M.Sc. Biotechnology

COURSE PATTERN AND SCHEME OF EXAMINATION

SEMESTER-I

SUBJECT	PAPER	WORK LOAD PER WEEK	INTERNAL ASSIGNMENTS MARKS	DURATION (HOURS)	EXAMINATION	
					Max. Marks	Min.Marks
THEORY						
BT-101: Biochemistry	I	4	20	3	80	32
BT-102: Microbiology and Biodiversity	II	4	20	3	80	32
BT-103: Cell Biology and Genetics	III	4	20	3	80	32
BT-104: Biophysical and Biochemical Techniques	IV	4	20	3	80	32
PRACTICALS						
BTP-101:Biochemistry, Microbiology and Biodiversity	I	6	--	4	100	40
BTP-102: Cell Biology, Genetics, Biophysical and Biochemical Techniques	II	6	--	4	100	40

SEMESTER-II

SUBJECT	PAPER	WORK LOAD PER WEEK	INTERNAL ASSIGNMENTS MARKS	DURATION (HOURS)	EXAMINATION	
					Max. Marks	Min.Marks
THEORY						
BT-201: Enzymology and plant Biochemistry	I	4	20	3	80	32
BT-202: Immunology and Immunotechnology	II	4	20	3	80	32
BT-203: Molecular Biology	III	4	20	3	80	32
BT-204: Bioinformatics and Biostatistics	IV	4	20	3	80	32
PRACTICALS						
BTP-201: Enzymology and Plant Biochemistry, Immunology and Immunotechnology	I	6	--	4	100	40
BTP-202: Molecular Biology and Bioinformatics and Biostatistic	II	6	--	4	100	40

SEMESTER-III

SUBJECT	PAPER	WORK LOAD PER WEEK	INTERNAL ASSIGNMENTS MARKS	DURATION (HOURS)	EXAMINATION	
					Max. Marks	Min.Marks
THEORY						
BT -301 Plant Biotechnology	I	4	20	3	80	32
BT-302 Genetic Engineering	II	4	20	3	80	32
BT-303 Microbial and Environmental Biotechnology	III	4	20	3	80	32
BT-304 Agricultural Biotechnology	IV	4	20	3	80	32
PRACTICALS						
BTP -301 Plant Biotechnology and Genetic Engineering	I	6	--	4	100	40
BTP-302 Microbial and Environmental Biotechnology and Agricultural Biotechnology	II	6	--	4	100	40

SEMESTER-IV

SUBJECT	PAPER	WORK LOAD PER WEEK	INTERNAL ASSIGNMENTS MARKS	DURATION (HOURS)	EXAMINATION	
					Max. Marks	Max. Marks
THEORY						
BT-401 Animal & Medical Biotechnology	I	4	20	3	80	32
BT-402-Bioprocess & Fermentation technology	II	4	20	3	80	32
PRACTICALS						
BTP-401 Animal & Medical Biotechnology and Bioprocess & Fermentation technology	I	6	--	4	100	40
INDUSTRIAL PROJECT **& INTERNAL PROJECT**		6	--		100 (75+25)	40

M.Sc.Biotechnology

COURSE PATTERN AND SCHEME OF EXAMINATION

I SEMESTER	Marks	I I I SEMESTER	Marks
BT-101: Biochemistry	100	BT -301 Plant Biotechnology	100
BT-102: Microbiology and Biodiversity	100	BT-302 Genetic Engineering	100
BT-103: Cell Biology and Genetics	100	BT-303 Microbial and Environmental Biotechnology	100
BT-104: Biophysical and Biochemical Techniques	100	BT-304 Agricultural Biotechnology	100
Practical-I	100	Practical-I	100
Practical-II	100	Practical-II	100
TOTAL	**600**	**TOTAL**	**600**
II SEMESTER		**IV SEMESTER**	
BT-201: Enzymology and Plant Biochemistry	100	BT-401 Animal & Medical Biotechnology	100
BT-202: Immunology and Immunotechnology	100	BT-402-Bioprocess & Fermentation technology	100
BT-203: Molecular Biology	100	Practical-I	100
BT-204: Bioinformatics and Biostatistics	100		
Practical-I	100	INTERNAL PROJECT* + INDUSTRIAL PROJECT**	100
Practical-II	100		
TOTAL	**600**	**TOTAL**	**400**

***.Internal Project (Research Methodology) :** Learning of Research Methodology under the supervision of faculty members. The student will be assigned a small research project (includes all methodologies of Biotechnology) in the beginning of the IV Semester and the report will be evaluated by external and internal examiners at the end of the semester.

