

CENTRE FOR BIOTECHNOLOGY & MICROBIOLOGY STUDIES,
SCHOOL OF ENVIRONMENTAL BIOLOGY,
A.P.S. UNIVERSITY, REWA (M.P.)

B.Sc. (Hon's) BIOTECHNOLOGY

PROGRAMME OUTCOME

PO#	PROGRAMME OUTCOME
PO1	Bachelor course in biotechnology offers the synergism of basic concepts of biology, biotechnology, molecular biology, genomics, Recombinant DNA technology, microbiology, biochemistry and bioinformatics with technological applications.
PO2	The main objective of this degree course is to produce graduates with enhanced skills, knowledge and research aptitude to carry out higher studies, entrepreneurship or research and development in the various health, research and industrial areas.
PO3	Develop proficiency in application of current aspects of biotechnology, molecular biology, Recombinant DNA technology, bioinformatics and genomics. Prepares the students for immediate entry to the workplace with sound theoretical, experimental knowledge in the area of health and pharmaceuticals, biochemicals, biofuel, environment related, food and dairy, cosmetics, biopolymers and related multidisciplinary fields.
PO4	Overall, the course offers basic foundation in biotechnology which enables the students to understand the concepts in biochemistry, molecular biology, microbiology, genetic engineering and related industrial technology.
PO5	Students will be able to design, execute, record and analyse the results of experiments in field of molecular biology, genomics,, Recombinant DNA technology, biochemistry, microbiology and genetic engineering.
PO6	Students will be able to work effectively in a group in the classroom, laboratory, industries and fieldbased situations.
PO 7	Become efficient in using standard operating procedures and will be well versed with the regulationsfor safe handling and use of chemicals as well as IPR and biosafety issues related to experiments in field of biochemistry, microbiology and genetic engineering.

(Program Outcomes)

PSOs

(Program Specific Outcomes)

PSO #	PROGRAMME SPECIFIC OUTCOME
PSO 1	Critical Thinking- Students will demonstrate an understanding of major concepts in all disciplines of biology, biochemistry, biotechnology microbiology and bioinformatics. Understand the basic concepts, fundamental principles, and the scientific theories related to various scientific phenomena and their relevancies in the day-to-day life.
PSO 2	Effective Communication- Development of various communication skills such as reading, listening, speaking, etc., which will help in expressing ideas and views clearly and effectively.
PSO 3	Social Interaction- Development of scientific outlook not only with respect to science subjects but also in all aspects related to life
PSO 4	Effective Citizenship- Imbibe moral and social values in personal and social life leading to highly cultured and civilized personality.

Course Outcome (COs)

S.No.	Course Name	Course Code
	Semester-I	
101	Cell Biology	C1
	Course Outcome	
CO1	Develop an understanding of the Cytoskeleton, Microtubules, microfilaments and Cell Membrane.	
CO2	Distinguish between the cellular organization of prokaryotic and eukaryotic cells	
CO3	Would have deeper understanding of cell at structural and functional level.	
CO4	Would have broad knowledge on the molecular interaction between cells.	
CO5	Would demonstrate a clear understanding of the signal transduction, secondary messengers.	
102	Animal Biodiversity 1	C2
	Course Outcome	
CO1	To understand diversity in animal kingdom	
CO2	will be able to understand role of protozoa in human and bacterial disease	
CO3	Study of Insects belongs to largest Phylum Arthropoda and associated diseases.	
CO4	Student will be able to identify the zoological samples belongs to different phyllums.	
CO5	Students will study the habitat and adaptations found in organisms.	
103	Chemistry -1	GEC1
	Course Outcome	
C01	Students will be informed about atomic structure	
C02	After studying this course students will have better understanding of chemical bonding	

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C03	Students will be informed about periodic table and s p d block elements	
C04	Students will be aware about thermodynamics and solid state	
C05	students will have better understanding of chemical analysis and structure	
104	English	AECC1
	Course Outcome	
C01	To enhance all the four communication skills in the students-- listening, speaking, reading and writing.	
C02	To familiarize the students with the nature and importance of effective communication skills in their professional life.	
C03	To make the students capable of actively participating in various individual/group communications such as group discussion, debate, meeting, presentation etc.	
C04	To enrich the vocabulary of the students to make them efficient communicators.	
C05	To strengthen the Grammar of the students.	
	SEMESTER -II	
201	Genetics & Molecular Biology	C3
	Course Outcome	
C01	Concept of gene, pseudogene, cryptic gene and split gene	
C02	DNA replication and regulation in prokaryotes and eukaryotes	
C03	Transcription in prokaryotes and eukaryotes, Translation in prokaryotes and eukaryotes	
C04	Post translation and transcriptional mechanism.	
C05	Gene expression in prokaryotes using Lac operon and Trp operon.	
202	Animal Biodiversity 2	C4
	Course Outcome	
CO1	To understand higher animal kingdom	
CO2	will be able to understand phylum chordata	

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CO3	Study of mammals	
CO4	Student will be able to identify the zoological samples belongs to different phylum.	
CO5	will study the nomenclature of animals and underatand	
203	Chemistry 2	GEC2
	Course Outcome	
C01	Students will be informed biomolecules	
C02	After studying this course students will have better understanding of carbohydrate lipid protein	
C03	Students will be informed about structure of DNA/RNA	
C04	Students will be aware about thermodynamics and solid state	
CO5	Students will be informed molecular arrangements	
204	Environmental Studies	AECC2
	Course Outcome	
C01	Have knowledge of the Modern fuels and their environmental impact – Methanogenic bacteria, Biogas, Microbial hydrogen Production, Conversion of sugar to alcohol Gasohol.	
C02	Comprehend the Structural and Functional dynamics of microbes, their diversity, activity and growth, community profiling their uses as biosensors, bioreporters, Microchips. Also know about Methanogenesis: methonogenic, acetogenic and fermentive bacteria	
C03	Have knowledge of treatment of municipal waste and Industrial effluents, Biofertilizers: Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil, algal and fungal biofertilizers (VAM).	
C04	Have basic understanding of Enrichment of ores by microorganisms (gold, copper, and Uranium),	
CO5	Environmental significance of Genetically modified microbes, plants and	

