SYLLABUS

M. Sc. Biotechnology

2021-22

IV Semester Course

(Choice Base Credit System)

School of Environmental Biology

Awadhesh Pratap Singh University Rewa M. P.

PO#	PROGRAMME OUTCOME
PO1	**Critical Thinking**: This program places a strong emphasis on the value of being conscious of our presumptions, challenging their accuracy, and approaching concepts and choices from several angles. It entails having the capacity to recognize, assess, and make sensible choices based on logical reasoning.
PO2	**Effective Communication:** This program helps participants improve their communication skills and makes sure they can express themselves accurately in written, spoken, and technological mediums. It also encompasses the capacity to link individuals, concepts, literature, media, and technology, as well as the capacity to communicate effectively and interpret the world.
PO3	**Social Interaction:** It emphasizes on the capacity to solicit the opinions of others, resolve conflicts, and aid in reaching decisions in group settings. It entails having the capacity to collaborate with others, forge agreement, and settle disputes.
PO4	**Effective Citizenship:** The necessity of sympathetic social concern and equity-focused national development is emphasized. It entails being aware of the problems that society faces, being involved in civic affairs via volunteering, and behaving in a way that reflects a thorough understanding of these problems.
PO5	**Ethics:** It emphasizes the significance of appreciating many value systems, comprehending the moral implications of choices, and taking accountability for them. It entails being conscious of ethical concerns and basing judgments on ethical principles.
PO6	**Environment and Sustainability:** Understanding environmental surroundings and sustainable development are the main objectives. It entails being conscious of how human behavior affects the environment and acting to advance sustainability.
PO 7	**Self-directed and Life-long Learning:** gaining the capacity to participate in independent, ongoing learning in light of socio-technical developments. It entails having the capacity to learn on one's own, adjust to new technology, and consistently acquire new abilities and information.

Programme Specific Outcomes

PSO1 Understanding and proposing experimental designs, develop problem solving abilities

of the protocols developed for commercially viable biotechnology products

PSO2 Learning bioprocessing techniques used in large-scale production units

PSO3 Developing skill sets for research, employability and entrepreneurship

PSO4 Finding sustainable solutions to issues pertaining to environment, health, agriculture etc.

M. Sc. Biotechnology (Choice Base Credit System)
A. P. S. University Rewa (M. P.)
Syllabus for Session 2021-22
The Scheme of Examination

M.Sc. Biotechnology -I						
Paper Code	**Paper Name**	**Course Type**	**THEORY**	**I. A.**	**Total Marks**	**Total Credits.**
101	Cell Biology	Core	60	40	100	4
102	Biochemistry	Core	60	40	100	4
103	Molecular Biology	Core	60	40	100	4
104	*Applied Microbiology	Generic Elective	60	40	100	4
105	Practical	-	100		100	4
106	Comprehensive viva-voce	-	100		100	4
			Total		**600**	**24**

M.Sc. Biotechnology -II						
Paper Code	**Paper Name**	**Course Type**	**THEORY**	**I. A.**	**Total Marks**	**Total Credits**
201	Bioinformatics and Biostatistics	Core	60	40	100	4
202	Immunotechnology	Core	60	40	100	4
203	Plant Biotechnology	Core	60	40	100	4
204	*Biophysical and Molecular Techniques	Generic Elective	60	40	100	4
205	Practical	-	100		100	4
206	Comprehensive viva-voce	-	100		100	4
			Total		**600**	**24**

M.Sc. Biotechnology –III						
Paper Code	**Paper Name**	**Course Type**	**THEORY**	**I. A.**	**Total Marks**	**Total Credits.**
301	Genetic Engineering	Core	60	40	100	4
302	Metabolism: Basic Concept And Design	Core	60	40	100	4
303	**(A)Bioprocess Engineering and Technology **OR**	Discipline centric elective	60	40	100	4
	**(B)Medical Biotechnology	Discipline centricelective				
304	*Environmental Biotechnology	Generic Elective	60	40	100	4
305	Practical	-	100		100	4
306	Comprehensive viva-Voce	-	100		100	4
			Total		**600**	**24**

M.Sc. Biotechnology –IV						
Paper Code	**Paper Name**	**Course Type**	**THEORY**	**I. A.**	**Total Marks**	**Total Credits.**
401	Entrepreneurship In Biotechnology & Intellectual Property Rights	Core	60	40	100	4
402	**(A)Plant Tissue culture technology **OR**	Discipline centric elective	60	40	100	4
	** (B) Animal CellCulture techniques	Discipline centric elective				
403	Dissertation and Presentation		-	-	100	4
404	Comprehensive viva-Voce				100	4
Semester Total					400	16
Grand Total					**2200**	**88**

M.Sc. Biotechnology
Semester-I
Paper-101

101: CELL BIOLOGY

Unit I

1. Concept of Cell: Prokaryotes and Eukaryotes (Plant and Animal Cell)
2. Cell Organelles (Nucleus, Mitochondria, Golgi complex, Endoplasmic reticulam (SER and RER), Chloroplast, Peroxisome and vacuoles)
3. Cell membrane: physiochemical properties; Molecular Organization- Biogenesisand Functions
4. Biogenesis of Mitochondria and Chloroplast

Unit II

1. Protein targeting and Molecular mechanisms of Vesicular transport, . Transport of small molecules across cell membranes: types and mechanisms.
2. Intracellular digestion: ultra structure and function of lysosomes Nutrient uptake and excretion. Transport by Vesicle formation: Endocytosis and Exocytosis.
3. Active transport by ATP powered pumps: types, properties and mechanisms.
4. Transport of proteins into Mitochondria and Chloroplast.

Unit III .

1. Cell Motility and Shape I: Structure and function of microfilaments, Microtubules and Intermediate Filaments.
3. Intra cellular communication through Cell Junctions: Occluding Junctions, Anchoring junctions and Communicating Junctions
4. Inorganic ions.

