5 Year Integrated M.Sc. Biotechnology
Syllabus

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Semester-V

Paper	Subject	Theory Hours
5-T1	Cell Biology	4
5-T2	Microbiology	4
5-T3	Genetics	4
5-T4	Biodiversity & Biostatistics	4
5-P1	T1+T2	6
5-P2	T3+T4	6

Semester-VI

Paper	Subject	TheoryHours
6-T1	Biophysical methods	4
6-T2	Biochemistry	4
6-T3	Immunology	4
6-T4	Mol.Biology	4
6-P1	T1+T2	6
6-P2	T3+T4	6

Semester-VII

Paper	Subject	Theory Hours
7-T1	Genetic Engineering	4
7-T2	Plant Biotechnology	4
7-T3	Animal Cell Culture	4
7-T4	Enzymology & Plant Biochemistry	4
7-P1	T1+T2	6
7-P2	T3+T4	6

Semester-VIII

Paper	Subject	Theory Hours
8-T1	Medical Biotechnology	4
8-T2	Microbial Biotechnology	4
8-T3	Environmental Biotechnology	4
8-T4	Agricultural Biotechnology & Bioethical Issues	4
8-P1	T1+T2	6
8-P2	T3+T4	6

Semester-IX

Paper	Subject	Theory Hours
9-T1	Bioprocess Engineering & Technology	4
9-T2	Advanced Biotechnology	4
9-T3	Bioinformatics	4
9-T4	Basics of Nanotechnology	4
9-P1	T1+T2	6
9-P2	T3+T4	6

Semester-X

Paper	Subject	
	PROJECT WORK*	

***.Industrial Project:** The student will undergo training in any Biotechnology Industry/Institute for one semester after completion of IX semester. The report will be submitted at the end of the X semester. The project report will be evaluated by the External and Internal (Chairperson, BOS, Biotechnology) examiners. A seminar will be conducted on the project by the same examiners.

5 Year Integrated M.Sc. Biotechnology-
Course/Paper Outcomes

Academic year	Name of the Course/ Paper Title	Course/Paper Code	Name of the Programme	Activities with direct bearing on employment, Entrepreneurship/skill development
2021-2022	**Cell Biology**	**5-T1**	**5 Yr Integrated M.Sc.Biotechnology**	To gain the knowledge of living cells such as prokaryotic and eukaryotic cells. To understand the molecular aspects of of Cell Signaling, Protein sorting Cell Cycle and Cell Division Cell Death Pathways. To understand the basics of cancer biology.
2021-2022	**Microbiology**	**5-T2**	**5 Yr Integrated M.Sc.Biotechnology**	This course will help students to acquire skills and competency in microbiological laboratory practices applicable to microbiological research or clinical methods, including accurately reporting observations and analysis, applications of Microorganisms in various fields.
2021-2022	**Genetics**	**5-T3**	**5 Yr Integrated M.Sc.Biotechnology**	To understand basic principles and exceptions of Mendelian inheritance. To learn the concepts of Linkage, crossing over and recombination. To gain knowledge about the organelle inheritance. To make students understand the role of the X and Y chromosomes in determining sex and how they are inherited. To impart knowledge about DNA damage and Repair mechanism
2021-2022	**Biodiversity & Biostatistics**	**5-T4**	**5 Yr Integrated M.Sc.Biotechnology**	To study various aspects of biodiversity. To understand global biodiversity (plant and animal) and the concept of Bioprospecting, biosafety, biopiracy and biodiversity conservation This course will help students' tools of biostatics in interpretation of biological data. Students will be able to characterize data and understand different sampling methods. To understand the concept of mean, mode, median, range, mean deviation, standard deviation, standard error, correlation & regression, chi square test, t-test.
2021-2022	**Biophysical methods**	6-T1	**5 Yr Integrated M.Sc.Biotechnology**	To understand the safety measures in laboratory, handling and care of instruments and demonstrate a broad understanding of life science technologies. To demonstrate ability to plan and execute experiments, and analyze and interpret outcomes. Demonstrate understanding of selected Basic Principles & Concepts about biological techniques like microscopy, centrifugation, electrophoresis, chromatography and basics of radioactivity.
2021-2022	**Biochemistry**	6-T2	**5 Yr Integrated M.Sc.Biot**	Students will be imparted knowledge about structure and function of different biomolecules (proteins, lipids, nucleic acids, and carbohydrates). Understanding of carbohydrate, protein, lipid, purine and pyrimidine

			echnology	biosynthesis and metabolism.
2021-2022	**Immunology and Immunotechnology**	6-T3	**5 Yr Integrated M.Sc.Biotechnology**	To introduce the basic concepts of cells and organs of the immune system and immunity. To study the structure and function of antigen and antibodies. Study of rearrangement of Ig genes. To learn about Major Histocompatibility Complex, antigen processing and presentation, complement system and cytokines. To provide knowledge about Humoral and Cell Mediated Immune Response: B- cell and T – cell receptor complex. Cell mediated cytotoxicity: T cytotoxic cells, Natural Killer (NK) Cells, Antibody dependent cell cytotoxicity (ADCC). To give an overview of hypersensitivity and autoimmunity. Transplantation: Graft vs. host reaction and rejection; Immunization and Vaccines. To provide knowledge of antigen-anibody interaction and Immunodiagnostic techniques: RIA and ELISA.
2021-2022	**Molecular Biology**	6-T4	**5 Yr Integrated M.Sc.Biotechnology**	To understand the concepts of Molecular Biology. To study the chemical & physical properties of nucleic acids. Learn experimental evidences for nucleic acid as carrier of genetic information. To understand DNA replication, transcription, translation in Prokaryotes and Eukaryotes. To study the basic features of genetic code. To understand the regulation of gene expression in Prokaryotes and Eukaryotes.
2021-2022	**Genetic engineering**	**7-T1**	**5 Yr Integrated M.Sc.Biotechnology**	Learning outcomes of this course are technical know-how on versatile techniques in recombinant DNA technology, application of genetic engineering techniques in basic and applied experimental biology and proficiency in designing and conducting experiments involving genetic manipulation. Development of an ability to design and conduct genetic engineering experiments, as well as to analyze and interpret data and construction of DNA and cDNA libraries. Development of research aptitude and technical skills to secure a job in genetic engineering labs. Understand genome complexity, genome organization and genome analysis. Learn Whole genome Sequencing, accessing whole genome sequence databases. Learn the procedures involved in PCR and southern hybridization, etc.
2021-2022	**Plant Biotechnology**	**7-T2**	**5 Yr Integrated M.Sc.Biotechnology**	Develop skills for application of plant tissue culture techniques. To get the knowledge about the genetic transformation and production of transgenic plants.
2021-2022	**Animal cell culture**	**7-T3**	**5 Yr Integrated M.Sc.Biotechnology**	To know the basics of animal cell culture and apply the knowledge in the relevant field of interest. Pursuing research related to animal cell and tissue culture at national and international level. To contribute in industries related to animal cell culture as scientists
2021-	**Enzymology**	**7-T4**	**5 Yr**	To understand the Mechanisms of enzyme action and