****.Industrial Project:** The student will undergo training in any Biotechnology Industry/Institute for 45 days after completion of II semester. The report will be submitted at the end of the IV 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.

Kakatiya University, Warangal

M. Sc. BIOTECHNOLOGY

(SEMESTER SYSTEM)

(Effective from 2010 -2011)

SYLLABUS

SEMESTER – I

BT-101: 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. Chemical and enzymatic methods for structural elucidation of starch and mucopolysaccharides.
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.

BT-102: MICROBIOLOGY AND BIODIVERSITY

Unit-I

1. Systematic position of microorganisms in living world, classification of microorganisms: Hackle's three kingdom concept, Whittaker's five kingdom concept, three domain concept of Cral Woese
2. Historical account of bacterial classification, detail account of bacterial classification according to the 1st edition of Bergy's manual of systematic bacteriology (up to sections). Detail account of bacterial classification according to the 2nd edition of Bergy's manual of systematic bacteriology (up to orders)
3. General characters, thallus organization, cell structure, reproduction and classification of fungi, nutrition, reproduction and parasexuality, structure, reproduction and molecular and biotechnological aspects of yeasts.
4. History, general properties and structure of viruses: Viruses related agents (viroids & prions), nomenclature and classification of viruses, auto virus infection, and persistent viruses. General features of virus reproduction, replication of ribonucleic acid (RNA) and deoxyribonucleic acid (DNA) viruses, bacteriophages, transmission of viruses, and management of viruses.

Unit-II

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). *Species Diversity:* Concept of species, measurement of species diversity, global distribution of species riches. *Ecosystem diversity:* Terrestrial and aquatic ecosystems. Centers of mega diversity and hotspots.
3. *Biodiversity vs. Biotechnology and* Bioprospecting, biosafety, biopiracy and Intellectual Property Rights (IPR).
4. *Biodiversity for Sustainable Development:* Sustainable management of biodiversity: International and regional policies. Biodiversity Act, National Biodiversity Board and Andhra Pradesh State Biodiversity Board.

Unit-III

1. Microbial Evolution: Evolution of earth and earliest life-forms; primitive organisms and their metabolic strategies.
2. Microbial Diversity: Bactria, Archea and their broad classification eukaryotic microbes, Yeast, Fungi, moulds and Protozoa; Viruses and their diversity.
3. Metabolic Diversity-I: Photosynthesis in microorganisms-Role of chlorophylls, carotenoids and phycobilins.
4. Metabolic Diversity-II: Calvin cycle, chemolitho-trophy; Hydrogen-iron, nitrateoxidizing bactetria. Nitrate and sulphate reduction; Methanogenesis and acetogenesis.

Unit-IV

1. Global Animal Diversity: A bird's view of animal kingdom. Domesticated animal diversity and wild animal resources of India. A brief account of diversity in aquatic life. A case study of over-fishing resulting in ecological disaster.
2. IUCN categories. Rare and endangered categories and extinct animals of India. Trends of extinction rates. Wildlife Act of India and CITES.
3. *Restoration Ecology:* Reasons for Restoration of animal habitats and corridors. Role of International and national organizations (IUCN, WWF) in the conservation of animal diversity.
4. *Biodiversity Conservation* : Principles and rationale. *Ex situ* and *In situ* conservation strategies (Incl. sperm/seed banks, cryopreservation, embryo collection and freezing creation of parks, wildlife sanctuaries, botanical gardens, etc.,)