Unit IV

1. Molecular Mechanisms of Cell-Cell Adhesions: Ca dependent cell-cell adhesions.
2. Molecular Mechanisms of Cell-Cell Adhesions: Ca independent cell-cell adhesions.
3. Extracellular Matrix of animals: Organization and Functions.
4. Extracellular Matrix Receptors on animal cells: Integrins.

Unit V

1. Cell Signaling: Signaling via G-Protein linked and enzyme linked cell surface receptors, MAP kinase pathways, Interaction and Regulation of signaling pathways. Bacterial chemo taxis and quorum sensing.
2. Eukaryotic Cell Division Cycle: Different Phases and Molecular Events.
3. Control of Cell Division Cycle: In yeast and mammalian cells.
4. Apoptosis: Phases and significance, Morphological and Biochemical changes associated

   With apoptotic cells, Apoptotic Pathways and regulators
5. Cancer: Molecular basis of carcinogenesis, carcinogens (Physical, Chemical and Biological)

Course Outcome

By the end of the paper, a student would be able to:

CO 1: To describe the molecules of life and conserved structures; recount how the working of cell was discovered through model organisms.

CO 2: To be able to recognize and identify the importance and functions of cell membrane

CO 3: To develop capacity to distinguish signaling pathways for regulation of various cellular mechanisms

CO 4: To be able to explain mechanism of development across species

CO 5: To evaluate the use of various model organisms to relate the development of vertebrates

M.Sc. Biotechnology
Semester-I
Paper-2

102. Biochemistry

UNIT-1

1. Biochemistry: The molecular logic of living organisms
2. The cell and its biochemical organization
3. Intra and inter molecular forces electrostatic interactions and Hydrogen bonding interaction.
4. Vander Waals and Hydrophobic interactions, Disulphide bridges
6. Role of water and weak interactions
7. Chemical foundations of Biology- pH, pK, acids, bases, buffers, weak bonds & Covalent bonds, Principles of thermodynamics

UNIT-2

1. Carbohydrates: classification, structure, functions; homo and hetero polysaccharides,animal, plant and microbe specific polysaccharides.

2. Lipids: Classification, nomenclature, structure and property of fatty acids,Simple lipids- Triglisrids, fates and Waxes. Compound lipids- classification, structure, distribution, and biological importance, role of prostaglandine,leukotrins and thromboxans.

3. Sterols- Cholestrol, role in biological system. Tarpenes and phenols.

4. Functions; Lipids associated with disease, diagnosis and treatment. Lipoproteins and biological membrane, micelles and liposomes.

UNIT -3

1. Nucleic acids: Structure, Properties of purines and pyrimidine bases,DNA : Structure, conformation, prokaryotic and eukaryotic DNA, nucleotides,Chromosomal and extrachromosomal DNA

2. RNA: Structure, types and function of mRNA, tRNA, Ribozymes: structure and functions.

3. Amino acids- classification, structure, property, Zwitter ion, titration curve and biologically important amino acids

4. Polypeptides- Conformational properties of polypeptides, protein sequencing methods.

5. Proteins: Classification, Primary structure, nature of peptide bond, Ramchandran plot, and secondary structure, hydrogen bonding, salt bridge, disulphide bonds, hydrophobic and hydrophilic interaction in proteine and role of these bonds in protein folding, α-helix, β- sheet, and beta turns structures etc.Tertiary and quaternary structure. Biological role of proteins. Proteins associated with diseases, diagnosis and treatment. Separation, purification and criteria of homogeneity, End group analysis Folding-unfolding equilibrium and denaturation of proteins

6. Prions- Structure role and association with disease

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UNIT-4

1. Enzymes; General characteristics and Catalytic power of enzymes and their classification, Energy considerations, Factors affecting enzyme activity, Enzyme kinetics, Michaelis-Menten equation, Allosteric enzymes and their regulation.
2. Methods of enzyme assay: Continuous & Sampling techniques, coupled kinetic assays, Significance of enzyme turn over number, Specific activity.
3. Enzyme purification techniques, Criteria of purity and tabulation of data Characterization of purified enzymes
4. Vitamins and cofactors: Structure, distribution, interaction and biologicalproperties
5. Hormones- structure, distribution and function.
6. Phenols – structure and biological property
7. Alkaloids – structure and biological properties

UNIT -5

1. Enzyme immobilization: Experimental procedures and effect on kinetic parameters
2. Uses of enzymes in Industries, textiles, leather andfood
3. Use of purified enzymes in Biosensors
4. Development of enzyme sensor for clinical diagnosis with specific examples

Course Outcome

By the end of the paper, a student would be able to:

CO 1: To identify biological importance of carbohydrates and lipids

CO 2: To distinguish between anabolic and catabolic processes of carbohydrates and lipids

CO 3: Compare and contrast metabolic pathway of complex carbohydrates in different living system

CO 4: To elucidate the role of lipids in maintaining homeostasis at cellular and systemic level

CO5: To describe the structure of protein and correlate with its functions such as like molecular motors, interaction, carriers, signalling, repair and structure.

M.Sc. Biotechnology
Semester-I
Paper-104

(*__Generic Elective__) APPLIED MICROBIOLOGY

Unit I 1 History and Scope of Microbiology, Microscopy (light microscopy, resolving power of different microscopes, ESR, ETR)

2. Classification of Microorganisms: Bacterial & Fungal Classification.
3. Morphology and fine structure of eubacteria, archebacterial cell wall and fungal cell Wall.
4. Cyanobacteria : General account and their economic importance
5. Mycoplasma and diseases caused by them

Unit II

1. Sterilization: Physical and chemical methods
2. Preparation of culture media, pure culture techniques and microbialstaining
3. Microbial growth: Bacterial growth curve, Mathematical expression, measurement of growth and factors affecting growth.
3. Microbial Nutrition: Nutritional classification of Microorganisms, Different carbon and Nitrogen sources, mode of nutrition, transport of nutrition across the bacterial membrane.
4. Oxygen toxicity: Study of catalase, peroxidase, superoxide dismutase, mechanism of oxygen toxicity
5. Taxonomic classification of microbes using molecular markers- 16 rRNA typing.