2022	**and Plant Biochemistry**		**Integrated M.Sc.Biotechnology**	Enzymes kinetics.. To study the Regulation of enzyme activity mechanism of some important enzymes. To know the Photosynthetic pigments and photosynthesis in bacteria and higher plants. To study the CO_2 fixation by C3, C4, and CAM pathways and photorespiration. Students will also be imparted knowledge about nitrogen fixation and *nif* and *nod* genes.
2021-2022	**Medical Biotechnology**	**8-T1**	**5 Yr Integrated M.Sc.Biotechnology**	Development of solid foundation and requisite research aptitude for further higher studies on regenerative medicines. Become competent to secure a job in biopharmaceutical and biomedical industry. Students will be able to understand the classification of genetic diseases, disease diagnosis and drug delivery & designs This course will help the students to acquire skills and competency in Prenatal diagnosis, gene therapy and Animal Cloning
2021-2022	**Microbial Biotechnology**	**8-T2**	**5 Yr Integrated M.Sc.Biotechnology**	The course will provide technical knowledge applications of industrial microorganisms. The course will also provide the technical knowledge of several industrial products such as amino acids, organic acids, industrial enzymes and beverages. To gain the knowledge about the role of microbes in food industry.
2021-2022	**Environmental Biotechnology**	**8-T3**	**5 Yr Integrated M.Sc.Biotechnology**	Explain the importance of microbial diversity and of molecular approaches in environmental microbiology. Describe existing and emerging technologies that are important in the area of environmental biotechnology; Describe biotechnological solutions to address environmental issues including pollution, mineral resource winning, renewable energy and water recycling. Learning outcome of Environment Biotechnology is to gain the knowledge of biodiversity, bioremediation, pollution.
2021-2022	**Agricultural Biotechnology**	**8-T4**	**5 Yr Integrated M.Sc.Biotechnology**	Engineering plants for biotic stress like insect and fungal diseases. Engineering plants for abiotic stress like drought and herbicide tolerance. Engineering plants for shelf life and nutritional quality. Gaining knowledge on biosafety, risk assessment and regulation of transgenic plants in India Understand the historical background, importance and levels of Biosafety at laboratory and industrial scale. Understanding of the relationship between society and science and the justification for biotechnological manipulation of plants, animals, and microorganisms.
2021-2022	**Bioprocess Technology**	**9-T1**	**5 Yr Integrated M.Sc.Biotechnology**	Plan a research career or to work in the biotechnology industry with strong foundation about bioreactor design and scale-up. Students will be able to explain the steps involved in the production of bioproducts and methods to improve modern biotechnology and can apply basic biotechnological principles, methods and models to solve biotechnological tasks. Graduates gain ability to investigate, design and conduct

				experiments, analyze and interpret data, and apply the laboratory skills to solve complex bioprocess engineering problems. Able to separate the molecules through chromatography and understand the complexity in scale up of unit operations. Able to choose the downstream steps within the constraints of biosafety and process economics
2021-2022	**Advanced Biotechnology**	**9-T2**	**5 Yr Integrated M.Sc.Biotechnology**	Students will be able to understand the mechanism of Site specific recombination and Advances in transgenic strategies for gene inhibition. The course will provide technical knowledge and applications of ribozyme technology, gene silencing and RNAi technology, genome editing using CRISPR Cas Students will the knowledge about host parasite interaction and genome mapping such as Fluorescent in situ hybridization (FISH) and Sequence tagged site (STS) mapping,
2021-2022	**Bioinformatics**	**9-T3**	**5 Yr Integrated M.Sc.Biotechnology**	Students will be able to analyze, interpret and study biological data (sequence, structure, etc) stored in various databases available on internet. Using existing software effectively to extract information from large databases and to use this information in computer modeling.
2021-2022	**Nanotechnology**	**9-T4**	**M.Sc.Biotechnology**	To know the preparation and characterization of appropriate nano materials with precision conceptualize the insertion of nano size in the relevant field of interest
2021-2022	**Industrial Project**	**Xth Sem**	**5 Yr Integrated M.Sc.Biotechnology**	In this course, the student will undergo training in any biotechnology industry/institute for 5-6 months during X semester. This will not only enhance knowledge base of students but also provide them exposure as to how to conduct and carry out a research based task. Students will also learn how to compile and interpret results.

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SEMESTER-V

5-T1 : CELL BIOLOGY

UNIT I:

1. Ultra structure of prokaryotic cell.
2. Ultra structure of Eukaryotic cell (cell wall, cell membrane, mitochondria, chloroplast, endoplasmic reticulum, golgi apparatus, vacuoles).
3. Chloroplast and Mitochondrial genome.
4. Ultra structure of Nucleus (Nucleolus, Nucleoplasm, Chromatin) and nuclear envelope.