BT-103: CELL BIOLOGY AND GENETICS

Unit I

1. Nucleus -Ultra structure of nucleus and nuclear envelope.
2. Organization of eukaryotic chromosome - structure of nucleosome and extent of chromatin condensation in metaphase chromosome. Euchromatin and heterochromatin (constitutive and facultative).Special Types of Chromosomes: Polytene and Lampbrush chromosomes, Nomenclature of chromosome, dosage compensation.
3. Cell cycle - Overview of eukaryotic cell cycle, regulation of cell cycle by cell growth and extra cellular signals, Cell cycle check points, Regulators of cell cycle progression -MPF, cyclins and cyclin-dependent kinases.
4. Cell differentiation. Cell death and proliferation-Apoptosis: definition, morphological and biochemical differences between apoptosis and necrosis, mechanism (internal and external signals) and significance. Brief account of biology of cancer.

Unit II

1. Cell Communication - General principles, Cell surface receptors (ion channel linked, G-protein linked and enzyme-linked receptors) and intracellular receptors,
2. Forms of intracellular signaling – Autocrine, paracrine, contact dependent, synaptic and endocrine signaling. Response of cell to signals. Intracellular signaling proteins: Different types and their role. Second messengers - cAMP pathway and role of calcium. Cellular interactions -Mocrovilli, tight junctions, belt and spot
3. Desmosomes, gap junctions-Electrical coupling, The connexon, factor mediating cell-self recognition (aggregation factor).
4. Cytoskeleton - Structure and functions of actin, microfilaments and intermediary filaments.

Unit III

1. Introduction to genetics: Mendel’s principles, Gene interaction & Modified ratios,
2. Multiple alleles, multiple factor inheritance, Extra chromosomal inheritance
3. Linkage and crossing over and genetic mapping: sex-linked inheritance, cytological evidence of crossing over in maize, crossing over frequency and map distances, recombination modelws: maize, yeast and Neurospora.
4. Population genetics: Hardy Weinberg law, factors influencing the equilibrium

Unit IV

1. Bacterial Genetics: Conjugation, Transformation, Transduction, recombination and gene mapping.
2. Phages Genetics: Gene fine structure, concepts of cistron, muton & recon, r II locus
3. Molecular mechanisms of mutations, Ames test for mutagenesis, DNA damage and repair,
4. Mutations: Chromosome variations in number and structure, Role of mutations in crop improvement

BT-104: BIOPHYSICAL AND BIOCHEMICAL TECHNIQUES

Unit I

1. Microscopy: Principles and application of light, phase contrast, fluorescence, scanning and transmission electron microscopy, cytophotometry and flow cytometry, fixation and staining.
2. Centrifugation: Basic principles of sedimentation, types of centrifuges and rotors. Preparative ultracentrifugation-differential centrifugation, Density-gradient, analytical ultracentrifugation and applications in determination of molecular weight, purity and detection of conformational changes in macromolecules.

Unit II

1. Separation methods - General principles and definitions, Paper chromatography, adsorption chromatography (thin-layer chromatography), gas-liquid chromatography,
2. Methods based on size: Principle of Gel filtration, methodology and applications. Dialysis, ultra filtration
3. Methods based on affinity: Principle of Affinity chromatography; methodology and applications. Ion-exchange chromatography: Principle & methodology
4. 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, identification of novel proteins in 2D gels, 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. Radioisotope Techniques : Types of isotopes, radioactive decay. Detection and measurement of radioactivity-GM counter, scintillation counter, autoradiography.
4. Preparation of label compounds: Pulse chase studies and tracer techniques, isotopes used in biology, safety methods in handling radioisotopes.