Unit III

1. Virus organization, Types, Isolation, cultivation, identification and viral replication.
2. Structure and morphology of bacteriophages, lytic and lysogenic cycle.
3. Life cycle of DNA viruses: SV 40, RNA viruses: Retroviruses.
4. Plant viruses: TMV, Gemini, CMV, Human Viruses: Influenza (SARS), Herpes Simplex virus, Rubella.

Unit IV

1. Infection and disease, types of infection, Mechanism of pathogenesis of bacterial and Viral disease and its diagnosis
2. Staphylococcal and Clostridial food Poisoning, Bacterial Diseases: Salmonellosis and Shigellosis.
3. Fungal Diseases: Histoplasmosis, Aspergillosis and Candidiasis, diagnosis and treatment
4. Viral diseases: diagnosis and treatment of Chicken Pox, Hepatitis B and Poliomyelitis.

Unit V

1. Host microbe interaction, Symbiosis, Antibiosis, Commensalisms, Competition,Mycorrhiza and its importance, Role of microbes in N, P and C cycle.
2. Aerobic and anaerobic respiration, fermentation and bioprocess engineering
3. Chemotherapeutic agents: Classification of Antibiotics, Broad and narrow spectrum antibiotics; Antibiotics from prokaryotes.
4. Anti-fungal and antiviral antibiotics, mode of action of antibiotics and mechanism of drug resistance, origin of drug resistance.

Course Outcome

By the end of the paper, a student would be able to:

CO 1: To analyse the role of microbiology in the field of Biotechnology

CO 2: To learn how to work with microbes

CO 3: To explain bioprocessing using microbes to get different products

CO 4: To evaluate the way the microbes can be improved to enhance quality and yield of products

CO 5: To appraise the techniques that have been developed in Microbial Biotechnology

M.Sc. Biotechnology
Semester-I
103- MOLECULAR BIOLOGY

Unit I

1. Mendelian Genetics-Principles
2. Human genetics (pedigree analysis, karyotypes and genetic disorder).
3. Nature of Gene Concept, Chemical Nature of Gene, Gene cistron relationship in Prokaryotes and Eukaryotes
4. DNA Replication: General features of Chromosomal Replication: and its Enzymology
5. Regulation of DNA replication

Unit II

1. Transcription in prokaryotes: Initiation, elongation and termination
2. Structure and Function of prokaryotic promoter
3. Control of transcriptional initiation in prokaryotes: Structure and function of RNA Polymerase: Sigma factors- Types and functions
4. Control of transcriptional termination: Attenuation and antitermination

Unit III

1. Regulation of gene expression in prokaryotes: Operon concept, induction and Repression, Structure and regulation of lactose, arabinose and tryptophan operons
2. Initiation of transcription in Eukaryotes: RNA Polymerases Types andproperties
3. Transcription factors- Types and properties; Enhancers- Structure and properties; Response Elements
4. Post-transcriptional Modification Eukaryotes- 5' and 3' modification ofmRNA
5. Molecular recombination

Unit IV

1. Post- transcriptional Processing of pre mRNA, pre rRNA and pre tRNA transcripts
2. Genetic Code: Evidence and properties; Wobble hypothesis; Transcriptional adaptors and amino acyl tRNA synthases.
3. Translation: Successive stages of protein synthesis in prokaryotes and its comparison with eukaryotes
4. Post-translational Modification: Types and Significance

Unit V

1. Regulation of Gene Expression in Eukaryotes: cis- acting DNA elements; Chromatin Organization and regulation of gene expression; regulation at the level of processing of Transcripts, RNA editing; Gene Alteration; DNA methylation and gene regulation; Regulation of gene expression by hormones, regulation of gene expression at translational level.
2. Transposable elements in Prokaryotes and Eukaryotes: Types and Significance
3. Oncogenes and Tumor Suppressor Genes: Properties and Significance
4. Mutation and DNA repair chromosomal aberration.

Course Outcome

By the end of the paper, a student would be able to:

CO 1: To compare the replication and repair mechanism in eukaryotic system with the Prokaryotic system

CO 2: To explain the process of transcription in eukaryotes and its multi-level regulation

CO 3: To correlate the external signaling with the changes in gene expression

CO 4: To describe gene regulation and its significance in biological sciences

CO 5: To learn to apply various molecular biology techniques in research

M.Sc. Biotechnology

Semester-II

201- BIOSTATISTICS AND COMPUTER APPLICATIONS

Unit I

1. Introduction to Biostatistics, Common terms, notions and Applications
2. Statistical population and Sampling Methods
3. Classification and tabulation of Data
4. Diagrammatic and graphical presentation
5. Frequency Distribution, Measures of central value
6. Measures of variability; Standard deviation, standard Error, Range, Mean Deviation, Coefficient of variation, Analysis of variance

Unit II

1. Basic tests, Test of significance; t-test, chi-square test.
2. Correlation and Regression; Basic of regression, regression analysis, Estimation, Testing, prediction, Checking and residual analysis.
3. Multivariate Analysis.
4. Design of Experiments, randomization, replication, local control, complimentary Randomized, randomized block design
5. Statistical Packages: SPSS, Graph pad etc

Unit III

1. Introduction to Information technology and computer
2. Office applications: MS- Office, MS- Word, MS- Excel and MS- PowerPoint
3. Introduction to data mining
4. Internet- introduction and application

Unit IV

1 . Over view of Bioinformatics: Merger of life sciences with computers.
2. Search engines: Google, Pub Med, NCBI, EMBL,
3. Protein and DNA databases: Swiss port, PIR, OMIM, Embank, ENTREZ, DDJB, MIPS,.
4. Sequence 4Databases: Contents, Structure, and annotation for Human Genome

Unit V

1. Databases, Plant Genome Databases, Retrieving and installing a programme (Tree Tool), Multiple sequence alignment programme - Clustal W , X. Genome analysis programs; BLAST, FASTA, CGC, Motif and profile Sequence search.
2. Phylogenetic analysis: Phylogenetic reconstruction, distance matrices, Parsimony, Philip.
3. Methods of prediction of Proteins, DNA, RNA, fold recognition, structure prediction
4. Computer aided drug designing: Basic principles, docking, ADME/TOX
5. Genome mapping applications: EST and Functional genomics
6. Use of genome analysis programs, primer designing tools.