UNIT II:

1. Chromosome organization in Prokaryotes.
2. Chromosome organization in Eukaryotes (Euchromatin, Heterochromatin, Chromosome condensation and Models).
3. Structure of special types of chromosomes (Polytene and Lamp Brush).
4. Cell division – Mitosis and Meiosis and significance.

UNIT III:

1. Cell cycle - (G_1, S, G_2 and M phases, Regulators of cell cycle Progression – MPF, Cyclins, CDKs, Cell cycle check points).
2. Cytoskeleton - Structure and functions of actin, microfilaments and intermediary filaments.
3. Cell communication - General principles, Cell surface receptors (ion channel linked, G- protein linked and enzyme linked receptors) and intracellular receptors.
4. Cell differentiation- apoptosis and necrosis.

UNIT IV:

1. Brief account of biology of cancer (different types, metastasis, tumor suppressor genes, oncogenes).
2. Intracellular signaling proteins: Different types and their role, cAMP and role of calcium.
3. Cell-Cell junctions – Desmosomes, gap junctions, electrical coupling.

4. Cell signaling in Plants-Plant growth regulators – ethylene, ABA, GA_3.

5-T2 : MICROBIOLOGY

Unit- I

1. History and discovery of microorganisms, Relevance of Microbiology, Branches of microbiology
2. Microbial taxonomy, nomenclature rules, taxonomic ranks, major characters used in identification.
3. Details of Ultrastructure of prokaryotic cell, Differences between the prokaryotic and eukaryotic cells

Unit-II

1. General characters, thallus organization, cell structure, reproduction and classification of fungi. Structure, reproduction and biotechnological aspects of yeasts.
2. General characters, classification and economic importance of mycoplasma , Mycobacteria, Actionomycetes and Archea
3. Discovery of viruses, chemical composition, morphology of viruses, Nucleic acid diversity in viruses, viroids

Unit-III

1. 1.Types of culture media, isolation, purification and preservation of microorganisms
2. Microbial growth kinetics, growth measurements, factors affecting growth.
3. Nutritional diversity of microorganisms, nutritional types: autotrophy, heterotrophy, chemotrophy, phototrophy, lithotrophy and organotrophy.

Unit-IV

1. Microorganisms of soil, water and air, and their significance
2. Role of microorganisms in biogeochemicals, carbon, nitrogen and phosphorus cycles
3. Applications of microorganisms in agriculture, environment, industry and medicine.

5-T3 : GENETICS

UNIT – I

1. Mendel's principles (Monohybrid ratios - Dominance and Recessive factors, Law of Segregation, Dihybrid and Tri-hybrid ratios – Law of independent assortment - Test cross and Back cross)
2. Deviation from Mendel's Laws - Incomplete Dominance (Flower color)
3. Lethality, Gene Interaction and Modified Ratios (Interactions involving two, more than two gene pairs).
4. Multiple Allelism – Multiple factors inheritance (Coat color in rabbits, eye color in Drosophila, ABO blood groups in humans, Rh blood groups, Incompatibility in Nicotiana) and Pleotropic genes.

UNIT –II

1. Extra chromosomal Inheritance
2. Linkage and Crossing over and genetic mapping, Crossing over frequency and map distances.
3. Cytological evidence of crossing over in Maize, Recombination models in Maize and Yeast.
4. Sex-linked Inheritance: Hemophilia, color blindness, holandric genes, Genetics of Sex determination.

UNIT –III

1. Population genetics: Hardy Weinberg Law, factors influencing the equilibrium.
2. Mutations : Types of mutations, Spontaneous & induced mutations
3. Molecular basis of mutations: Transitions, Transversions & Frame shift mutations, Ames test for mutagenesis, DNA damage and repair.
4. Structural and numerical variations in chromosomes. Role of mutations in crop improvement.

UNIT –IV

1. Bacterial genetics : Recombination in microorganisms: Molecular mechanism of transformation, Conjugation , Transduction and Tetrad analysis
2. Phages Genetics: Gene fine structure (R – II locus), Benzer models of gene structure (Cistron, Recon and Muton).
3. Gene concept: Classical and modern concepts.
4. Accessory Genetic Elements: Plasmids, Transposons and Retro elements.

5-T4 : BIODIVERSITY AND BIOSTATISTICS

Unit-I

1.Biodiversity:Definition,levels,organization,uses and valuing biodiversity.

2.Genetic Diversity: Nature and origin of genetic variation, measuring genetic diversity variation. Wild relatives of cultivated/domesticated/cultured organisms(plants/animals/microbes).

3.Species Diversity: Concept of species, measurement of species diversity, global distribution of species riches.

4.Ecosystem Diversity: Terrestrial and aquatic ecosystems. Centers of mega diversity and hot spots.

Unit-II

1.Biodiversity vs Biotechnology and Bioprospecting, biosafety, biopiracy and Intellectual Property Rights (IPR).

2.Biodiversity for Sustainable Development: Sustainable management of biodiversity: International and regional policies. Biodiversity Act, National Biodiversity Board and Andhra Pradesh State Biodiversity Board.

3.IUCN categories: Rare and endangered categories and extinct animals of India. Trends of extinction rates. Wildlife Act of India and CITES.

4.Biodiversity Conservation: Principles and rationale. Ex situ and Insitu conservation strategies(Incl.sperm/seed banks,cryopreservation,embryo collection and freezing creation of parks, wildlife sanctuaries, botanical gardens, etc.,)

Unit-III

1.Introduction to Biostatistics, Applications of Biostatistics.
2.Variables,Random Variables, discrete and Continuous variables. Population sample and random sample
3.Mean, Mode,Quartiles,Geometric and Harmonic means. Frequency, Frequency distribution.
4. Frequency curve, frequency polygon and histogram.