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	animals.	
	SEMESTER-III	
301	Bio-analytical Tools	C5
	Course Outcome	
C01	Concept of electromagnetic radiation, absorption spectrum, Beer's law and Lamberts law, Principle, working and applications of spectrophotometer and AAS	
C02	Concepts of chromatography and concept of partition coefficient	
C03	Principle, methodology and application of various chromatographic techniques	
C04	Centrifugation and Electrophoresis-Principles and applications	
CO5	Importance of radioactivity in biological studies, GM counters and Scintillation counting.	
302	Plant Biotechnology	C6
	Course Outcome	
C01	Have a strong foundation of basics of botany. Study of physiology of plants.	
C02	The students will get proper knowledge about the media preparation for In-vitro propagation of plants and different aseptic techniques used during preparation.	
C03	The students will learn the role of techniques haploid plant production and its significance.	
C04	The students will learn about the protoplast isolation and somatic hybridization of protoplast and its application.	
C05	The students will learn about the transgenic plants and different strategies to make recombinant and its application.	
303	Biochemistry & Metabolism	GEC3
	Course Outcome	
C01	Characteristic of Enzymes, enzyme inhibition and kinetics	
C02	Carbohydrate metabolism, significance of glycolysis and ETC, untreated diabetes	

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C03	Lipid metabolism and production of ketone bodies	
C04	CO4 Protein metabolism, role of urea cycle and errors of protein metabolism	
C05	Basics Biomolecules and secondary metabolism	
304	Industrial Fermentation	SEC1
	Course Outcome	
C01	Understand the basics of industrial fermentation technology	
C02	Have knowledge of fermentation medium and sterilization techniques	
C03	Have knowledge of Industrial fermentation process, types of fermentation	
C04	Know the process development, upstream and downstream processing	
C05	Understand the production of Industrial fermented products	
SEMESTER-IV		
401	Immunology	C7
	Course Outcome	
C01	Know the history and scope of Immunology.	
C02	Understand the types of Immunity: Passive, Active, Innate and Acquired immunity, Humoral and Cell Mediated Immunity and the cell and organs of immune responses and their functions, B & T cells.	
C03	Have basic knowledge of Antigens as haptens, epitopes and Factors influencing immunogenicity, and Antibodies as their Structure, types, production and functions of immunoglobulins also about Clonal selection theory and Antigen Antibody reactions as Precipitation, Immuno-electrophoresis, Haem-agglutination, RIA and ELISA.	
C04	Comprehend Histocompatibility, structure of MHC class I, II & III antigens and their mode of antigen presentation, MHC restriction Complement system: Components, Classical and alternate pathways of complement activation, Hypersensitivity, Autoimmunity	
C05	Understand Passive and Active immunization, Types of Vaccines: Inactivated, Attenuated, Recombinant and Sub Unit Vaccines, Peptide and DNA Vaccines	
402	General Microbiology & Physiology	C8
	Course Outcome	

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CO1	Study of Basics of microbiology & Basics of Recombination in Prokaryotes	
CO2	General Classification of microbes	
CO3	Basics of Control of Microorganisms	
CO4	Study of bacteriophages and microbes in extreme environments and microbial interactions	
CO5	General Classification of microbes, viruses and fungal kingdom	
403	Biotechnology & Human Welfare	GEC4
	Course Outcome	
CO1	Get knowledge about classification of pathogenic microbes, protozoal parasites, and medical bacteriology.	
CO2	Get to know about viral diseases and medical mycology and preventive measures.	
CO3	To understand how blood cell are formed, blood cancer, about brain as well as brain tumour. Pathology of AIDS, Japanese encephalitis, yellow fever, dengue and TB.	
CO4	To understand various therapeutics measures including antibiotics.	
CO5	To get knowledge about medico-legal aspects of medical biotechnology	
404	Molecular Diagnostics	SEC2
	Course Outcome	
C01	Molecular diagnostics are used to identify infectious diseases such as chlamydia, influenza virus and tuberculosis or specific strains such as H1N1 virus or SARS-CoV-2.	
C02	Molecular diagnostics are also used to understand the specific strain of the pathogen—for example by detecting which drug resistance genes it possesses—and hence which therapies to avoid	
C03	In addition, assays based on metagenomic next generation sequencing can be implemented to identify pathogenic organisms without bias.	
C04	Molecular diagnostics is a more sensitive method allowing detection of lower amounts of infectious agents and therefore giving the ability to detect infections earlier than was previously possible.	

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CO5	This ability is especially significant in blood screening.	
	SEMESTER -V	
501	RECOMBINANT DNA TECHNOLOGY	C9
	Course Outcome	
C01	Students get proper knowledge about the DNA manipulative enzymes: Restriction enzymes and DNA ligases, and Gene cloning vectors.	
C02	learn about screening and selection of recombinant host cells, Expression of cloned DNA	
C03	Learn about the basics of Electrophoretic techniques, Polymerase chain reaction (PCR), Site directed mutagenesis (SDM), Nucleic acid sequencing: Blotting techniques.	
C04	Students will have knowledge of Application of r-DNA technique in human health, Production of Insulin, Production of recombinant vaccines: Hepatitis B, Production of human growth hormone.	
CO5	learn about screening and selection of recombinant host cells, Gene Libraries, cloning techniques,	
502	Environmental Biotechnology	DSE1
	Course Outcome	
C01	CO1 Have knowledge of the Modern fuels and their environmental impact – Methanogenic bacteria, Biogas, Microbial hydrogen Production, Conversion of sugar to alcohol Gasohol.	
C02	Comprehend the Structural and Functional dynamics of microbes, their diversity, activity and growth, community profiling their uses as biosensors, bioreporters, Microchips. Also know about Methanogenesis: methonogenic, acetogenic and fermentive bacteria- technical processes and conditions	
C03	Gain insight on Bioremediation and Phytoremediation of soil & water contaminated with oil spills, heavy metals and detergents and use of microbes in degradation of lignin and cellulose using and of pesticides and other toxic chemicals by micro-organisms, Degradation of aromatic and chlorinated	