Course Outcome

By the end of the paper, a student would be able to:

CO1: To enable to promulgate the understanding of formulating, pursuing and analyzing research benefitting human development

CO2: To sensitize students regarding the ethics of conducting research by enabling in-depth understanding of plagiarism

CO3: To impart necessary traits to analyze, compare, logically criticize and evaluate biological data

CO4: To developing competitive acumen to use modern-age computer programs to analyze and represent research data

CO 5: To be able to develop and elevate skills of scientific writing to present research interpretations in a form of research paper, presentation, book chapters and short communication

M.Sc. Biotechnology
Semester-II

202--IMMUNOTECHNOLOGY

UNIT I

1. Immune response: Innate immune mechanisms and characteristics of adaptive immuneresponses, Hematopoiesis.
2. Anatomical organization of Immune System: Primary Lymphoid Organs, Secondary Lymphoid Organs, Ontogeny and Phylogeny of lymphocytes, Lymphocyte traffic.
3. Cell of immune system: Mononuclear cells and granulocyte, Antigen presenting cells, lymphocytes and their subsets. Antigens, Heptanes: Factor affecting immunogenecity, Super antigen.
4. Inflammation: its mediator and the process, cell-adhesion molecules

UNIT II

1. Major histocompatibility systems: Structure of MHC I and II molecules, polymorphism,distribution variation and function. Organization of MHC complex in mouse and humans. Association MHC with disease.
2. Recognition of antigens by T and B cells: Antigen processing, Role of MHC molecules in Antigen presentation and co stimulatory signals.
3. T-Cell receptor complex, T- Cell accessory membrane molecules, activation of T –cells, organization and arrangement of T-receptor genes.
4. B-cell receptor complex, activation of B-cells, Immunoglobulins: molecular structures, types and function. Antigenic determinants on immunoglobulins.

UNIT III

1. Molecular mechanism of antibody diversity: Organization of genes coding for constantand variable regions of heavy chain and light chain. Mechanism of antibody diversity,Class Switching.
2. Antigen-Antibody interaction avidity and affinity measurement.
3. Monoclonal antibodies: production, characterization and application in diagnosis, therapyand basic research.
4. Compliment System, components, Activation pathway and regulation of activation pathway, complement deficiency, role of complement system in immune responses.

UNIT IV

1. Cytokines: Structure and functions, cytokine receptors, signal transductions mediated by cytokine receptors, cytokine regulation of immune responses, cytokine related diseases and therapeutic applications of cytokines.
2. Cytotoxic T-cell and their mechanism of action, NK cell and mechanism of target cell destruction. Antibody dependent cell mediated cytotoxicity, delayed type hypersensitivity.Techniques of Cell-mediated immunity.
3. Immunoregulation by Antigens, Antibodies, immune complexes, MHC and cytokines.
4. Hypersensitivity: definition, IgE mediated hypersensitivity, mechanism of mast cell degranulation, mediators of type I reactions and consequences. Type II reactions, immune complex mediated hypersensitivity and delayed type hypersensitivity.

UNIT V

1. Autoimmunity: Organ specific diseases, systemic disease, mechanism ofautoimmunity.
2. Immunodeficiency Syndrome: Primary Immunodeficiencies and Secondary Immunodeficiencies and their diagnosis and therapeuticapproaches.
3. Vaccines: Active and passive immunization, whole organism vaccines, macromolecules as vaccines, Recombinant vector Vaccines, DNA Vaccines, synthetic peptide Vaccines and sub-unit Vaccines.
4. Immunodiagnostics: development of Immunodiagnostic Kits for infectious and non-Infectious disease with examples. Precipitation techniques, Agglutination, Fluorescence Techniques, ELISA, RIA, Western Blotting and immuno-histochemical techniques.

Course Outcome

By the end of the paper, a student would be able to:

CO 1: To have an in depth understanding on the history of important landmarks in the mammalian immune system

CO 2: To be able to correlate the molecules and organs of immune system

CO 3: To be able to understand and infer the use of immunological for methods diagnosis and therapeutics

CO 4: To be able to analyse the negative connotations of the immune system

CO 5:Compare and contrast the response of the host immune system to different pathogens

M.Sc. Biotechnology

Semester-II

203- Environmental Biotechnology

UNIT I

1. Environment: basic concepts, Environment pollution: types, methods for measurement of pollution
2. Population ecology(R & K selection)
3. Community ecology,
4. Waste treatment & Utilization: solid waste management, Waste water management
5. Biomedical waste and its management

UNIT II

1. Xenobiotics and its degradation
2. biosurfactants and biofilms
3. Integrated pest management- An ecological approach
4. Bioremediation: In -situ and ex -situ techniques, advantages of bioremediation, Applications of genetically engineered microbes (GEM) inbioremediation.
5. Phytoremediation: Types and its applications

UNIT III

1. Environmental monitoring: Bioindicators
2. Biogeography
3. Global environmental problems (Global warming, ozone depletion and kyotoprotocol) and their management
4. Petroleum biotechnology

UNIT IV

1. Biotransformation: Steroids
2. Mushroom Cultivation
3. Biofertilizers and its applications
4. Immobilization of microbial cells (Biofilms) and their applications
5. Biopesticide and its applications.

UNIT V

1. Conservation biology (principle of conservation, Indian case studies on conservation, project tiger and biosphere reserve, National Parks and sanctuaries)
2. Microbial production of SCP
3. Bioleaching, Concept of Green Energy
4. Environmental Protection act: legal issues and current scenario

Course Outcome

By the end of the paper, a student would be able to:

CO 1: To describe the role that biotechnology concepts have helped in environment management

CO 2: To describe the innovations and development of tools in Biotechnology

CO 3: To produce biofertilizer and explain the role that biotechnology concepts have helped in environment management

CO 4: To study the role of pollutants in human health and global environmental problems

CO 5: To study the need of conservation and design of action plans.