SEMESTER – II

BT-201:ENZYMOLOGY AND 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 behaviour-KMF, MWC models, 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. Concept of free energy: Energy metabolism, Thermodynamic principles in biology, Energy rich bonds, weak interactions,
2. Coupled reactions and oxidative phosphorylations, group transfer, biological energy transducers, bioenergetics. Glycolysis and TCA cycle, HMP shunt, Gluconeogenesis, Energy derivations in fermentation, aerobic and anaerobic respirations.
3. Glyoxylate cycle, Components and organization of mitochondrial electron transport system

Unit III

1. Chloroplast as an energy transducing organelle.
2. Photosynthetic pigments and photosynthesis in bacteria and higher plants. Cyclic and non-cyclic photophosphorylation, Mechanism of photophosphorylation.
3. Pathways of CO_2 fixation by C3, C4, and CAM pathways.
4. Photorespiration. Fatty acid oxidation (ß-oxidation). Biosynthesis of fatty acids, triglycerides and cholesterol, ketone bodies synthesis.

Unit IV

1. Nitrogen fixation: Diazotrophic microorganisms, nitrogen fixation genes. Transfer of *nif* genes to non-diazotrophic microorganisms.
2. Organization, regulation and expression of Nif genes,
3. *Nod* genes, structure function and role in nodulation,
4. Hydrogenase : Hydrogen metabolism, Genetic engineering of hydrogenase genes.

BT-202: IMMUNOLOGY AND 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.

BT-203: 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.
4. Replication of E. coli chromosome and M13 genome. Rolling circle replication in bacteriophage. Eukaryotic DNA replication. Autonomous replication sequences (ARS). Regulation of ColE1 plasmid DNA replication. Termination and fidelity of DNA replication. Nearest neighbour base pair analysis. Inhibitors of DNA replication.
5. 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. Role of catalytic RNA. Inhibitors of transcription.
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. Inhibitors of protein synthesis – antibiotics and other inhibitors. Post-translational modifications.
4. Protein sorting and targeting. Signal hypothesis-signal sequences, signal recognition particle, and molecular chaperones, protein degradation. Lysosomal degradation. The ubiquitin pathway - protein stability and N-end rule.

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.

BT-204: BIOINFORMATICS AND BIOSTATISTICS

UNIT-I

1. Introduction to Computers Overview of computer organization and historical perspective, computer applications in various fields of science and management, Data representation: Number systems, character representation codes
2. Binary, hex, octal codes and their interconversions. Binary, arithmetic, floating point arithmetic, signed and unsigned numbers. Data storage: Primary and Secondary storage.
3. Introduction to various computer devices such as keyboard, mouse, printers, disk files, floppies etc. Concept of computing, Operating Systems such as Windows NT, UNIX etc. (only brief user-level description).
4. Introduction to organization and architecture of mainframe, mini and micro systems. Introduction to E-mail, ftp, login and other network services, world wide web, MS-Office.

UNIT-II

1. Biological databases: Basic concepts of databases, bioinformatics and importance of databases, integration of databases and its need.
2. DNA databases, protein-sequencing databases, functional motifs databases, protein-structure databases.
3. Sequence analysis: Concepts of DNA/protein-sequence alignment and their importance, sequence alignments and alignment programs.
4. Comparative-sequence analysis: Pair-wise sequence alignment, multiple-sequence alignments, methods like BLAST, FASTA. Tools like CLUSTAL. Dynamic programming, similarity algorithms, affina gap penalty

UNIT-III

1. Molecular modeling, Proteomics: functional and structural proteomics.
2. Genomic studies, 3D structure, and domain structure – DNA binding domains. Molecular modeling.
3. Determination of structure of proteins. Predicting protein structure – secondary structure, Methods of protein modeling
4. Microarray technology, human genome project and applications.

Unit IV

1. Introduction to biostatistics: Variables, random variables, discrete and continuous variables, population and sample estimate, mean, median, mode, frequency distribution, frequency curve, frequency polygon and histogram.
2. Measures of dispersion: Range, variance, coefficient of variance, standard deviation (SD) and standard error (SE).
3. Probability distribution: Normal, binomial and poison.
4. Test of hypotheses: Students t-test, X^2 distribution (Chi-square), correlation coefficient and analysis of variance (ANOVA)

SEMESTER – III

BT-301 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

BT – 302 GENETIC ENGINEERING

Unit-I:

1. Restriction endonucleases and their importance in gene cloning.
2. Enzymes used in recombinant-DNA technology: DNA polymerases, ligases and DNA modifying enzymes (methylases, alkaline-phosphatases, topoisomerases).
3. Cloning vectors: Plasmids, Phagemids, Cosmids, Viral vectors, shuttle vectors and Binary Vectors.
4. Gene cloning strategies, analysis and expression of cloned genes.