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	hydrocarbons and petroleum products.	
C04	Have knowledge of treatment of municipal waste and Industrial effluents, Biofertilizers: Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil, algal and fungal biofertilizers (VAM).	
CO5	Have knowledge of Degradation of aromatic and chlorinated hydrocarbons and petroleum products.	
503	Animal Biotechnology	SEC3
	Course Outcome	
C01	Students get proper knowledge about the history and Scope of Animal Tissue Culture, Culture Media, Simulating natural conditions for growth of animal cells. Have knowledge of Production and Applications of monoclonal antibodies, and Transgenic Animals	
C02	gain knowledge about Primary Culture, cell lines and Secondary Culture, transformed animal cells and continuous cell lines. Monolayer formation, Synchronization.	
C03	learn about transfection of animal cell lines, Selectable makers and Transplantation of Cultural Cells. Microinjection, In vitro fertilization and Stem cell technology.	
C05	learn about the basics of expression of Cloned proteins in animal cell and Production of Vaccines in animal Cells.	
	Field Project & Training-1 (Bioprocess Technology)	
	Course outcome	
CO1	Bioprocess technology itself is very important and job oriented branch of Biotechnology. The student will be aware of fermentation and its basics	
CO2	The student will have hands on experience in drug/antibiotic production at industrial level.	
	SEMESTER-VI	
601	Developmental Biology	C10
	Course Outcome	

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C01	Student will learn how a single cell becomes an organized grouping of cells that is then programmed at specific times to become specialized for certain tasks.	
C02	While embryonic development involves a series of highly controlled and coordinated steps, cancer exhibits a lack of cellular control.	
C03	Part of the “nature vs. nurture” paradigm involves non-genetic mechanisms that play a role in switching on and off various genes during development. IRP scientists are at the forefront of research into the importance of chromatin and epigenetics in many aspects of development and disease, including potential uses in gene therapies.	
C04	Learn the importance of chromatin and epigenetics in many aspects of development and disease, including potential uses in gene therapies.	
CO5	Understanding the key regulatory pathways behind development may point the way towards therapies designed to modulate disrupted pathways.	
602	FORENSIC SCIENCE	DSE2
	Course Outcome	
C01	Study of basics of Forensic sciences Human DNA quantization	
C02	Alternative genetic markers & Compromised DNA evidence	
C03	Mitochondrial DNA and Non-human DNA	
C04	Y-chromosome analysis, Microbial analysis, Sperm detection and separation	
CO5	Miniaturization and automation	
603	MEDICAL MICROBIOLOGY	DSE3
	Course Outcome	
C01	Get knowledge about classification of pathogenic microbes, protozoal parasites, and medical bacteriology.	
C02	Get to know about viral diseases and medical mycology and preventive measures.	
C03	To understand how blood cell are formed, blood cancer, about brain as well as brain	

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C04	tumour. Pathology of AIDS, Japanese encephalitis, yellow fever, dengue and TB.	
CO5	learn medical mycology and preventive measures.	
604	Field Project & Training 2 (Genomics & Proteomics)	
	Course Outcome	
C01	This course will consolidate the learning, knowledge and skills in the area of genomics and proteomics that have already taken place as well as developing the capability of the students to undertake and complete an academic research to apply what is learned in theory.	
C02	The course will develop the critical thinking, , problem solving, research and communication skills of the participants.	
C03	They will be able to raise a research question, answer it and write about its findings	
C04	Development of crucial skills among the participants will help them in boosting their employability	
	SEMESTER-VII	C11
	Enzymology	
CO1	To describe the different models of enzyme catalysis and the mechanisms for its assessment	
CO2	To explain various methods for identifying active site residues	
CO3	To illustrate the several methods for the enzyme regulation	
CO4	To appreciate the applicability of enzymology in various industries for growth and sustainability	
CO5	To develop skill for analyzing kinetic data of enzyme substrate reaction	
	Bioethics & Bio-safety	DSE4

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CO 1	To evaluate, understand and become aware of the risk factors and ethical issues associated with inbreeding in humans and pre-natal diagnosis of genetic diseases.	
CO2	Students will be informed about the safety measures and levels of laboratory.	
CO3	Students will be aware about the ethical issues and laws associated with laboratory and research	
CO4	Students will learn the research protocols and its importance's	
CO5	Students will learn the consequences of research copying	
	Research Methodology	C12
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	
	Field Project & Training	
CO1	The students will be supervised to go to the fields of their interest and learn the basics of research work	
C03	They will be able to raise a research question, answer it and write about its findings	
C04	Development of crucial skills among the participants will help them in	

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	boosting their employability	
	SEMESTER-VIII	C13
	Medical Biotechnology	
CO1	Importance 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 gene therapy and research in the area	
	Biostatistics & Bioinformatics	C14
CO1	To expose students to use computational power to evaluate biological information	
CO2	Acquire skills to retrieve information from biological data-bases, analyze it and further remodel protein and genes to create their phylogeny	
CO3	To impart necessary traits to analyze, compare,	
CO4	To developing competitive acumen to use modern-age computer programs to analyze and represent research data	
CO5	logically criticize and evaluate biological data	
	Research Project	
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.	

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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.	