M.Sc. Biotechnology

Semester-II
(*Generic Elective)
204- Biophysical Chemistry – Techniques

Unit-1

1. Concept of free energy of molecules. Introduction to various force fields and their relative merits and demerits. Techniques for Molecular energy minimization, Monte Carlo and Molecular Dynamics simulation.
2. Water, PH, Buffer, Handerson and Hasselblach equation.
3. Titration of weak acid and weak bases
4. Basic calculation of concentration of deferent unit
5. Mass Spectrometry

Unit-2

1. Micro calorimetry (DSC and ITC) and its application
2. Circular Dichroism spectroscopy
3. UV, visible and Fluorescence spectroscopy, IR and Raman Spectroscopy
4. X-Ray Diffraction
5. Nuclear Magnetic Resonance (NMR)
6. ESR
7. Mass Spectroscopy

Unit-3

1. Ion exchange chromatography
2. Affinity Chromatography,
3. Paper chromatography
4. Thin layer chromatography
5. Gas liquid chromatography
6. Gas chromatography
7. Column chromatography
8. HPLC
9. Exclusion chromatography
10. Isoelectrofocusing

Unit - 4

1. Analytical Ultracentrifugation: Sedimentation velocity and equilibrium, determination of molecular weights
2. Electrophoresis of DNA, proteins and enzymes.
3. Southern, northern and western blotting
4. DNA Fingerprinting
5. Tracer Techniques – Nature and types, Decay units and preparation of labeled biological compounds.

Unit-5

1. DNA sequencing
2. Gene mapping techniques
3. Functional genomics (expression profiling, transcriptome, DNA array, gene function determination , protein interaction)
4. EMSA and FACS and Flow cytometry
5. PCR and its different variations, Analysis of molecular markers(SSLP , RFLP, AFLP, RAPD, ISSR, STS)

Course Outcome

By the end of the paper, a student would be able to:

CO 1: To explain techniques used in understanding the nature of proteins

CO 2: Ability to isolate and estimate chloroplast

CO3: To learn use instruments to interpret the results

CO 4: Apply the techniques of chromatography and electrophoresis to separate bio-molecules.

CO 5: To describe the various centrifugal techniques used for fractionation of cells, cell Organelles and bio-molecules.

M.Sc. Biotechnology

Semester-III

301- GENETIC ENGINEERING

Unit I

1. The recombinant DNA Technology : General concept and principle ofcloning
2. Enzymes: Nucleases and restriction endonucleases- properties and types; phosphomonoesterases; polymerase; terminal deoxynucleotidyl transferase; poly A polymerase, Linkers, adaptors and homopolymer tailing.
3. prokaryotic host- vector system: Characteristics of E.coli as host; vectors for cloning in E.coli (plasmid, bacteriophage- EMBL, DASH, gt10/11, ZAP etc and plasmid-phage)
4. Other Prokaryotic host vector systems: BAC, Characteristics of Gram positive and Gram negative organism as host and suitable vectors for cloning; Shuttle Vectors

Unit II

1. Design and characteristics of expression vectors for cloning in prokaryotes and factorsthat affect expression.
2. Cloning in Yeast: Properties of yeast as host for cloning and different types of vectors designed for cloning in yeast
3. Cloning in animal system: Animal system as a model host, Methods of introduction of foreign DNA in animal system; Vectors for cloning in animal system- SV-40, vaccinia virus, baculovirus and retrovirus vectors ,pMal, GST, pET based vectors, Pichia basedvectors.
4. Plant transformation technology: Features of Ti and Ri plasmids, mechanism of DNA transfer.

Unit III

1. Methods for Constructing rDNA and cloning: Inserts; vector insert ligation; infection, transferring and cloning
2. Methods for screening and selection of recombinant clones
3. DNA Libraries: types, advantages and disadvantages of different types of libraries; Different methods for constructing genomic and full length cDNAlibraries
4. Gross anatomy of cloned insert- size, restriction mapping and location

Unit IV

1. Fine anatomy of DNA segment- General principle of chemical andenzymatic methods of nucleotide sequence analysis and advantages of automatic gene sequencers.
2. Localization of cloned segments in genomes- molecular and chromosomallocation
3. Methods for determination of copy number of a cloned gene ingenome
4. Mutant construction: Introduction, deletion, insertion and point mutation

Unit V

1. Principles and applications of Blotting techniques- Southern, Northern, Western and Eastern blotting; Polymerase Chain reaction and types (multiplex, nested, RT, real time, touch down PCR, hot start PCR, colony PCR), Oligonucleotide
2. Principle and applications of gel mobility shift assay, DNA fingerprinting and DNA Foot printing, restriction fragment length polymorphism, Chromosome mapping and chromosome painting
3. Application of Recombinant DNA technology in Medicine & Industry
4. Si RNA technology: Micro RNA Construction of Si RNA vectors: Gene silencing and its applications in agro industry.

Course Outcome

By the end of the paper, a student would be able to:

CO1: To explain the basic tools required in recombinant DNA technology

CO2: To explore the methods used to study gene location and structure

CO3: To know the various techniques used to study the gene expression and regulation

CO4: To assess the techniques used in analyzing transcripts and proteins

CO5: To be discuss problems associated with production of recombinant molecules

M.Sc. Biotechnology

Semester-III

302- Metabolism: Basic Concept and Design

Unit-1

1. Basic concept, laws of thermodynamics, ATP role in metabolism, oyher high energy phosphate molecule.
2. Mechanism of Enzyme catalysis and action, Enzyme inhibition, activation of enzymes
   Immobilized enzymes
3. Different mechanisms of enzyme catalysis acidbase and covalent catalysis
4. Molecular mechanism of action of chymotrypsin, Lysozyme and carboxy peptidase
5. Structure-function relationship of enzymes

Unit-2

1. Glycolysis: Key structure and reactions, formation of1,6 bisphosphate, formation of glyceraldehyde 3-phosphate, formation of pyruvate and generation of second ATP, entryof fructose and galactose into glycolysis, phosphofructokinase as key enzyme in glycolysis,hoxokinase and pyruvatekinase as regulatory enzymes, conversion of pyruvate into ethanol lactate or acetyl CoA.
2. Gluconeogenesis: Synthesis of carbohydrates by noncarbohydrate precursors, gluconeogenes is nota reversal of glycolysis, activation of pyruvatecarboxylase by acetyl CoA, oxaloacetate shuttle,energy consumption in the synthesis of glucose from pyruvate, reciprocal regulation of gluconeogenesis and glycolysis, conversion of lactate and alanine into glucose
3. Pentose phosphate pathway : Generation of NADPH and interconnection of glycolysis and pentose phosphate pathway, control of rate of pentose phosphate pathway by NADPH+, regulation of flow of glucose 6 phosphate by the need of NADPH, ribose 5 phosphate and ATP, glucose 6 phosphate dehydrogenase defficiency.

