	50
<b>BIOP 06</b>	PRACTICAL	50
<b>BIOP 07</b>	PRACTICAL	50
	<b>SEMESTER VI</b>	
<b>BIOT 15</b>	COMPUTATIONAL BIOLOGY AND BIOINFORMATICS	50
<b>BIOT 16</b>	PLANT BIOTECHNOLOGY	50
<b>BIOT 17</b>	IMMUNOLOGY AND VACCINES	50
<b>BIOT 18</b>	FOREST AND AGRICULTURE BIOTECHNOLOGY	50
<b>BIOT 19</b>	BIOTECHNOLOGY AND SOCIETY	50
<b>BIOT 20</b>	NANOTECHNOLOGY	50
<b>BIOP 08</b>	PRACTICAL	50
<b>BIOP 09</b>	PRACTICAL	50
<b>BIOP 10</b>	PRACTICAL	50
	<b>GRAND TOTAL</b>	<b>1500</b>

Each course is a credit course i.e. to be taught

1. 3 days in a week (45 min/week) or two days in a week (two hours/week)

2. In a semester, each course will be taught on an average 32-34 hours /semester.

## **BIOT 01: BIOMOLECULES: STRUCTURE AND FUNCTION:**

### **Unit I**

Carbohydrates: Chemical structures, nature, properties.  
Classification and Importance in Biological Cells.

### **Unit II**

Amino acids: Classification, properties, structure.  
Zwitterions nature.  
Proteins: Classification, Structure and Function.  
Primary, Secondary, Tertiary and Quaternary Structure.

### **Unit III**

Enzymes: Classification, Characteristics. Factors affecting enzyme activity.  
Enzyme Kinetics, Activation and Inhibition.  
Non Protein Enzymes.  
Application of Enzymes.

### **Unit IV**

Lipids: Structure, Classification, Properties and Function.  
Vitamins: Fat soluble and water soluble.  
Classification and function of Vitamins and Hormones.

### **Unit V**

Bioenergetics: Thermodynamic System, I and II law of Thermodynamics.  
Free energy, standard free energy change. Redox potential. High energy Phosphate compounds. Free energy of Hydrolysis of ATP, and sugar phosphates.

## **BIOT 02: CELL BIOLOGY**

### **Unit I**

Cell as a basic unit of living systems: The cell theory. Broad and detailed classification of cell types within an organism.

Cell, tissue, organ and organism and different levels of organization of otherwise genetically similar cells.

### **Unit II**

Cell division and Cell cycle.

Cell synchrony and its applications.

Anomalies in Cell Division

### **Unit III**

Cell cell interaction. Cell locomotion.

Muscle and Nerve cells.

Cell senescence and death Cell differentiation.

### **Unit IV**

Structure and function of cell organelles;

Ultrastructure of cell membrane, cytosol, golgi bodies, endoplasmic reticulum (rough and smooth), ribosomes.

Cytoskeletal structures (actin, microtubules etc.)

### **Unit V**

Mitochondria, chloroplasts, lysosomes, peroxisomes.

Nucleus(nuclear membrane, nucleoplasm, nucleolus, chromatin)

## **BIOT 03: BIOCHEMICAL TECHNIQUES**

### **Unit I**

Microscopy: Bright Field, Dark Field, Phase Contrast, Fluorescence, Electron

Microscopy, SEM and TEM.

### **Unit II**

Colorimetry and Spectrophotometry: Lambert-Beer's Law Colourimetry spectroscopy

UV, Visible, Fluorescence, Atomic absorption, IR.

### **Unit III**

Chromatography

Paper Chromatography, Thin layer Chromatography, Gas

Chromatography, Gel filtration

Chromatography, Ion exchange Chromatography.

### **Unit IV**

Electrophoresis Techniques and applications: Agarose gel, native PAGE, SDS-PAGE.

### **Unit V**

Physical Methods of Imaging Intact Biological Structures:

Principle and Techniques of: (a) ECG (b) EEG (c) X-rays (d) CAT-Scan (e) Ultra Sound

(f) NMR-Imaging.

## **BIOT 04: MICROBIOLOGY**

### **Unit I**

History of Microbiology: Anton Von Leewenhoek, Louis Pasteur, Robert Koch, Edward Jenner, Joseph Lister.

Bacterial Nomenclature: Classification - methods of classification; Whittaker's 5 kingdom classification, Bacterial species - strains.

### **Unit II**

Prokaryotic and Eukaryotic cell.