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BSc. BIOTECHNOLOGY SEM-1				
S.No.	Paper code	PAPER NAME	PAPER CATEGORY	CREDIT
1.	C1	Cell Biology	MAJOR	06
2.	C2	Animal Diversity -1	MINOR	06
3.	GEC1	Chemistry -1	GEC	04
4.	AECC1	English	AECC	04
5.				
BSc. BIOTECHNOLOGY SEM-2				
		PAPER NAME	PAPER CATEGORY	CREDIT
	C3	Genetics & Molecular Biology	MAJOR	06
	C4	Animal Diversity -2	MINOR	06
	GEC2	Chemistry -2	GEC	04
	AECC2	Environmental Studies	AECC	04
BSc. BIOTECHNOLOGY SEM-3				
		PAPER NAME	PAPER CATEGORY	CREDIT
	C5	Bio-analytical Tools	MAJOR	06
	C6	Plant Biotechnology	MINOR	06
	GEC3	Biochemistry & Metabolism	GEC	04
	SEC1	Industrial Fermentation	SEC	04
BSc. BIOTECHNOLOGY SEM-4				
		PAPER NAME	PAPER CATEGORY	CREDIT
	C7	Immunology	MAJOR	06
	C8	General Microbiology & Physiology	MINOR	06
	GEC4	Biotechnology & Human Welfare	GEC	04
	SEC2	Molecular Diagnostics	SEC	04
BSc. BIOTECHNOLOGY SEM-5				
		PAPER NAME	PAPER CATEGORY	CREDIT
	C9	Recombinant DNA Technology	Major	06

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	DSE1	Environmental Biotechnology	DSE	04
	SEC3	Animal Biotechnology	SEC	04
		Field Project & Training-1 (Bioprocess Technology)		06
BSc. BIOTECHNOLOGY SEM-6				
		PAPER NAME	PAPER CATEGORY	CREDIT
	C10	Developmental Biology	Major	06
	DSE2	Forensic Science	DSE	04
	DSE3	Medical Microbiology	DSE	04
		Field Project & Training 2 (Genomics & Proteomics)		06
BSc. BIOTECHNOLOGY SEM-7				
		Paper Name	PAPER CATEGORY	CREDIT
	C11	Enzymology	MAJOR	06
	DSE4	Bioethics & Bio-safety	DSE	04
	C12	Research Methodology	Minor	04
		Field Project & Training 3 (.....)		06
BSc. BIOTECHNOLOGY SEM-8				
		Paper Name	PAPER CATEGORY	CREDIT
	C13	Medical Biotechnology	MAJOR	06
	C14	Biostatistics & Bioinformatics	MINOR	04
		Research Project (.....)		10

ABBREVIATION:

CC- CORE COURSE (MAJOR/MINOR)

DSE- DISCIPLINE SPECIFIC ELECTIVE

SEC- SKILL ENHANCMENT COURSE

AECC-ABILITY ENHANCMENT COMPULSORY

COURSE

GEC- GENERIC ELECTIVE COURSE

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s.no.	Class	Paper	Category	Credit
BT-101	BSc Biotechnology 1st	Cell Biology	MAJOR	06

Unit-1

Introduction, Scope and Importance, History of Cytology. Prokaryotic cell, Eukaryotic cell(Plant and Animal Cell). Structure of cell wall.

Plasma membrane: structure and functions (simple diffusion, facilitated diffusion, active transport, endocytosis, pinocytosis, phagocytosis, and exocytosis).

Unit-2

Structure and functions of mitochondria, chloroplast, Structure and functions of Endoplasmic reticulum, Endoplasmic reticulum targeting proteins, protein folding and processing in ER, Targeting of lysosomal protein. Structure and function of Golgi complex, Protein Glycosylation within the Golgi. Structure and functions of Ribosome. Lysosome and Intracellular digestion.

Unit-3

The nucleus and nucleolus. structure and classification of Chromosomes. Chromosome structure and its types. Lampbrush and Polytene Chromosomes. **Cellular reproduction:** Cell cycle- mitosis and meiosis.

Unit-4

Cell Motility and Shape I: Structure and function of microfilaments and Intermediate Filaments. Molecular Mechanisms of Cell-Cell Adhesions. Extracellular Matrix of animals, Cell signaling. Introduction and application of stem cells.

Unit-5

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General introduction of Cancer, Apoptosis and necrosis.

Techniques in cell biology: chromosomal banding techniques. Principles and applications of light microscope and electron microscope (Scanning and transmission). Karyotyping and Idiogram.

s.no.	Class	Paper	Category	Credit
BT-102	BSc Biotechnology 1 st	Animal Diversity -1	Minor	06

Paper-2nd (BT-102)

Animal Diversity -1

Unit-1

Elementary Knowledge of Zoological Nomenclature and International Code.
Classification of Lower Invertebrates (According to Parker and Haswell 7th edition)
Classification of Higher Invertebrates (According to Parker and Haswell 7th edition)
Protozoa- Type, Study of Plasmodium, Protozoa and Diseases.

Unit-2

Porifera- Type study of Sycon. Types of Canal system.
Coelenterata- Type study of Obelia Corals and Coral Reef formation.

Unit-3

Helminthes- Type study of Liver Fluke. Nematodes and diseases.
Annelida- Type study of earthworm, metamerism. Type Study of Hirudinaria.
Structure and significance of Trochophore larva.

Unit-4

Arthropoda- Type study of Prawn. Types study of Periplanata.
Larval forms of Crustacea.
Insect as Vectors of human diseases.

Unit-5

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Mollusca- Type study of Pila

Echinodermata- External features and water vascular system of Star fish. Larval forms of Echinoderms.

Minor Phyla – Ectoprocta & Rotifera.

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COURSE OUTCOMES

After completion of the course, a student will be able to COURSE OUTCOME

s.no.	Class	Paper	Category	Credit
BT-103	BSc Biotechnology 1 st	Chemistry -1	GEC	04

Paper- 3rd**Chemistry -1****Unit-1**

Atomic Structure: Idea of de Broglie matter wave, Heisenberg uncertainty principle, atomic orbital's, Quantum numbers, shapes of s, p, d orbitals, Trends in periodic table and applications in predicting and explaining the physical and chemical behaviors. Atomic radii, ionic radii, ionization energy, electron affinity and electro negativity.

Unit-2

Chemical Bonding: Valence bond theory and its limitations, directional characteristics of covalent bond, various types of hybridization and shapes of simple inorganic molecules and ions, Valence shell electron pair repulsion (VSEPR) theory, homonuclear and heteronuclear (CO and NO) diatomic molecules, Weak interactions, Hydrogen bonding, van der Waal forces.