Unit-3

1. Electron transport and oxidative phospherylation, energetics of oxidative phosphorylation, enrgy yield by complete oxidation of glucose.
2. Citric acid cycle: Formation of acetyl CoA from pyruvate, condensation of oxaloacetate with acetyl CoA to form citrate, isomerization of citrate intoisocitrate, oxidative decarboxylation of succinyl CoA, generation of high energy phosphate from succinyl CoA, regeneration of oxalate, sloichiometry of citricacid cycle, pyruvate dehydrogenase complex, citric acid cycle as a source of biosynthetic precursors, control of pyruvate dehydrogenase complex, control of citric acid cycle, citric acid cycle and its high energy yield.
3. Carbohydrate Metabolism: Photosynthesis, C_3, C_4 & CAM plants.

Unit-4

1. Fatty acid oxidation
2. Digestion, mobilization and transport of fatty acids, Mobilization of stored triglycerides by hormones, activation of fatty acids and their transport tomitochondria, oxidation of saturated fatty acids, Oxidation of unsaturated fattyacids, and oxidation of odd chain fatty acids. Ketone bodies, over production of kelone bodies.
3. Biosynthesis of fatty acids
4. Formation of malony CoA, fattyacid synthase complex, fattyacid synthase multifunctional proteins, shuttling of acitate out of mitochondria as citrate, Reactions of fatty acidsynthase, regulation of fatty acid biosynthesis, Biosynthesisof triglycerols, membrane phospholipids and prostaglandins.

Unit-5

1. Amino acid degradation oxidative deemination, conversion of NH_4 into urea, linkage between ureacycle and citirc acid cycle, conversion of alanineserine and cystein into pyruvate, conversion of aspartate and asparagine into oxalocetate, conversion of several amino acid into alpha ketoglutarate through glutamate, succinyl CoA as a point of entry for some amino acids, leucine degradation to acetylCoA and acetoacetyl CoA, phenyl alanine degradation to acetoacetate and fumarate.
2. Biosynthesis of amino acids : Conversion of nitrogen to NH_4 by micro-organisms, conversion of amonia into amino acids by way of glutamata and glutamine,conversion of citric acid Intermediates to amino acids,glutamate as precursor of glutamine, proline and arginine, conversion of 3-phosphoglycerate to serine, synthesis of cystein from serine and homocysteine,feed back regulation of amino acid biosynthesis.
3. Biosynthesis and degradation of Nucleotides:
   Purine biosynthesis : formation of PRPP, Biosynthesis of IMP, Purine nucleotide interconversions, regulation of purine biosynthesis.
   Pyrimidine Biosynthesis : Assembly of the pyrimidinenucleus, synthesis of di & tri phosphates, formation of deoxyribonucleotides, thymine biosynthesis salvage pathway for purine and pyrimidine nucleotides, Degradation of purines and pyrimidines to uric acid and urea.

Course Outcome

By the end of the paper, a student would be able to:

CO 1: To distinguish between anabolic and catabolic processes of carbohydrates and lipids

CO 2: Compare and contrast metabolic pathway of complex carbohydrates in different living System

CO 3: To elucidate the role of lipids in maintaining homeostasis at cellular and systemic level

CO4: To describe the different models of enzyme catalysis and the mechanisms for its Assessment

CO5: To explain various methods for identifying active site residues

M.Sc. Biotechnology

Semester-III

(**Discipline centric elective)

Paper-303(A)

303 A : BIOPROCESS ENGINEERING AND TECHNOLOGY

UNIT I

1. Introduction to bioprocess engineering
2. Isolation, preservation and Maintenance of Industrial microorganisms.
3. Kinetics of microbial growth and death,
4. Media for industrial fermentation. Air and media sterilization

UNIT II

1. Aeration and Agitation systems for bioreactor
2. Safety in fermentation laboratory
3. Strain improvement of industrially important microorganism.
4. Bioreactors: Principle, Kinetics, types, design, and application.

UNIT III

1. Flow behaviour of fermentation fluids
2. Gas-Liquid mass transfer, significance of Ka, and Heat transfer.
3. Automation for monitoring and control.

UNIT IV

1. Downstream processing: Introduction, removal of microbial cells and solid matter, foam reparation, precipitation, centrifugation, cell disruption, chromatography
2. Extraction:-solvent, two phase, liquid extraction
3. Product recovery processes
4. Crystallization, packaging and quality assurance.
5. Classification of product formation
6. Product synthesis kinetics

UNIT V

1. Microbial Production of antibiotics: Penicillin;
2. Microbial Production of Vitamins & amino acids (Vit B12 & Glutamic acid)
3. Microbial production of enzymes: Amylase,
4. Microbial production of alcoholic beverages: Distilled alcoholic beverages-Beer, microbial production of Vinegar.
5. Microbial production of Organic acids: Citric acid & Acetic acid
6. Microbial production of solvents: Ethanol and acetone
7 Microbial production of food –SCP

Course Outcome

By the end of the paper, a student would be able to:
CO 1: To analyse the role of microbiology in the field of Biotechnology
CO 2: To learn how to work with microbes
CO 3: To explain bioprocessing using microbes to get different products
CO 4: To evaluate the way the microbes can be improved to enhance quality and yield of products
CO 5: To appraise the techniques that have been developed in Microbial Biotechnology

M.Sc. Biotechnology

Semester-III

Paper-303(B)

(**Discipline centric elective)

Medical Biotechnology

UNIT I

Biotechnology in medicine: History, scope & importance of Biotechnology in medicine Disease Diagnosis (DNA, RNA probes), Detection and Treatment of genetic Diseases.