Unit-II:

1. Construction of Genomic libraries: genome mapping and chromosome walking and DNA foot printing, BAC and YAC.
2. C-DNA synthesis: Isolation of eukaryotic mRNA and mechanism of C-DNA synthesis, c-DNA libraries and *in vitro* packaging.
3. Genome sequencing: Different strategies.
4. Expression vectors: Bacterial, Yeast, Animal and Plant

Unit-III:

1. Blotting techniques: Southern, Western and Northern blotting techniques.
2. Molecular markers: RFLP, RAPD, AFLP, SSR and their applications.
3. DNA finger printing technology and its application in forensic medicine
4. PCR Technology-Designing and synthesis of oligonucleotide primers-PCR amplification of specific DNA sequences, current innovations, cloning PCR products, mutagenesis by PCR, thermostable DNA polymerases and applications of PCR technology in Biology and medicine.

Unit-IV:

1. Introduction of Recombinant DNA molecules into appropriate hosts-competent cells preparation.
2. Transposable elements, types and mechanism of transposition.
3. Ribozyme Technology: molecular mechanism of antisense molecules and its applications, Biochemistry of ribozyme-hammer head, hair pin and other ribozymes and application of ribozyme technology
4. Gene silencing and RNA*i* technology

BT-303 MICROBIAL AND ENVIRONMENTAL BIOTECHNOLOGY

Unit I

1. Biomonitoring of Environment – biological indicators, biosensors, genosensors. Self purification of the ecosystems, pollution tolerance – Global environmental problems and influences.
2. Waste water treatment through aerobic microorganisms – biological filters, aeration tanks, biological ponds and land treatment
3. Waste water treatment through anaerobic microorganisms – septic tanks, upflow anaerobic sludge blanket (UASB), anaerobic attachment film expanded bed (AAFEB), anaerobic rotating biological contractor.
4. pollution control biotechnology – commercial blends of microorganisms and enzymes, immobilized cells and enzymes, biotechnological approaches for recovery of useful prorducts from sewage and industrial wastes.

Unit II

1. Microbial degradation of pesticides - taxonomy, biochemistry and molecular biology.
2. Biodesulphurization of coal and hydrocarbons – molecular mechanisms, kodama pathway and 4 S pathway, advanatages to environment.
3. Microbial leaching and biomining (Copper and Uranium) – *in situ* and *ex situ* leaching processes, factors affecting the leaching, plasmids and genes in biomining.
4. Environment and bioenergy – Microbial degradation of lignocelluloses, biofuels (bioethanol, methane, hydrogen).

Unit-III

1. An overview of fermentation technology, range of fermentation processes, components of fermentation process.

2. Industrial microorganisms: isolation, preservation, screening and strain improvement and maintenance. Formulation of industrial media: Medium requirements for fermentation processes. Stoichiometry of cell growth and product formation, scale – up process and starter culture technology

3. Types of fermentations: batch, continuous, fed-batch, solid state, sub-merged.Aerobic and anaerobic, dual and multiple fermentations, their advantages and disadvantages.

4. Importance of downstream processing in industrial fermentation processes. Problems and requirements of bio product recovery and purification. Physico- chemical basis of bio separation processes.

5. Fermentation economics - Market potential, some effects of maintenance legislation on production of antibiotics and recombinant proteins, plant and equipment.Continuous culture, recovery costs,

UNIT -IV

1. Microbes important in food microbiology: fungi and bacteria contamination of foods. Factors influencing food spoilage (intrinsic and extrinsic).Food poisoning and food bore infections, bacterial and fungal toxins. General principles of food preservation.