Unit-3

s - Block elements: Comparative study, diagonal relationships, salient features of Hydrides, Solvation and complexation tendencies. **p- Block elements:** Comparative study of groups 13–17 elements, compounds like hydrides, oxides, halides of group 13-16, basic properties of halogens, inter halogens and polyhalides. **d- blocks elements:** First transition series - Properties of the elements of the first transition series, stability of their oxidation states, coordination number. Second and Third transition series – General characteristics, comparative treatments with their 3d- analogues in respect of ionic radii, oxidation state and magnetic property.

Unit-4

Thermodynamics- Principles, Kirchhoff's equation, calculation of w, q, ΔU , ΔH , The Hender- Hasselbatch equation, of thermodynamics, Enthalpy, Second law of

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thermodynamics, Entropy free energy, chemical equilibrium, law of mass action, Le Chatelier's principles.

Different States: Structural differences between - solids, liquids and gases. Intermolecular forces, Definition of space lattice, unit cell. Bragg's equation. crystal structure of NaCl, KCl and CsCl, Ideal and non ideal solutions, methods of expressing concentration of solutions, Acid-Base concept.

Unit-5

Chemical kinetics & its scope, Rate of reaction, factors influencing the rate of reactions, zero order, second order, pseudo order, half life & mean life, various theories of chemical kinetics, Arrhenius equation & catalysis.

Solution, ideal & non ideal solution, Different methods of concentration expression, Raoult's law

S.No.	Class	Paper	Category	Credit
BT-104	BSc Biotechnology 1 st	English	AECC	04

English Communication

1. Introduction: Theory of Communication, Types and modes of Communication

2. Language of Communication:

Verbal and Non-verbal (Spoken and Written)

Personal, Social and Business Barriers and Strategies

Intra-personal, Inter-personal and Group communication

3. Speaking Skills:

Monologue

Dialogue

Group Discussion

Effective Communication/ Mis- Communication

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Interview

Public Speech

4. Reading and Understanding

Close Reading

Comprehension

Summary Paraphrasing

Analysis and Interpretation

Translation(from Indian language to English and vice-versa)

Literary/Knowledge Texts

5. Writing Skills

Documenting

Report Writing

Making notes

Letter writing

BSc. BIOTECHNOLOGY SEM-2

S.No.	CLASS	PAPER NAME	PAPER CATEGORY	CREDIT
BT-201	BSc. BIOTECHNOLOGY SEM-2	Genetics & Molecular Biology	MAJOR	06

Genetics & Molecular Biology

Unit-1

Importance of Genetics, Gene, allele, genotype and phenotype.

Mendelian laws of inheritance, Monohybrid cross, Law of Dominance and the law of segregation, Dihybrid cross and law of independent assortment.

Interactions of genes, complementary genes, reversions, lethal genes, epistasis. Multiple

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alleles, Blood groups, Rh factor.

Unit-2

Sex linked inheritance: X linkage, sex linkage in man, color blindness, Hemophilia (Bleeder's disease) and other genetic diseases.

Characteristics of X linked inheritance.

Y linked inheritance in Man, Inheritance of X-Y linked Genes. Human genetics (pedigree analysis, karyotypes and genetic disorder).

Unit-3

Structure of prokaryotic and eukaryotic genomes. Molecular basis of life.

Nucleic acids as genetic material. Structure of DNA and its alternative forms.

Structure and Types of RNA. DNA replication in prokaryotes (enzymology and process)

Unit-4

Prokaryotic gene expression: Prokaryotic transcription, Genetic code

Prokaryotic translation. Regulation of gene expression: Operon concept (Lac and Trp operon)

Unit-5

DNA recombination: molecular mechanisms

Mutation (point mutation, frame shift mutation) chromosomal aberration and DNA repair.

Oncogenes and Tumor Suppressor Genes: Properties and Significance

Insertion elements and transposons.

S.No.	CLASS	PAPER NAME	PAPER CATEGORY	CREDIT
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BT-202	BSc. BIOTECHNOLOGY SEM-2	Animal Diversity -2	MINOR	06
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Animal Diversity -2

Unit-1

Origin of Chordates Classification of phylum Chordata upto orders according to Parker and Haswell (Latest edition).

Hemichordata – External features and affinities of Balanoglossus. Urochordata – Type study of Herdmania.

Cephalochordata – Type study of Amphioxus. Affinities of Amphioxus.

Unit-2

Comparative account of limb bones and girdles of vertebrates (Amphibia, Reptiles, Birds and Mammals).

Comparative account of digestive system. Comparative account of respiratory system. Comparative account of aortic arches and heart. Comparative account of brain

Placentation in mammals.

Unit-3

Origin of life- modern concepts only. Lamarckism, Darwinism.

Modern synthetic theories: Variations, Mutation, Isolation & speciation Adaptation and mimicry Micro, macro evolution and mega evolution.

Unit-4

Aquaculture

Prawn culture: Culture of fresh water prawn, methods of prawn fishing , preservation and processing of prawns.

Pearl culture and pear industry. Major carp culture : Management of ponds , preservation and processing of fishes. Maintenance of Aquarium.

B.Sc. (Hon's) BIOTECHNOLOGY

Unit-5

Economic Entomology

Sericulture: Species of silkworm, life history of *Bombyx mori*, Sericulture Industry in India. Apiculture – Life cycle of the species methods of bee keeping, products of bees, enemies of bees. Lac culture: Lifecycle, and association with the host plant. Biological control of insect pests.

S.No.	CLASS	PAPER NAME	PAPER CATEGORY	CREDIT
BT-203	BSc. BIOTECHNOLOGY SEM-2	Chemistry -2	GEC	04

Chemistry -2 (Basics of Organic Chemistry)

Unit-1

Structure of Organic compounds, bond length, bond angle, Hydrogen bond, Resonance, Electronic effects, inductive, Mesomeric, Electromeric & Hyperconjugation. Nucleophiles and Electrophiles, Reaction intermediates Carbonium ions, Carbanions, Free radicals and Carbenes, Homolytic fission and Heterolytic fission.