Genetic Counseling and Forensic Medicine: Fertility control, Genetic counseling, (Chance of having child with congenital defects, choice of Baby sex)

DNA Fingerprinting in Forensic Medicines.

UNIT 1I

Gene therapy: Definition and types of Gene therapy, Initial success and future of Gene therapy, Vectors and other delivery system of gene therapy, Target tissue for gene therapy system, Gene therapy of genetic diseases(Neurological Disorders, Cystic Fibrosis),Gene therapy of Acquire diseases(Infectious Diseases, Cardiovascular diseases, cancer), Nanobiotechnology for drug targeting and gene therapy.

UNIT III

Pharmaceutical Biotechnology: Drug development, drug manufacturing processes, manufacturing processes of antiviral drugs, drug designing, Novel drug delivery systems, Antimicrobial drugs.

Pharmacogenetics: Pharmacogenetics and personalized medicine, genetics and genomics in medical practice, use of SNPs in pharmocogenomics.

UNIT IV

Genetic Engineering: Genetic and recombinant vaccines; Edible vaccines production of therapeutic proteins; Genetic engineering for production of Factor VIII, tissue plasminogen activator, Interferon.

Tissue Engineering: Tissue engineering of skin and cartilage and their applications, properties and types of stem cells, culture and applications of stem cells, Transplant rejection, Intellectual property issues in using human embryonic stem cells.

UNIT V

UNIT IV

Drug Discovery and Designing: History and molecular aspects of drug discovery, drug discovery in cancer, microbial genomics for new antibiotics, drug designing.

Metabolic engineering: Cloning and expression of heterologous genes, molecular breeding of Bio synthetic pathways, metabolomics and metabolic engineering, limitations in metabolic engineering.

Monoclonal Antibodies auto Antibodies

Course Outcome

By the end of the paper a student would be able to:

CO1: Improrrtance of Biotechnology in development of medicines

CO2: Role of genes in development of disease

CO3: Production of genetic and recombinant vaccines.

CO4: Production and uses of monoclonal antibodies.

CO5: Basics of drug designing

M.Sc. Biotechnology

Semester-III

(*Generic Elective)

304 PLANT BIOTECHNOLOGY

Unit I

1. Objectives, roles, landmark and new challenges in plant breeding.
2. Plant breeding techniques: Mutational breeding and distant hybridization.
3. Generation of genetically modified crops for resistance against biotic andabiotic stresses and nutritional quality.
4. Seed production techniques: release of new varieties.

UNIT II

1. Germplasm Conservation and maintenance
2. Plant Pathology overview and future perspectives
3. Organic farming: Methods and management
4. Hydroponics and aeroponics

UNIT III

1. Somaclonal variation and its application for plant improvement
2. Protoplast isolation and fusion, selection of hybrid cell and cybrids
3. Cryopreservation techniques and application
4. GM crops (development and future aspects.)

UNIT IV

1. Plant cloning vectors: ti Plasmid and viral vectors (CaMV based vectors, Gemini viruses,
2. TMV based vectors, Antisense RNA and ribosome technology
3. Transgenics in crop improvement: Methods for gene transfer field, Chloroplast transformation, testing and commercialization.
4. Plant physiology, plant hormones, stress physiology, secondary metabolites, photoperiodism and vernalization,solute transport and translocation.

UNIT V

1. Plant Genome mapping: Physical and molecular maps , Gene tagging
2. Insect resistance, Bt genes, Non-Bt like protease inhibitors, alpha amylase inhibitor, green House technology
3. Seed production techniques, release of new varieties and plant breeders' right: UPOV 369, 370,372.

Course Outcome

By the end of the paper, a student would be able to:

CO1 : Learn basic organic farming method.

CO2: To Learn production of GM Crops.

CO 3: To understand plant cloning vectors

CO 4: To learn basics of plant physiology

CO5: To learn techniques of plant genetic mapping

M.Sc. Biotechnology
Semester-IV

401: ENTREPRENEURSHIP IN BIOTECHNOLOGY &INTELLECTUAL PROPERTY RIGHTS

Unit 1

1. Creativity & Entrepreneurial personality and Entrepreneurship in Biotechnology Organizational structure & Management, Capital Management, Product innovation and management Government schemes for commercialization of technology (e.g. Biotech Consortium)

Unit 2

1. Basics of production management: Methods of manufacturing-Project/Jobbing, Batch Production, Flow/Continuous production, process production-Characteristics of each Method. Plant location-Importance-Factors affecting location-factory Building-Plant Layout- Installation of Facilities.
2. Operational Research: Linear Programming, PERT and CPM; Production Planning & Control-Scheduling-Gantt Charts-Documentation-Production Work Order.
3. Basics of material management
4. Personnel management E.g., Communication skills; Managerial and personal, training ,etc.

Unit 3

1. Kaizen (Continuous improvement in product & management)
2. Six Sigma
3. Biotech enterprises: Small, Medium & Large
4. Quality control in Biotech industries

Unit 4

1. Govt. regulations for biotech products
2. Public policy, regulatory and ethical challenges facing the biotechnology Entrepreneurship
3. Business development for medical products
4. Business development for consumable products

Unit 5

1. Patenting System: WTO, Paris Convention, Indian Legislations
2. Intellectual Property: A. Copy Right & Industrial Properties, Trademarks, Designs, Geographical Indications
3. IPR & Technology transfer, Role of patentee & Licensor
4. Patent process & Patent laws & e-filing

Course Outcome

By the end of the paper, a student would be able to:

CO1: To learn basics of patenting laws and regulations
CO2: To develop entrepreneurship among the students
CO3: To understand basics of working culture of biotechnology industry.
CO4: to enhance knowledge of Intellectual property rights like copyright trademark.
CO5: To learn filing of patent and associated rule regulations.