Unit-IV

1.Measures of dispersion: Range, Variance, coefficient of variance, SD,SE
2.Probability distribution: Normal, binomial and poison.
3.Tests of hypothesis: Students t –test,x2(chi-square)-distribution
4.Correlation coefficient and analysis of variance ANOVA.

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SEMESTER-VI

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6-T1 : Biophysical Methods

Unit I

1. Microscopy: Principles and application of light, phase contrast, fluorescence, scanning and transmission electron microscopy
2. Cytophotometry and flow cytometry, fixation and staining.
3. Centrifugation: Basic principles of sedimentation, types of centrifuges and rotors. Preparative ultracentrifugation-differential centrifugation, Density-gradient, analytical ultracentrifugation and applications.

Unit II

1. Separation methods - General principles and definitions, Paper chromatography, adsorption chromatography (thin-layer chromatography), gas-liquid chromatography,
2. Methods based on affinity: Principle of Affinity chromatography; methodology and applications. Ion-exchange chromatography: Principle & methodology
3. High-performance liquid chromatography: Principle, instrumentation, practical procedure and applications.

Unit III

1. Electrophoresis: General principles and definitions. PAGE-Native-PAGE, SDS-PAGE,
2. Iso-electricfocussing, 2D electrophoresis, Capillary electrophoresis.
3. Agarose gel electrophoresis : Preparation, separation and determination of molecular size of DNA, denaturing agarose gel electrophoresis and their applications, recovery of DNA from agarose gels.
4. Pulse-field gel electrophoresis : principle, methodology and applications in separation of large DNA fragments.

Unit IV

1. Spectroscopy: Electromagnetic spectrum of light, simple theory of absorption of light molecules, Beer-Lambert law, absorbance, transmittance, extinction, coefficient, light sources, monochromatic, type of detection, UV, visible spectrophotometer, infra red spectroscopy.
2. Raman spectroscopy, flame photometer, atomic absorption, plasma emission, mass ESR and NMR spectrometry, MALDI – TOF, ESI MS.

3. Preparation of label compounds: Pulse chase studies and tracer techniques, isotopes used in biology, safety methods in handling radioisotopes.

6-T2: Biochemistry

Unit I

1. Buffer and measurement of pH.
2. Hydrodynamic properties of biomolecules: viscosity, diffusion, osmosis, partial specific volume and Donnan's effect.
3. Carbohydrates – Classification and properties of carbohydrates, mono (glucose, galactose, fructose), di (lactose, maltose, sucrose) and poly (starch, glycogen, cellulose) sacharides.
4. Lipids – Classification. Structure and biological functions of fatty acids, triacylglycerols, steroids. Physico-chemical properties and analysis of fats and oils. Structure and functions of postaglandins, leukotrienes, thromoboxanes.

Unit II

1. Amino acids – classification, Structure and physico-chemical properties, Peptides – Peptide bonds.
2. Naturally occurring peptides (glutathione, bradykinin, kallikrien, tyrocidin). Peptide synthesis by solid-phase technique.
3. Proteins – Classification, Isolation and purification of protein, criteria of homogeneity.
4. Primary structure of proteins and its sequence determination.

Unit III

1. Secondary (Ramachandran plot), tertiary and quaternary structural features of proteins, Protein folding (Alfensen's experiment on ribonuclease).
2. Forces responsible for protein stability. Structural organization: globular (myoglobin, Hemoglobin), fibrous proteins (collagen, Keratins, silk fibroin).
3. Denaturation and renaturation of proteins, chaotropic agents.
4. Structure and functions of glycoproteins and lipoproteins.

Unit IV

1. Nucleic Acids – Structure of purines, pyrimidine, nucleosides, and nucleotides.
2. Structure, Properties and functions of nucleic acids (DNA, RNA). Different forms of DNA and RNA. Three dimensional structure of RNA.
3. Isolation of nucleic acids, Denaturation and renaturation of nucleic acids,
4. Chemical synthesis of DNA. The law of DNA constancy.

6-T3: Immunology & Immunotechnology

Unit I

1. Phylogeny of immune system. Types of immunity – innate and acquired.
2. Cells of the immune system – B-cells, T-cells, phagocytes, inflammatory cells, antigen presenting cells.
3. Organs – primary, secondary and tertiary lymphoid organs. Antigens – nature, types, factors influencing antigenicity, haptens, adjuvants and super antigens.
4. Antibodies – structure, types, classes and functions. Antibody diversity – theories of antibody diversity, mechanism of diversification, allelic exclusion.

Unit II

1. T-cell receptor – structure and diversity.
2. MHC – Types, structure, distribution, self-restriction, T-and B-cell activation. Maturation of lymphocytes – positive and negative selection, process of maturation.
3. Antigen processing and presentation – cytosolic and endosomal pathways, T and NK cell – mediated lysis of cells, ADCC.
4. Complement system – components, cascades, MAC, outcomes. Cytokines – classification, properties and role as immunomodulators.

Unit III

1. Hypersensitivity – classification, mediators, mechanism, consequences of hypersensitive reaction.
2. Autoimmunity - concept of tolerance of autoimmune disorders, basis and therapy for autoimmune disorders.
3. Transplantation – transplantation antigens, mechanism of graft rejection, graft versus host reaction, immunosupressors. Tumor immunity – tumors of immune system, immune responses against tumors.
4. Immunodeficiency – primary and secondary immunodeficiency, combined immunodeficiency, complement deficiency, AIDS.