Unit-2

Introduction, Nomenclature, Isomerism, Preparation and General Properties of Aliphatic hydrocarbons, Alkanes, Alkenes and Alkynes, Cycloalkanes,

Unit-3

Introduction, Nomenclature, Preparation and general properties of Alcohols, Phenols, Aldehyde and Ketones. Aromaticity.

B.Sc. (Hon's) BIOTECHNOLOGY

Unit-4

Carbohydrates(monosaccharides, diasaccharides and polysaccharides) : classification and general properties, Glucose and fructose (open chain and cyclic structure), Overview of primary, secondary, tertiary and Quaternary structure of proteins. Introduction, glycerides, synthetic detergents, Introduction, classification of amino acids

Unit-5

Stereochemistry: Simple molecules , Hybridization, conformation & configuration, Geometrical isomerism, optical isomerism, Chirality, Enantiomers and optical activity

S.No.	CLASS	PAPER NAME	PAPER CATEGORY	CREDIT
BT-204	BSc. BIOTECHNOLOGY SEM-2	Environmental Studies	AECC	04

Environmental Studies

Unit 1- The multidisciplinary nature of Environmental Studies, Definitions, scopes & importance, need for public awareness. Natural resources:, renewable & non renewable resources, natural resources & associated problems of forest, water, minerals, food, energy & land resources. Conservation of natural resources, Environmental Ethics:, issues & possible solutions, water conservation, rain water

harvesting & watershed management, resettlements & rehabilitation of peoples.

Unit 2- Ecosystems; Concept of an ecosystem, structure & function of an ecosystem, energy flow in the ecosystem, ecological succession, food chain, food webs & ecological pyramids. Types, characteristic features, structure & function of following ecosystem; forest ecosystem, grassland ecosystem, desert ecosystem, aquatic ecosystem (ponds, streams, lakes, rivers, oceans, estuaries etc.)

Unit 3- Concepts of Biodiversity: Definition of Genetic species & ecosystem diversity, biogeographical classification of india- value of diversity: consumptive use, productive use, social, ethical, Aesthetic & option values. Biodiversity at global, national & local levels. Hotspot of diversity, threats to biodiversity: habitat loss, poaching of wild life, man wild life conflicts. Endangered & endemic species of india, conservation of biodiversity.

Unit 4- Definition of environmental pollution, causes, effects, & control measures of air, water, soil, marines, thermal & noise pollution. Climate Change: global warming, acid rain, ozone layer depletion & nuclear accidents. Solid Waste management: causes, effect & control measures of urban & industrial wastes. Role of an individual in prevention of pollution.

Unit 5- Disaster managements: Floods, earthquakes, cyclones, & landslides. Waste lands reclamation, Consumerism & waste product. Population explosion: family welfare programmes, environment & human health, HIV/AIDS: Role of information technology in environmental & human health. Environmental legislation: environment protection act. Air(prevention & control of pollution) Act. Water (prevention & control of pollution) Act. Wild life protection Act. Forest conservation Act.

S.No.	CLASS	PAPER NAME	PAPER CATEGORY	CREDIT
BT- 301	BSc. BIOTECHNOLOGY SEM-3	Bio-analytical Tools	MAJOR	06

Bio-analytical Tools

Unit-1

PH Metter, Buffer, Handerson and Hasselblach equation, Titration of weak acid and weak bases.
Tracer Technique.

Unit-2

Spectroscopic Technique: Principle and its applications- UV, visible and Fluorescencespectr

Unit-3

Chromatographic Technique: Principle and its Application, Types(Adsorption and Partition Chromatography). Paper, Thin layer, Ion-Exchange, HPLC.

Unit - 4

1 Centrifugation Technique,
Electrophoresis of DNA, proteins and enzymes. Southern, northern and western blotting

B.Sc. (Hon's) BIOTECHNOLOGY

Unit-5

DNA

Fingerprinting

(VNTR) PCR and

its different

variations.DNA

sequencing

S.No.	CLASS	PAPER NAME	PAPER CATEGORY	CREDIT
BT- 302	BSc. BIOTECHNOLOGY SEM-3	Plant Biotechnology	MINOR	06

Plant Biotechnology

UNIT I

Plant Tissue Culture: Basic aspects of plant biotechnology (History, application, scope and importance), laboratory and culture media for plant tissue culture, cell Culture and its applications.

Clonal Propagation and Protoplast Culture: Micro propagation, Somaclonal Variation, Production and uses of Haploids, Protoplast isolation, Regeneration of plant, Somatic Hybridization

UNIT II

B.Sc. (Hon's) BIOTECHNOLOGY

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

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).

Chloroplast Engineering: plants Engineering of Chloroplast Genome, Transformation of chloroplast genome in higher plants, Transplastomic Plants and its applications (in Tobacco, Potato, Rice, Tomato etc.)

UNIT V

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

S.No.	CLASS	PAPER NAME	PAPER CATEGORY	CREDIT
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BT- 303	BSc. BIOTECHNOLOGY SEM-3	Biochemistry & Metabolism	GEC	04
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Biochemistry & Metabolism**Unit-1**

The foundation of biochemistry: Biochemical organization of Cell, Intra and inter molecular forces electrostatic interactions and Hydrogen bonding interaction, Vander Waals and Hydrophobic interactions, Disulphide bridges, Role of water and weak interactions, Chemical foundations of Biology- pH, pK, acids, bases, buffers, weak bonds & Covalent bonds.

Unit-2

1. **Carbohydrate:** Classification, Structure & functions.
2. **Lipid:** Classification, nomenclature, structure and properties, Role of lipids in biological system.
3. **Amino Acids:** Classification, structure, properties, Biological important of Amino Acids

Unit-3

1. **Proteins:** Structural organization (Primary, Secondary, Tertiary and Quaternary structure), α helix, β pleated, Biological role of Proteins. Enzyme as a biological catalyst.
2. Structure, function and properties, types of Nucleic Acid (Nucleotide, DNA, RNA), Ribozymes.