M.Sc. Biotechnology

Semester-IV

Paper-402-A

(**Discipline centric elective)

Animal Cell culture

UNIT I

Animal cell and tissue culture: History and scope of animal biotechnology and genomics, advantage and Laboratory Facilities

Introduction and organization of animal cell and tissue culture laboratory for Cell and Tissue Culture, Substrate, Culture Media and Procedures for Cell and Tissue Culture, Primary cell Culture and Cell Lines,

Stem Cells: Introduction, Origin, Types and functions of Stem Cells, Therapeutics, cloning for embryonic stem cells, Stem Cell Therapy.

UNIT II

1. Primary and established cell line cultures
2. Serum and protein free defined media and their applications
3. Introduction to balanced salt solutions and simple growth medium: rationale of composition of medium, role of CO2 and supplements

4.Organ/Embryo Culture: Primary Tissue Explanation Techniques, Organ Culture, Embryo Culture.

5.Cell and Tissue engineering: Approaches and Bio-Materials for tissue engineering, Tissue engineering of skin (Skin Graft), Engineering of Bone Crafts and Artificial Nerve Crafts, Future Limitations and Possibilities of Tissue Engineering.

UNIT III

In Vitro Fertilization and Embryo Transfer: In Vitro Fertilization in Human, Embryo Transfer (ET) in Humans, Super Ovulation and Embryo Transfer in Farm Animals (e.g. Cow).

Cloning of Animals: Method, Types and utility of cloning animals, Cloning for Production of Transgenic Animals, Human Cloning and Ethical issues and Risk.

UNIT IV

Transgenic Animals: Gene Transfer or Transfection (Transfection of embryo, unfertilized eggs, culture of mammalian cells), Transgenic Animals, Cryopreservation. Measurement of parameters of growth, Scaling up of animal cell culture, Cell synchronization, 3-D animal cell culture, 4. FISH and applications of animal cell culture

UNIT V

Molecular Maps: Genetic Maps Using Molecular Markers, Cytogenetic Maps Using Molecular Markers, Physical Maps Using Molecular Markers.

Genomics and Proteomics: Human Genome project, Progressing Genomic Research (Drosophila, Mouse, Rat, Chimpanzee), Integrated Genomic Maps and Linkage Disequilibrium, Maps of the Future, Introduction types and application of proteomics.

Course Outcome

By the end of the paper, a student would be able to:

CO 1: To demonstrate the culturing of animal cells in vitro

CO 2: Comprehend how biotechnology has helped in Drug Discovery and Development

CO 3: To explain the culturing of animal cells in vitro and its applications

CO4: To study and learn basic about human genome and molecular markers and progressive research.

CO5: Student will learn about cell ,tissue transplanting techniques and also aware with there significance for the human welfare.

M.Sc. Biotechnology
Semester-IV
Paper-402 (B)
(**Discipline centric elective)
Plant Tissue Culture

UNIT I

Plant Tissue Culture: Basic aspects of plant biotechnology (History, application, scope and importance), laboratory

Sterlization techniques

Culture media for plant tissue culture, cell Culture and its applications.

Clonal Propagation and Protoplast Culture: Micro propagation

UNIT II

Somaclonal Variation, Protoplast isolation, Regeneration of plant, Somatic Hybridization Gene Transfer in Plants: Vectors of gene transfer (Plasmids, Agrobacterium and Virus vector) Transformation technique (Agrobacterium mediated gene transfer, DNA mediated gene transfer (DMGT) Removal of selected Marker Genes from Transgenic Plants, Regulatory sequences of induced genes.

Transgenic Plant resistance against Stress: Development of herbicide resistant transgenic plant, Development of insect resistant transgenic plant, Transgenic plant resistance against virus, bacterial and fungal pathogens, transgenic plant resistance against abiotic stress.

UNIT III

Production of virus free plants

Haploid production: ovary and anther culture

Genetically Modified Crops and Floricultural Plants: Transgenic plants with improved crop productivity, Transgenic plants with improved nutritional quality, Transgenic plants for Floriculture. Molecular Farming:

Transgenic Plants for Value Added Specialty Crops, Transgenic Plants for Edible Vaccines, Transgenic Plants for Antibodies and Transgenic Plants for Biopharmaceuticals

UNIT IV

Transgenic Plants for Biosafety: Biosafety regulations of Transgenic Crops, Commercialization of Transgenic plants, quality modifications of plants (Modification of starch quality, modification and future of oil quality and modification of seed protein quality).

Choloroplast Engineering: plants Engineering of Chloroplast Genome, Transformation of choloroplast genome in higher plants, Transplastomic Plants and its applications (in Tabacco, Patato, Rice, Tomato etc.)

UNIT V

Protoplasm fusion

Construction of Molecular Maps: Preparation of Genetic Maps, (cereals, millets, sugarcane, cotton, Soyabean, Pea, Sunflower, etc.), Molecular genetics maps of high density plants, Uses of molecular genetics maps.

Genomics: Microcllinearity in DNA Sequences of Small Genomic Regions, Thale cress genome, Rice (Oryza Sativa)

Course Outcome

By the end of the paper, a student would be able to:

CO1 : Learn basic plant tissue culture method.

CO2: To Learn different culture medium, major and micronutrients.

CO 3: To understand plant breeding experiments and callus culture

CO 4: To produce transgenics and virus free plants.

CO5: To learn cryopreservation methods

M.Sc. Biotechnology
Semester-IV
Paper-403
Dissertation andPresentation

Course Outcome

By the end of the Dissertation , a student would be able to:

CO1 : students would be able to learn how to design the objectives or experiment.

CO2: students would be able to learn the different techniques through experimental design.

CO 3: students would be able to analyze the data through statistical software.

CO 4: students would be able to gain the knowledge of basic research.

CO5: students would be able to think independently in various research areas and design of experiment so that they will absorb in various pharmaceutical industries and research lab in the country and abroad.