Unit IV

1. Antigen- antibody interactions – principle, lattice hypothesis.Precipitation reaction – radial immunodiffusion, Ouchyterlony technique, immunoelectrophoresis, counter current and rocket electrophoresis.
2. Agglutination reactions – bacterial and hemeagglutination, passive agglutination, agglutination inhibitions assay. RIA and ELISA – principle, methodology and application. Immunofluorescence, FAACS, immunoblotting.
3. Hybridoma technology – polyclonals, monoclonals, selection, HAT medium, production of monoclonal antibodies and applications.
4. Vaccines – concept of immunization, routes of vaccination. Types of vaccines – whole organism (attenuated and inactivated) and component vaccines (synthetic peptides, DNA vaccines, recombinant vaccines, subunit vaccines, idiotypic based vaccines, deletion vaccines, glycoconjugate vaccines), Vaccine delivery systems.

6-T4 : Molecular Biology

Unit I

1. DNA Replication and repair: Modes of replication. Experimental evidences for semi-conservative mode of replication - Meselson–Stahl, and Cairns experiments.
2. Replication fork, continuous and discontinuous DNA synthesis.
3. Enzymes and proteins in replication - Single strand DNA binding proteins (SSB), Helicases, Topoisomerases, DNA ligases. Priming by RNA polymerase and primase. DNApolymerases - E.coli DNA polymerase I, II and III, and Eukaryotic DNA polymerases. Inhibitors of DNA replication
4. Reverse transcription.

Unit II

1. Promoters and their characterization. Enhancer sequences.
2. Transcription (RNA Biosynthesis): Initiation, elongation and termination of RNA synthesis. Monocistronic and polycistronic RNAs. Polynucleotide phosphorylase. RNA polymerases - structure of E. coli RNA polymerase, and nature of eukaryotic RNA polymerases.
3. RNA splicing and splicing mechanisms. Splicing of nuclear pre-tRNA, group I and group II introns, and pre-mRNA splicing. Excision of multiple introns.
4. Posttranscriptional modifications of eukaryotic hnRNA – capping, methylation and polyadenylation.

Unit III

1. Translation (Protein synthesis): Elucidation of the genetic code - experimental studies of Nirenburg and Khorona.
2. General features of genetic code, codon degeneracy and universality. Mitochondrial genetic code, tRNA role in protein synthesis. Amino acyl-tRNA synthetases, wobble hypothesis.

3. Mechanism of initiation, elongation and termination of protein synthesis. Translational factors. Post-translational modifications.

Unit IV

1. Regulation of gene expression: House-keeping genes, constitutive genes, and regulatory genes. Induction and repression. Regulatory proteins- DNA-binding motif of regulatory proteins. Role of zinc fingers, leucine zippers, helix-turn-helix.
2. Regulation of gene expression in prokaryotic operons. Negative regulation and positive regulation. Fine structure of lac operon. Repressor and the catabolite activator proteins in gene regulation of lac operon. Dual functions of the repressor in ara operon.
3. Transcriptional control by attenuation in trp-operon. Regulation of gene expression in eukaryotes.
4. Hormones and environmental factors affecting gene expression. Homeotic genes and their regulation.

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SEMESTER-VII

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7-T1 : Genetic Engineering

Unit-I:

1. Restriction endonucleases and their importance in gene cloning.
2. Cloning vectors: Plasmids, Phagemids, Cosmids, Viral vectors, shuttle vectors and Binary Vectors.
3. Recombinant DNA preparation and analysis

Unit-II:

1. Enzymes used in recombinant-DNA technology: DNA polymerases, ligases and DNA modifying enzymes (methylases, alkaline-phosphatases, topoisomerases).
2. Introduction of recombinant DNA molecules into appropriate hosts- Competent cells preparation.
3. Blotting techniques: Southern, Western and Northern blotting techniques.

Unit-III:

1. Construction of Genomic libraries
2. Mechanism of C-DNA synthesis, c-DNA libraries and *in vitro* packaging.
3. Molecular markers: RFLP, RAPD, AFLP, SSR and their applications

Unit-IV:

1. PCR Technology: Thermostable DNA polymerases, PCR amplification of specific DNA sequences, Designing and synthesis of oligonucleotide primers, current innovations and cloning PCR products,
2. Mutagenesis by PCR and applications of PCR technology in Biology and medicine.
3. DNA finger printing technology and its application in forensic medicine

7-T2 : Plant Biotechnology

Unit-I:

1. Introduction to cell, tissue and organ culture and different types of Tissue culture media and composition.
2. Cytodifferentiation *in vitro*.
3. Role of nutrients and growth regulators in plant growth and differentiation
4. Cell suspension cultures, Production of Secondary metabolites and biotransformation.

Unit-II:

1. Micropropagation including production of virus-free plants and clonal propagation.
2. Somatic Embryogenesis and Synseed technology, embryo rescue of wide hybrids
3. Somaclonal variations and role in crop improvement
4. Androgenic haploidy (Pollen & Anther Culture) and its importance in crop improvement.

Unit.III

1. Protoplast studies: Isolation, culture, fusion and selection of hybrid cells, somatic hybrids and cybrids and applications
2. Cell line selection: Induction and selection of mutants-drought and disease resistant.
3. Cryopreservation and conservation of Germplasm.

Unit.IV:

1. Genetic transformation Methods: Vector *(Agrobacterium)* mediated genetic transformation
2. Physical Methods: electroporation, microinjection and particle bombardment and selection of transformants and regeneration of transgenic plants.
3. Selectable markers and reporter genes in genetic transformation-types and their role

7-T3 : Animal Cell Culture

UNIT-I

1. Introduction to animal cell culture and Equipment, Culture vessels for animal cell culture
2. Cell culture media: basal salt solution, natural media, artificial media, Serum free media (advantages and disadvantages)
3. Physicochemical properties of culture media
4. Preparation and sterilization methods: reagents and media

UNIT-II

1. Types of animal cell cultures and their culture procedures in preparation: primary and secondary (Cell line)
2. Types of disaggregation: tissues, cells and cell counting
3. Subculture and Maintenance of animal cell cultures, properties of cell lines
4. Biology and characterization of cultured cells.