Unit-4

1. Basic Concept & Law of thermodynamics. Role of ATP in Metabolism.
2. Metabolism of Glucose- Glycolysis , intermediate Metabolism, Krebs Cycle, Electron Transport chain.
3. Metabolism of lipids

Unit-5

1. Carbohydrate Metabolism in plants.

B.Sc. (Hon's) BIOTECHNOLOGY

C₃, C₄, CAM Cycle, Pentose Phosphate Pathway.

2. Metabolism of Amino Acids.

S.No.	CLASS	PAPER NAME	PAPER CATEGORY	CREDIT
BT- 304	BSc. BIOTECHNOLOGY SEM-3	Industrial Fermentation	SEC	04

Industrial Fermentation

UNIT I

Isolation and Culture of microorganisms: History, scope and importance of industrial biotechnology, isolation, screening, culture and preservation of microorganism, strain improvement.

Fermentation Technology: Bioreactor design, and operation types of fermenters, Fermentation media, Batch. Fed batch, continuous culture system, *In situ* recovery of products.

UNIT II

Alcohol and acid Production: Industrial production of alcoholic beverages vinegar, Ethanol, organic acids, Amino acids and Antibiotics.

Enzyme Production: Properties and types of enzymes, Enzymes production, types and application, immobilization of Enzymes, Enzyme/protein Engineering, industrial processing: (Down stream processing, recovery, extraction and purification of fermentation products).

UNIT III

Dairy Industry: Fermented foods cheese production, use of enzymes in food industry, processing of milk and dairy products (Pasteurized milk, sterilized milk, cream and butter), enzymes in fruit juice and brewing industries (Fruit Juice and Wines, Beer), single cell protein.

B.Sc. (Hon's) BIOTECHNOLOGY

Polymer and colloid production: Microbial and algal polysaccharides and polyesters production, (Production of Hydrocolloids and polyhydroxyalkonoides) Mass culture technique for algae, primary and secondary metabolites of microorganism and plants.

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.

UNIT V

Fuel biotechnology: Concept scope and importance of bio-fuels, bio-ethanol, bio-diesel, bio-hydrogen and biogas. **Bio-pesticides:** Microbial insecticides (Types Production and uses) Bio-pesticides (Types production and uses) principles and objectives of integrated nutrient management, biofertilizer

S.No.	CLASS	PAPER NAME	PAPER CATEGORY	CREDIT
BT- 401	BSc. BIOTECHNOLOGY SEM-4	Immunology	Major	06

Immunology

UNIT I

Immunity and Immune response: Innate immune and characteristics of adaptive immune Responses, Hematopoiesis. Anatomical organization of Immune System: Primary Lymphoid Organs, Secondary Lymphoid Organs, Cell of immune system: Mononuclear cells and

granulocyte, Antigen presenting cells, lymphocytes and their subsets.

UNIT II

Inflammation: its mediator and the process, cell-adhesion molecules and their role in Inflammation, role of anaphylatoxins, granulocyte in inflammatory process.

Major histocompatibility systems:

UNIT III

Antigen: Properties, types and determinants of antigenicity, Heptanes: Factor affecting immunogenicity, Super antigen.

Antibody: Nature, Types and Structure of Immunoglobulin and Their Functions. Antigen-Antibody interaction avidity and affinity.

UNIT IV

Monoclonal antibodies: production, characterization and application .Compliment System, components, Activation pathway and regulation.Hypersensitivity and its types.

UNIT V

Autoimmunity and Immunodeficiency Syndrome Vaccines: Active and passive immunization. Immunotechniques: Immunodifusion, Immunoprecipitation, ELISA, RIA.

B.Sc. (Hon's) BIOTECHNOLOGY

S.No.	CLASS	PAPER NAME	PAPER CATEGORY	CREDIT
BT- 402	BSc. BIOTECHNOLOGY SEM-4	General Microbiology & Physiology	Minor	06

General Microbiology & Physiology

UNIT I

Fundamentals, History and Evolution of Microbiology.

Classification of microorganisms: Microbial taxonomy, criteria used including molecular approaches, Microbial phylogeny and current classification of bacteria.

Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.

UNIT II

Cultivation and Maintenance of microorganisms: Nutritional categories of microorganisms (autotrophs, heterotrophs, chemotrophs), methods of isolation, Purification and preservation.

UNIT III

Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria.

Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways
Bacterial Reproduction: Transformation, Transduction and Conjugation.
Endospores and sporulation in bacteria.

UNIT IV

Control of Microorganisms: By physical, chemical and chemotherapeutic Agents

Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms.

Sewage composition and its disposal.

B.Sc. (Hon's) BIOTECHNOLOGY

Food Microbiology: Important microorganism in food Microbiology: Moulds, Yeasts, bacteria. Major food born infections and intoxications, Preservation of various types of foods. Fermented Foods.

Unit V

Phototrophic metabolism: anoxygenic & oxygenic photosynthesis, Photosynthetic pigments physiology of bacterial photosynthesis cyclic & non cyclic phosphorylation carbon dioxide fixation, calvin cycle. Methanogens.

S.No.	CLASS	PAPER NAME	PAPER CATEGORY	CREDIT
BT- 403	BSc. BIOTECHNOLOGY SEM-4	Biotechnology & Human Welfare	GEC	04

Biotechnology & Human Welfare

UNIT I

Industry: protein engineering; enzyme and polysaccharide synthesis, activity and secretion, alcohol and antibiotic formation.

UNIT II

Agriculture: N₂ fixation: transfer of pest resistance genes to plants; interaction between plants and microbes; qualitative improvement of livestock.

UNIT III

Environments: e.g. chlorinated and non-chlorinated organ pollutant degradation; degradation of hydrocarbons and agricultural wastes, stress management, development of biodegradable polymers such as PHB.

B.Sc. (Hon's) BIOTECHNOLOGY

UNIT IV

Forensic science: e.g. solving violent crimes such as murder and rape; solving claims of paternity and theft etc. using various methods of DNA finger printing.