Characteristics and examples of Archaeobacteria, eubacteria, PPLO, viruses, viroids and prions; Size, shape and arrangement of bacterial cells, cell wall, cytoplasmic membrane (Protoplasts, spheroplasts), flagella, pili, spores and cysts.

Staining Techniques: Simple (Monochrome and Negative) and Differential (Gram and Acid fast).

### **Unit III**

Bacterial Nutrition- Nutritional classes of microorganisms, Extremophiles.

Microbiological media and its types. Different methods of Cultivation of Microorganisms.

### **Unit IV**

Microbial Growth, Growth curve, Conditions affecting growth.

Batch and Continuous Cultivation, Diauxic Growth, Synchronous Growth.

Measurement of bacterial growth.

### **Unit V**

Control of Microorganisms.

Sterilization, Disinfection, Sanitation, Pasteurization.

Physical and chemical methods of control, Phenol co-efficient.

## **BIOT 05: GENETICS**

### **Unit I**

Introduction to genetics. Genotype and Phenotype.

A brief overview of Mendel's Laws of Inheritance.

DNA as Genetic material- Experimental proof.

Structure and types of DNA and RNA. Properties of nucleic acids.

### **Unit II**

Chromosomes- structural organization of prokaryotic and eukaryotic chromosomes. Nucleosome structure, Euchromatin, Heterochromatin, Satellite DNA, telomeres, centromeres. Types of chromosomes on the basis of centromere position. Special Chromosomes- Polytene and lampbrush chromosomes. Banding pattern in human chromosomes.

### **Unit III**

Chromosomal mutation: Variation in chromosomal structure and number. Hereditary defects- Klinefelter's syndrome, Down's syndrome, Turner's syndrome, Cri-du-chat syndrome. Applications of polyploidy.

### **Unit IV**

Microbial Genetics- Recombination in bacteria: Molecular mechanism of recombination. Transformation, Transduction (Generalized and Specialized), Conjugation. Davis U Tube experiment.

### **Unit V**

Gene Mutations- Types, Physical and Chemical Mutagens.

Analysis of Spontaneous and Induced mutations.

Mutant analysis in biochemical pathways. Isolation of auxotrophs.

Replica plating techniques, Penicillin enrichment technique.

## **BIOT 06: IMMUNOLOGY**

### **Unit I**

Normal flora of Human body.  
Infection and its types.  
Mechanism of pathogenesis.

### **Unit II**

Organs of Immune system- Spleen, Thymus, Lymph nodes  
Cells of Immune system- T cells- its types and receptors, B cells and its receptors.

### **Unit III**

Immunity- Innate and Acquired, Humoral and cell-mediated immunity.  
Host defense mechanism- First, Second and Third Line of Host Defense.  
Primary and Secondary response.

### **Unit IV**

Antigens- Properties and types, Adjuvants.  
Immunoglobulins- Structure, types and functions.  
Generation of Antibodies.

### **Unit V**

Agglutination and Precipitation reactions.  
Hemagglutination and Passive Hemagglutination, Immunofluorescence,  
ELISA, RIA, Coombs test (Direct and Indirect), Latex agglutination, ODD  
and RID.

## **BIOT 07: MOLECULAR BIOLOGY**

### **Unit I**

DNA replication- experimental proof of semi conservative nature.  
DNA replication in prokaryotes and eukaryotes (mechanism, accessory proteins and enzymes involved in replication).

### **Unit II**

Structure of Prokaryotic gene.  
Prokaryotic transcription and regulation.  
Eukaryotic transcription, transcription factors and regulation.  
Post- transcriptional modifications- 5'-cap formation, 3'-end processing, polyadenylation and gene splicing.

### **Unit III**

Translation in Prokaryotes and Eukaryotes - Mechanism of initiation, elongation and termination. Co and Post Translational modifications.

### **Unit IV**

Regulation of gene expression in prokaryotes.  
Induction and repression.  
Operon model (*lac*, *his*, *ara* and *trp* operon), catabolite repression.

### **Unit V**

Insertion elements and transposons. IS elements, Tn3 family, Yeast TY elements and P elements.  
Extra chromosomal DNA in Prokaryotes- Plasmids.

## **BIOT 08: ANIMAL BIOTECHNOLOGY**

### **Unit I**

History and development of cell culture.

Culture media for Animal cell culture- BSS, Serum containing and Serum free media.

Growth factors- EGF, ECF, PDGF, IL-1, IL-2, NGF and Erythropoitin.

Physical requirements for growing animal cell in culture.

### **Unit II**

Differentiation of cells.