UNIT-III

1 Measurement of growth parameters of cultured cells (growth

2 cycle of cultured cells, plating efficiency of cultured cells)

3 Measurement of cell death: cytotoxicity and cell viability assays

4 Cell synchronization, senescence and apoptosis

5 Cell transformation and cell cloning

UNIT-IV

1. Vaccine, hormone production, *in vitro* culture of tissues and organs
2. Stem cell technology: embryonic stem cells, maintenance of stem cells in culture, characterization of stem cells
3. Cryopreservation: principles of cryopreservation, cell bank
4. Applications of animal cell culture

7-T4 : Enzymology & Plant Biochemistry

Unit I

1. Enzymes: Definitions and nomenclature (EC recommended).
2. Enzymes kinetics, derivation of michaelis-menten constant, determination of V-max and Km, enzyme inhibition: competitive and non-competitive inhibition.
3. Regulation of enzyme activity: allosteric enzymes, models explaining allosteric behavior, feed back inhibition in metabolism.
4. Mechanisms of enzyme action, active site and its location, binding site, chymotrypsin, ribonuclease, carboxyl peptidase as models.

Unit II

1. Energy metabolism, Thermodynamic principles in biology, Energy rich bonds
2. Coupled reactions and oxidative phosphorylations, biological energy transducers. Glycolysis and TCA cycle, HMP shunt,
3. Gluconeogenesis, aerobic and anaerobic respirations. Components and organization of mitochondrial electron transport system.

Unit III

1. Chloroplast as an energy transducing organelle.
2. Photosynthetic pigments and photosynthesis in higher plants. Organization of photosystem-I & II Cyclic and non-cyclic photophosphorylation, Mechanism of photophosphorylation.ATP synthase
3. Pathways of CO_2 fixation by C3, C4, and CAM pathways.
4. General account on Photorespiration Photosythetic efficiency.

Unit IV

1. Nitrogen fixation: Diazotrophic microorganisms, nitrogen fixation genes. Organization, regulation and expression and transfer of *nif* genes
2. *Nod* genes, structure function and role in nodulation
3. Photobiology: Photoreceptors, Phytochrome, Cryptochrome, Their role in developmental process and regulation of gene expression

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SEMESTER-VIII

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8-T1: MEDICAL BIOTECHNOLOGY

Unit-I:

1. Scope and importance of Medical Biotechnology
2. Classification of genetic diseases: Chromosomal disorders- Numerical disorders e.g.-trisomics, monosomics, Structural disorders e.g.- deletions, duplications, translocations and inversions, Chromosomal instability syndromes, Gene controlled diseases-autosomal and X-linked disorders, Mitochondrial disorders.
3. *In vitro* fertilization in humans- types and causes of male and female infertility, sperm collection and cryopreservation, artificial insemination, super ovulation and Oocyte recovery, embryo culture and transfer.
4. Introduction to newer vaccine approaches namely-subunit vaccines, synthetic vaccines, DNA vaccines, recombinant vaccines, Hepatitis-B vaccines, edible vaccines, nanoparticles in vaccine delivery system. Current strategies for development of vaccines against HIV

Unit-II:

1. Cell and tissue engineering: Potential use of stem cells- Cell based therapies; Nanomedicine.
2. Cancer genetics: Evolution of cancer, oncogenes, Tumor suppressor genes, Stability of genome, Control of cell cycle.
3. Disease diagnosis: DNA Probes, Enzyme probes- glucose oxidase, lactate oxidase, monoamine oxidase; PCR amplification and diagnosis- Applications in forensic medicine, Haemoglobinopathies
4. Pharmacokinetics: drug delivery & designs

UNIT III:

1. Prenatal diagnosis and genetic counseling of inherited human diseases
2. human gene therapy (*ex vivo, in vivo* methods) & applications, genetic counseling
3. Methods of gene therapy: Vector engineering, gene correlation, gene editing, gene silencing, gene targeting, prospects of germ line therapy.
4. Mass production of bioactive substances: interferon, interleukins and lymphokines.

UNIT IV:

1. Animal Cloning: ethical social implications.
2. Transgenic animals (mice, cattle, sheep), animals as bioreactors in molecular farming and Gene knockout technology
3. Human genome sequences- mapping and cloning of human- disease genes.
4. Health care products, Products from recombinant DNA technology- Insulin, HGH, Factor VIII, Tissue plasminogen activator.

8-T2. MICROBIAL BIOTECHNOLOGY

UNIT-I: Microorganisms Applications

1. Isolation, primary and secondary screening of and strain improvement of industrially –important microbes.
2. Maintenance and preservation of industrial microorganisms
3. Immobilization technology for cells and enzymes and its applications
4. Commercial blends of microorganisms and enzymes

UNIT-II Bioprocess Technology

1. Design of a typical microbial fermenter :body construction, aseptic operation, containment
2. Formulation of industrial media: Medium requirements for fermentation process, medium optimization
3. Sterilization of media and fermenters ; scale -up process and starter culture technology
4. Types of fermentations: batch, continuous, fed batch, solid state, submerged fermentation process.

UNIT-III Industrial Microbiology: Industrial production of -

5. Amino acids – Glutamic acid
6. Organic acid- Lactic acid
7. Antibiotics- Streptomycin and Penicillin
8. Oranic solvents-Ethanol and Citric acid
9. Enzymes-Amylases, proteases and lipases
10. Bevarages-Beer and Wine
11. Vitamins- B12

UNIT-IV Microbes in Food industry

1. Industrial production and preservation of foods: Dairy products – cheeses, yogurt , acidophilous milk, and oriental foods:saurekrant,Idly
2. yeast and yeast products: brewer's yeast baker's yeast, food and fodder yeast, bread making
3. Production of single-cell proteins (bacterial, yeast, fungal and algal):Advantages and disadvantages
4. Edible mushrooms and their cultivation: Oyester, Button and Paddy straw mushrooms

8-T3. ENVIRONMENTAL BIOTECHNOLOGY

Unit I:

1. An Introduction to Environmental Biotechnology, Solid waste management – Waste generation, handling, storage, processing, transport, bailing,; composting- incineration, pyrolysis, land farming – waste disposal by sanitary land filling (aerobic and anaerobic degradation), waste minimization , recycling and product re-use.
2. Biodegradation of Pesticides - Microbes known for pesticide degradation, microbial metabolism of pesticides, molecular mechanism of pesticide degradation, molecular breeding, degradative plasmids, microbes and cloning strategies.
3. Microbial leaching and biomining – Types and methods of bioleaching, Chemistry and microbiology of bioleaching, *in situ* and *ex situ* leaching process of copper and uranium, plasmidas and genes in biomining.
4. Sewage treatment through microorganisms- Composition of sewage, aerobic treatment of sewage (biological filters, aeration tanks, biological ponds, irrigation fields), anaerobic treatment of sewage (septic tank, imhoff's tank, Upflow anaerobic sludge blanket-UASB, Anaerobic attachment film expanded bed - AAFEB).

Unit II:

1. Biodelignification- Major groups of lignin, pathways of lignin biosynthesis, lignin degrading enzymes, chemistry of lignin degradation, kappa number, biopulping and biobleaching in wood based industries, environmental advantages.
2. Bioetahnol - Fermentative bioconversion of lignocelluloses to ethanol. Biosynthesis of ethanol – milling, liquefaction, saccharification, fermentation, distillation, dehydration and blending, co-products, Social and scientific perspective of bioethanol, bioethanol vs.food crisis. biogas - hydrogen to reverse the global warming.
3. Biodesulphurization of coal/petrolem/diesel – Bioprocessing of coal, Mechanism of inorganic sulphur removal, Organic sulphur removal by Kodama pathway and 4 S pathways, Asian Brown Clouds – Acid Rains.
4. Biofertilizers and biopesticides and Integrated Pest Management – Bacterial, algal, fungal bioferilizers, earthworms as bioferilizers; Biopesticides – Bacterial, fungal, plant, biochemical pesticides, Integrated pest management and sustainable agriculture.

Unit III:

1. Biosorption of heavy metals – metal binding targets and organisms, metal-microbial interactions, biomethylation of elements, commercial biosorbents, metal precipitation,phytoremediation

2. Bio-medical waste management – waste category, waste class and description,treatment and disposal systems,cost of biomedical waste management,
3. GEMs and their products- construction and release of GEMs and their impact on the environment, concept of biosafety – biosafety levels, biocontaminants, good microbiological practices, biosafety guidelines, biohazards, biological weapons, biosecurity programs, bioethical issues, general approval procedures.
4. Carbon sequestration for reduction of green house effect – Vision and aim of carbon sequestration, methods and steps in carbon sequestration, managemental strategies for carbon sequestration, microbial technology for carbon sequestration, economics of carbon sequestration.

Unit IV:

1. Pollution control biotechnology- Commercial blends of microorganisms and enzymes, immobilized cells and enzymes, biotechnological approaches for recovery of useful products from sewage and industrial effluents
2. Microbial techniques for treatment of industrial effluents in pulp and paper, tanning and leather, distillery and dye industries – primary treatment, secondary treatment, aerobic process, treatment by bacteria and fungi and enzymatic treatment.
3. Emission control biotechnology - air sampling techniques- Impactors and impingers, - cyclones, fabric filters, electrostatic precipitators, scrubbers; air sanitation – control of air borne pathogens, biotechnological methods for the abatement of environmental bio-pollution
4. Biomonitoring of the environment – Plants as pollution indicators, algal pollution induces (Odum, Nygaard, Palmer, Margalef, Kothe), biosensors and genosensors, biofilters, biofuel cells and biochips. Endorphins.

8- T4. AGRICULTURAL BIOTECHNOLOGY & BIOETHICAL ISSUES

UNIT-I:

1. Application of plant transformation for productivity and performance: Herbicide resistance – phosphinothricin, glyphosate, atrazine.
2. Molecular aspects of abiotic stress responses and genetic engineering for drought, salinity and Temperature.
3. Molecular Pharming.
4. Plantibodies and plants as bioreactors

UNIT II:

1. Insect resistance – bt genes. Structure and function of cry proteins – mechanism of action, critical evaluation of its impact on insect control. Non-bt like protease inhibitors, alpha amylase inhibitors and lectins
2. Virus resistance – coat protein mediated, nucleocapsid gene and RNAi approach
3. Fungal resistance – PR proteins-1- chitinase, -3 beta glucanases.
4. Nematode resistance - Nematode infestation and engineering for nematode resistance.

UNIT III:

1. Plastid transformation-Chloroplast genetic system, plastome engineering in higher plants & advantages.
2. long shelf-life of fruits and flowers: use of ACC synthase, polygalacturanase, ACC oxidase. Male sterile lines: barstar and barnase systems.
3. Genetic improvement of oil quality.
4. GM Crops: Improvement of nutritional quality and Golden Rice

Unit IV:

1. Biotechnology and Society – Social, ethical and legal aspects of Biotechnology.
2. Implications of Biotechnology on health, environment, food and sustainable agriculture.
3. Biotechnology in industries – International collaboration, national level policies on Biotechnology.
4. Regulatory mechanisms in releasing GMOs. IPRs. Plant breeders rights, WTO, GATT & TRIPS. Biosafety regulations

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SEMESTER-IX

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9- T1: BIOPROCESS ENGINEERING AND TECHNOLOGY

Unit: I Fermentation technology.

1. History of fermentation technology. General requirements of fermentation processes
2. Basic design and construction of fermentor and bioreactor parts and accessories
3. Behaviour of microbes in different bioreactors (airlift, fluidized, batch, continuous, fed-batch conditions) construction type stability and analysis of bioreactor
4. Advantages and disadvantages of bioreactor

Unit: II Fermentation process.