2. Microbial food fermentation: Fermentation in food processing, role of microorganisms in food fermentation. Microbial products of food; SCP, mushrooms, Fermented beverages , fermented meat and meat products. Fermented milk products. Yeasts fermentation and a yeast products.

3. Industrial production of enzymes: cellulases, amylases, proteases, lypases, Immobilization of enzymes and cells and their applications.

4. Industrial production of Biopesticides – Bacterial, viral and fungal , Biopolymers – Extra cellular polymers, Biosurfactants - Classification , production and application, Vaccines– Bacterial and viral vaccines.

5. Industrial production of Organic acids - lactic acid, Citric acid, Amino acids - L – lysine, Glutamic acid, Solvents -ethyl alcohol, Antibiotics- Streptomycin, penicillin, Vitamins - B_{12}, Riboflavin and Biofuels - Methane.

BT-304 AGRICULTURAL BIOTECHNOLOGY

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, 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

Semester IV:

BT.401: ANIMAL CELL CULTURE & MEDICAL BIOTECHNOLOGY

Unit-I: Animal Cell Culture-I

1. Principles of animal cell and tissue culture
2. Techniques of cell and tissue cultures: sources of cells, techniques of cell cultures and types of animal cells.
3. Maintenance of animal cell cultures, properties of cell lines, vaccines and hormone production, *in vitro* production of tissues and organs.
4. Kinetics of cell and tissue growth, primary and established cell lines.

Unit-II: Animal Cell Culture-II

1. Cell culture media, culture procedures in preparation of animal cell cultures, primary culture, cell lines
2. Cloning-somatic cell fusion-tissue cultures, organ culture, embryo culture.
3. Measurement of cell death and apoptosis: Cytotoxicity and cell proliferation assays.
4. Stem cell technology: stem cell culture and transplantation and applications

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. Pharmacokinetics: drug delivery & designs
5. Mass production of bioactive substances: interferon, interleukins.

UNIT IV:

1. Animal Cloning: ethical social implications.
2. Transgenic animals (mice, cattle, sheep) and animals as bioreactors in molecular farming.
3. Human genome sequences- mapping and cloning of human-disease genes.
4. Genetic disorders: Monogenic and multifactor disorders (Cardiovascular and neurological diseases).

BT.402: BIOPROCESS & FERMENTATION TECHNLOGY

Unit I

1. History of fermentation technology. General requirements of fermentation process.
2. Basic design and construction of Fermentor and bioreactor, parts and accessories. Batch Fermentor, continuous-stirred-tank Fermentor.
3. Types of bioreactors-tower, jet loop, airlift, fed-batch reactor, Tubular, fluidized – bed, enzyme bioreactor, bubble column, packed-bed reactor.
4. Advantage and disadvantages of construction type, stability analysis of bioreactor.

Unit II

1. Medium requirements for fermentation process, buffers and antifoam agents. Medium formulation for optimal growth – media optimization. Simple and complex media.
2. Sterilization methods of media Fermentor – thermal death kinetics, main parameters to be monitored and controlled in fermentation.
3. Solid-state and submerged fermentation
4. Aerobic and anaerobic fermentations

Unit III

1. Basic principles in Bioprocess.
2. Upstream unit operations involved in bioprocess
3. Generalized process – flow-sheets
4. Transport phenomenon in bioprocess – mass transfer (OTR), Mass transfer coefficient, heat transfer, heat transfer coefficient.

Unit IV

1. Isolation of fermentation product: distillation, solvent extraction, adsorption, ultra filtration, membrane separation, precipitation.
2. Recovery of fermentation products-removal of insoluble, centrifugation, sedimentation, flocculation, electro – precipitation, gravity settling (grinding, homogenization, leaching)
3. Purification of fermentation products: chromatography, crystallization, recrystallization, desiccation, spray draying, adhesive spray dryers, drum dryers, freeze dryers, product formulation.
4. Fermentation economics, Effluent treatment.

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