Initiation of cell culture.

Isolation and disaggregation of explants.

Development of primary culture.

Growth curve of animal cell in culture.

Commonly used cell lines- their organization and characteristics.

### **Unit III**

Organ culture- techniques, advantage and applications.

Methods for Transfection of animal cells.

Transplantation of cultured cells.

Methods for Cell fusion.

### **Unit IV**

Selectable markers, HAT selection and antibiotic resistance.

Hybridoma technology for production of monoclonal antibodies.

Production of vaccines and special secondary metabolites- insulin, growth hormones and interferons.

Production of T-plasminogen activator and clotting factor VIII

### **Unit V**

Bioreactors for large scale production of animal cells.

Over production and processing of chosen proteins.

A brief introduction to Transgenic animals- general methods for production, advantages and ethical issues.

## **BIOT 09 GENETIC ENGINEERING**

### **Unit I**

Scope and history of genetic engineering.

Basic requirement of genetic engineering- isolation of genomic and plasmid DNA from Bacteria, Plant and Animal cells.

Enzymes required for recombinant DNA technology (Restriction and other enzymes) and their practical application

(Nuclease, polymerase, Ribozyme, ligase, Alkaline Phosphate, etc.)

### **Unit II**

Vector as marker .plasmid cosmid ,phage, YAC plant and Animal vectors, Transfection Transformation methods. Markers for identifying transfer/transformed cells. Reporter genes: CAT/LUC/GUSS etc.

plasmid Cloning Vectors- nomenclature, properties of good vector.

Phage  $\lambda$ , M-13 vectors.

Yeast vectors- YAC,

Plant vectors- *Agrobacterium tumefaciens*, *A. rhizogenes*.

Animal vectors- SV-40, Retrovirus vectors, Vaccinia virus.

### **Unit III**

Construction of genomic and cDNA library.

Manipulation of purified DNA and introduction of DNA into living cells.

### **Unit IV**

Blotting- Southern, Northern, Western, Dot-blot.

Introduction to PCR, RAPD and RFLP.

### **Unit V**

Gene therapy (Basic principle and introduction).

Introduction to Gene Mapping.

Biosafety guidelines, Intellectual Property Rights, Recombinant DNA

Safety Guidelines.

## **BIOT10: FERMENTATION TECHNOLOGY**

### **Unit I**

General concepts of industrial microbiology.  
Primary and secondary screening  
Strain development strategies.  
Sterilization of fermentor, media and air.

### **Unit II**

Inoculum development.  
Scale up of fermentation process.  
Raw material for media preparation.  
Processing and preservation of food.

### **Unit III**

Types of fermentations processes.  
Design of typical batch fermentor.  
Agitation, Aeration, pH, Temperature and dissolved oxygen.  
Factors affecting fermentor design. Types of fermentors.

### **Unit IV**

Production of Solvent- Ethyl Alcohol. Production of Antibiotics- Penicillin.  
Production of Enzymes- Amylase. Immobilization and applications of enzymes.

### **Unit V**

Production of Vitamins- Riboflavin and Cyanocobalamin.  
Production of Organic Acids- Acetic Acid, Production of Amino Acids- Glutamic Acid.

## **BIOT 11: ENVIRONMENTAL BIOTECHNOLOGY**

### **Unit I**

Microbial analysis of water, wastewater management.  
Treatment of municipal waste and industrial effluents.

### **Unit II**

Biopesticides- Bacterial and Fungal.  
Genetically modified crops containing insecticidal genes.  
Biofertilizers- Nitrogen fixers, PSB, Mycorrhiza and VAM.

### **Unit III**

Conventional fuels- firewood, plant, coal gas, animal oils and their environmental impact. Modern fuels- Methanogenic bacteria and biogas, microbial hydrogen production, gasohol experiment, solar energy.  
Plant based petroleum industry. Cellulose degradation for combustible fuels and their environmental impact.

### **Unit IV**

Microbial leaching of copper and uranium. Biorecovery of petroleum-MEOR, Bioremediation and Biodeterioration- Petroleum products, leather, textile and paper.

### **Unit V**

Biosensors and Biopolymers.  
Biochips, Biofilms and Bioplastics.  
Microorganisms as Bioindicators.  
Biological weapons and bioterrorism.

## **BIOT 12 : MEDICAL BIOTECHNOLOGY**

### **Unit 1.**

Gene therapy – background, types of gene therapy (ex vivo & in vivo), choosing targets for gene therapy, vectors in gene therapy, retroviruses, adenoviruses, adeno-associated viruses, types of gene delivery, Weismann barrier (soma-to-germ line barrier), epigenetic inheritance, problems & ethics.