1. Medium requirements for fermentation process, buffers and antifoam agents,Medium formulation for optimal growth, media optimization simple and complex media
2. Sterilzation methods of media, fermentor, thermal death kinetics, main parameters to be controlled in fermentation.
3. Solid- substrate , slurry fermentations and its applications, whole cell immobilization, advantages and disadvantages of bioreactor
4. An overview of aerobic and anaerobic fermentation processes and their applications in the biotechnology industry

Unit: III Mechanism of bioprocess.

1. An overview of traditional and modern applications of bioprocess in industry
2. Basic principles in bioprocess. Generalized process flow-sheets.
3. Outline of an integrated bioprocess and the various (Upstream and Downstream)unit operations.
4. Transport phenomenon in bioprocess- Mass transfer, Oxygen transfer rate (OTR), Mass transfer coefficient,heat transfer,heat transfer co-efficient.

Unit:IV Screening of bio fermentation products:

1. Isolation of fermented products: distillation, solvent extraction, adsorption,ultra filtration,membrane separation and precipitation
2. Recovery of fermentation products: removal of insoluble, centrifugation, edimentation, flocculation, electro-precipitation, gravity settling (grinding,homogenization, leaching)
3. Purification of fermented products: Chromatography, crystallization, recrystallization, desiccation, drum dryers,freez dryers, product formulation.
4. Fermentation economics, effluent treatment and its disposal

9- T2: ADVANCED BIOTECHNOLOGY

Unit-I:

Advances in transgene technology: Inducible expression systems, Application of site specific recombination, Advances in transgenic strategies for gene inhibition and transcriptome analysis in abiotic stress conditions in higher plants.

Unit –II:

Pharmaceutical Biotechnology: Drug discovery, design and development: drug discovery without a lead (Penicillin). Lead discovery (Random screening, targeted screening). Lead modifications – identification of active part (Pharmacophore) and functional group modifications. Structural modifications to increase potency (Homologation, chain branching, ring-chain transformation, bioisosterism,peptidomimetics.

Unit –III:

Protein Engineering: Basic concepts for design of a new protein molecule-solid phase peptide synthesis, sitedirected mutagenesis for specific protein function, design and construction of novel proteins and enzymes with specific example of enzyme engineering, - dihydrofolatereductase.Protein engineering for protein purification– affinity tags, transit peptide.

Unit –IV:

Metabolic Engineering and industrial products: Plant secondary metabolites, control mechanisms and manipulation of phenylpropanoid pathway, shikimate pathway, alkaloids, industrial enzymes, biodegradable plastics, polyhydroxybutyrate.

9- T3: BIOINFORMATICS

Unit-I:

1) Biological databases: Basic concepts of databases, importance of databases, integration of databases and its need.
2) Nucleotide sequence databases, protein sequence databases, functional motif databases, Protein structure databases.
3) Sequence Analysis: Concept of DNA and protein sequence alignments and their importance. Sequence alignment programs.
4) Comparitive sequence analysis: Pair-wise sequence alignment and tools of Local and Global alignment, multiple sequence alignment and tools like Clustal W2 and T-Coffee.

Unit-II:

1) Primary, secondary, tertiary and quarternary structures of proteins.
2) Forces influencing protein structure; Molecular chaperones; Protein folding, domain, motifs.
3) Protein databases: GenPept, RefSeq, Swiss-Prot, PIR, PRF, PDB, SCOP, CATH.
4) Proteomic tools: proteomic chip arrays, high resolution mass spectroscopy.

Unit-III:

1) Introduction to gene, genome and genomic branches. Define homology, analogy, orthologs and paralogs.
2) Evolution of genome:lateral or horizontal transfer of genome; phylogenetic analysis
3) Structural genomics:Genetical and physical mapping of genomes and applications.
4) Microarray technology, transcriptome and applications.

Unit-IV

1) Define metabolome, metabolites, metabonomics and give an account of their application in toxicology, functional genomics, and nutrigenomics.
2) Analytical technologies: Seperation methods like GC/MS, HPLC; Detection methods like mass spectrometry, NMR.
3) Immunology: Basic concept, antigen, hapten, antibody diversity.
4) Cell and hormone mediated immune responses. Major histocompatability complexes.

9- T4. BASICS OF NANOTECHNOLOGY

Unit-I

Introduction to Nanotechnology: Size dependent properties. Size dependence of sedimentation rate, adsorption effects, scattering of light, absorption of electromagnetic radiation, electrical and magnetic properties. Effects of confinement on protein stability.

Unit-II

Carbon based Nanomaterials: CNTs-synthesis of carbon nanotubes. Growth mechanism, electronic structure of carbon nanotubes, preparation and characterization of fullerenes and graphene. Nanodiamond, BN nanotubes.

Unit-III:

Synthesis of Nanomaterials**:** Physical methods: Methods based on evaporation, sputter deposition, chemical vapor deposition (CVD), electric arc deposition.
Chemical Methods: Colloids and colloids in solution, synthesis of nanoparticles by colloidal routes, micro emulsions, Sol-Gel method.
Biological Methods: Introduction to biomaterials, Synthesis using microorganisms and plant extracts

Unit-IV

Diagnostics and prognostics: principles and applications of Nanoarrays and Nanofluidics.
BioNanomechanics: NanoBiomotors. Mechanics of cilia and flagella. Nanobioelectronics: Nanowires based on DNA. Molecular transistors, Voltage gated ion channels. Nanopore sequencing of DNA.

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SEMESTER-X

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Paper	Subject	Marks
1.	PROJECT WORK*	200 (150 marks for project work and 50 marks for defending)

***.Industrial Project:** The student will undergo training in any Biotechnology Industry/Institute for one semester after completion of IX semester. The report will be submitted at the end of the X semester. The project report will be evaluated by the External and Internals (Head and Chairperson, BOS, Biotechnology) examiners. A seminar will be conducted on the project by the same examiners.