**Unit 2.**

Gene Delivery methods – Viral delivery (through Retroviral vectors, through, Adenoviral vectors), Non-viral delivery, Antibody engineering.

**Unit 3.**

Cell Adhesion-based therapy – integrins, inflammation, cancer & metastasis. Drug delivery – conventional & new approaches to drug delivery.

**Unit 4.**

Synthetic therapy – synthetic DNAs, therapeutic Ribozymes, synthetic drugs. Tissue Engineering – Skin, Liver, Pancreas.

**Unit 5.**

Gene therapy Models – Liver diseases, Lung diseases, Hematopoietic diseases Circulated gene products, Cancer & Auto-immune diseases.

**Unit 1.**

DNA Typing : DNA polymorphisms: the basis of DNA typing, Minisatellite analysis, Polymerase chain reaction based analysis, Short tandem repeat analysis,

**Unit 2.**

Mitochondrial DNA analysis, Y chromosome analysis, Randomly amplified polymorphic DNA (RAPD) analysis.

**Unit 3.**

Proteomics and beyond : Analysis of the transcriptome, Proteomics-Expression analysis & Characterization of proteins, Metabolomics & global biochemical networks.

**Unit 4.**

Single Nucleotide Polymorphisms - The nucleolar proteome, Mapping disease-associated SNPs : Alzheimer's disease.

**Unit 5.**

RNA isolation, cDNA, preparation, Hybridization, Real Time PCR, DNA microarrays, Proteomics; radiolabelling of protein; Isoelectric focusing, mass spectrophotometry.

**BIOT 14: BIODIVERSITY AND TAXONOMY****Unit 1.**

Basic concept of Biodiversity – What is Biodiversity, Why should we conserve it, Elements of Biodiversity - Ecosystem Diversity, Genetic Diversity, Species Abundance & Diversity, Patterns of Species Diversity.

**Unit 2.**

Global patterns of Biodiversity – measuring biodiversity, Cataloging and Discovering Species, Geographical Patterns of Species Richness, Biogeography, Importance of Distribution Patterns (Local Endemics, Sparsely Distributed Species, Migratory Species), GAP Analysis.

**Unit 3.**

Biodiversity & Conservation – Overexploitation threatening living species, International Trade, Animals threatened by International trade, Problems in Controlling International Trade (Enforcement, Reservations, Illegal Trade), Free Trade & the Environment, Free Trade & Conservation, Common patterns of Overexploitation.

**Unit 4.**

Exotic Species – Plants, Invertebrates, Fishes, Amphibians, Reptiles, Birds, Mammals, Detrimental Effects of Exotic Species.

**Unit 5.**

Endangered Species Conservation – The US Endangered Species Act, State Endangered Species Acts Successes and Failures of the Endangered Species Act Role of ESA in Habitat Protection, Critical Habitat, Problems with the Endangered \ Species Act, Habitat Conservation Plans

**BIOT 15: COMPUTATIONAL BIOLOGY AND BIOINFORMATICS.**

**Unit 1.**

BASIC Programming to determine statistical and kinetic constants.

**Unit 2.**

Practicing DNA and protein sequence analysis.

**Unit 3.**

Practicing molecular modeling using modeling packages viz: DTMM and homology modeling.

**Unit 4.**

Practicing database package viz: DBaseIII and graphical plotting package, Constructing the phylogenetic tree for the specific proteins and DNA.

**Unit 5.**

calculation of secondary structural components of proteins by using the specific software. (ex. Data from circular dichroism or Fourier transfer infrared)

**BIOT 16: PLANT BIOTECHNOLOGY**

**Unit 1.**

Plant Tissue Culture applications – micropropagation, from Callus to plant, somatic embryogenesis, somaclonal variation, valuable germplasm, chemicals from plants, genetically engineered plants.

**Unit 2.**

Applications of Plant Genetic Engineering – crop improvement, herbicide resistance, insect resistance, virus resistance, plants as bioreactors.

**Unit 3.**

Genetic modification in Agriculture – transgenic plants, genetically modified foods, application, future applications, ecological impact of transgenic plants.

**Unit 4.**

Genetically modified foods – organic foods, types of organic foods, identifying organic foods, organic food & preservatives.

**Unit 5.**

Genetic modification in Food industry – background, history, controversies over risks, application, future applications.

**BIOT 17: IMMUNOLOGY AND VACCINES**

**Unit 1.**

Major Histocompatibility complexes – class I & class II MHC antigens, antigen processing.

**Unit 2.**

Immunity to infection – immunity to different organisms, pathogen defense strategies, avoidance of recognition, inactivation of host-immune effector mechanisms.

**Unit 3.**

Immuno-techniques - Blood grouping, Antigen-Antibody reactions : agglutination, precipitation, immuno-electrophoresis, Coomb's test, ELISA, RIA.

**Unit 4.**

Vaccines & Vaccination – adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents, tumor vaccines, principles of vaccination, passive & active immunization, immunization programs & role of WHO in immunization programs.

**Unit 5.**

Auto-immune diseases – autoimmunity & auto-immune diseases, factors contributing development of auto-immune diseases, mechanism of development, breakdown of self-tolerance, rejection of transplants, molecular mimicry, diagnosis & treatment of auto-immune diseases, replacement therapy, suppression of autoimmune processes, nature of auto-antigens, immunodeficiency.

## **BIOT 18: FOREST AND AGRICULTURAL BIOTECHNOLOGY**

### **Unit 1.**

Methods for gene transfer in plants: In vitro establishment of mycorrhiza micropropagation of plants through tissue culture;

### **Unit 2.**

Application in agriculture :- production of diseases resistance plants .transfer of nif gene transgenic plants: virus resistant transgenic plants, insect resistant and herbicide resistant.

### **Unit 3.**

Major crop plants; challenges in agriculture; Impact of fertilizers and possible alternatives; Diazotrophic microorganisms in cropland; Losses due to biotic and abiotic stresses; Engineering for resistance against salinity, drought, herbicides, frost and pests;

### **Unit 4.**

Genetic basis of flowering and its possible applications; Delaying fruit ripening; Production therapeutic molecules in plants; edible vaccines; other value added plants;-golden rice, immunotherapeutic drugs –edible vaccines, Plant antibody, edible interferon.

### **Unit 5.**

Altered fiber strength; social forestry; Engineering for timber quality; Cultivating plants as alternative fuel resource; Conserving biodiversity and germplasm;

## **BIOT 19: BIOTECHNOLOGY AND SOCIETY(ETHICAL ISSUES/GM FOOD) BIO HAZARDOUS/BIOWEAPONS**

### **Unit 1.**

Molecular technologies – an overview of Genetic screening for any predisposition symptoms, Cancer screening, Cloning, Gene therapy, DNA fingerprinting,(Paternity and Forensics) in vitro fertilization, surrogate motherhood, PGD, transgenic organisms, xenotransplantation, GMOs.

### **Unit 2.**

Social issues - public opinions against the molecular technologies.

### **Unit 3.**

Legal issues – legal actions taken by countries for use of the molecular technologies.

### **Unit 4.**

Ethical issues – ethical issues against the molecular technologies. Necessity of Bioethics, different paradigms of Bioethics – National & International.

### **Unit 5.**

Intellectual Property Rights – Why IPR is necessary, TRIPS & IPR, IPR – national & international scenario, IPR protection of life forms.

## **BIOT 20: NANOTECHNOLOGY**

### **UNIT1.**

General Introduction: Basics of Quantum Mechanics, Harmonic oscillator, magnetic Phenomena, band structure in solids, Mossbauer and Spectroscopy, optical phenomena bonding in solids, Anisotropy.

### **UNIT 2.**

Nanomedicine : Developing of Nanomedicine Nanosystems in use, Protocols for nanodrug Administration, Nanotechnology in Diagnostics applications, materials for used in Diagnostics and Therapeutic applications, Molecular Nanomechanics, Molecular devices, Nanotribology, studying tribology at nanoscale, Nanotribology applications

### **UNIT3.**

Mechanical properties: Strength of nano crystalline SiC, Preparation for strength measurements, Mechanical properties, Magnetic properties.

### **UNIT4**

Electrical properties: Switching glasses with nanoparticles, Electronic conduction with nano particles. Optical properties: Optical properties, special properties and the colored glasses. Process of synthesis of nano powders, Electro deposition, important nano materials

### **UNIT5**

Nanobiology : Interaction between biomolecules and nanoparticle surface, Different types of inorganic materials used for the synthesis of hybrid nano-bio assemblies, Application of nano in biology, nanoprobe for Analytical Applications-A new Methodology in medical diagnostics and Biotechnology, Current status of nano Biotechnology, Future perspectives of Nanobiology, Nanosensors.