UNIT V

Health: e.g. development of non-toxic therapeutic agents, recombinant live vaccines, gene therapy, diagnostics, monoclonal in *E.coli*, human genome project.

S.No.	CLASS	PAPER NAME	PAPER CATEGORY	CREDIT
BT- 404	BSc. BIOTECHNOLOGY SEM-4	Molecular Diagnostics	GEC	04

MOLECULAR DIAGNOSTICS

UNIT I

Enzyme Immunoassays:

Comparison of enzymes available for enzyme immunoassays, conjugation of enzymes.

B.Sc. (Hon's) BIOTECHNOLOGY

Solid phases used in enzyme immunoassays. Homogeneous and heterogeneous enzyme immunoassays. Enzyme immunoassays after immuno blotting. Enzyme immuno histochemical techniques. Use of polyclonal or monoclonal antibodies in enzymes immuno assays.

Applications of enzyme immunoassays in diagnostic microbiology

UNIT II

Molecular methods in clinical microbiology:

Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide polymorphism and plasmid finger printing in clinical microbiology

Laboratory tests in chemotherapy:

Susceptibility tests: Micro-dilution and macro-dilution broth procedures.

Susceptibility tests: Diffusion test procedures. Susceptibility tests: Tests for bactericidal activity. Automated procedures for antimicrobial susceptibility tests.

UNIT III

Automation in microbial diagnosis, rapid diagnostic approach including technical purification and standardization of antigen and specific antibodies. Concepts and methods in idiotypes. Antiidiotypes and molecular mimicry and receptors. Epitope design and applications. Immunodiagnostic tests. Immuno florescence. Radioimmunoassay.

UNIT IV

GLC, HPLC, Electron microscopy, flowcytometry and cell sorting. Transgenic animals.

Unit V:

PCR based molecular diagnosis, genotyping, Single nucleotide polymorphism

Lethal disease diagnosis i. e. sickle cell anemia

Genetic counselling and treatment strategies.

S.No.	CLASS	PAPER NAME	PAPER CATEGORY	CREDIT
BT- 501	BSc. BIOTECHNOLOGY SEM-5	Recombinant DNA Technology	Major	06

RECOMBINANT DNA TECHNOLOGY

UNIT I

Molecular tools and applications- restriction enzymes, ligases, polymerases, alkaline phosphatase. Gene Recombination and Gene transfer: Transformation, Episomes, Plasmids and other cloning vectors (Bacteriophage-derived vectors, artificial chromosomes), Microinjection, Electroporation, Ultrasonication, Principle and applications of Polymerase chain reaction (PCR), primer-design, and RT- (Reverse transcription) PCR.

UNIT II

Restriction and modification system, restriction mapping. Southern and Northern hybridization. Preparation and comparison of Genomic and cDNA library, screening of recombinants, reverse transcription,. Genome mapping, DNA fingerprinting, Applications of Genetic Engineering Genetic engineering in animals: Production and applications of transgenic mice, role of ES cells in gene targeting in mice, Therapeutic products produced by genetic engineering-blood proteins, human hormones, immune modulators and vaccines (one example each).

B.Sc. (Hon's) BIOTECHNOLOGY

UNIT III

Random and site-directed mutagenesis: Primer extension and PCR based methods of site directed mutagenesis, Random mutagenesis, Gene shuffling, production of chimeric proteins, Protein engineering concepts and examples (any two).

UNIT IV

Genetic engineering in plants: Use of *Agrobacterium tumefaciens* and *A. rhizogenes*, Ti plasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants, Use of plant viruses as episomal expression vectors.

UNIT V

S.No.	CLASS	PAPER NAME	PAPER CATEGORY	CREDIT
BT- 502	BSc. BIOTECHNOLOGY SEM-5	Environmental Biotechnology	DSE	04

Environmental Biotechnology

UNIT I

Basic concepts of Environment: Basic concept of Environment & its component

B.Sc. (Hon's) BIOTECHNOLOGY

(Origin of earth, atmosphere, life & ecosystem), Scope & importance of environmental biotechnology.

Global Environmental Problems: Ozone depletion, UV- B, Green House Effect, Acid Rain, Climate change

UNIT II

Environmental Monitoring: Methods for sampling & measurement of air pollution, methods for sampling & measurement of water pollution, methods for sampling & measurement of soil pollution, permissible limits & indices for pollution.

Environmental Pollution & Control: sources, effects & control of air pollution, noise pollution, thermal pollution, water pollution, soil & solid waste pollution.

UNIT III

Bioremediation: Bio-remediation of inorganic & organic pollutants, bioremediation of xenobiotics, phytoremediation.

Solid & liquid waste Treatment: Microbial treatment of solid waste, liquid waste (Example sewage) waste water treatment, biotechnology for enhanced oil recovery.

UNIT IV

Clean Technology: Integrated pest management, biopolymer production & bioplastic technology, biotechnology for energy (production of biofuel, biogas, microbial hydrogen).

Bio-fertilizers: vermin compost, green manure, use of microbes for improving soil fertility.

UNIT V

Restoration Technology: Reforestation through micro-propagation, Soil restoration, Lake Restoration, Biodiversity conservation.

Biosensor and Bio-reporter Technology: Principle types and application of biosensor, bio-reporter (Reporter Gene System).

S.No.	CLASS	PAPER NAME	PAPER CATEGORY	CREDIT
BT- 503	BSc. BIOTECHNOLOGY SEM-5	Animal Biotechnology	SEC	04

Animal Biotechnology

UNIT I

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

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

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

B.Sc. (Hon's) BIOTECHNOLOGY

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.

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.

S.No.	CLASS	PAPER NAME	PAPER CATEGORY	CREDIT
BT- 601	BSc. BIOTECHNOLOGY SEM-6	Developmental Biology	Major	06

DEVELOPMENTAL BIOLOGY

UNIT I: Gametogenesis and Fertilization

Definition, scope & historical perspective of development Biology, Gametogenesis –

B.Sc. (Hon's) BIOTECHNOLOGY

Spermatogenesis, Oogenesis Fertilization - Definition, mechanism, types of fertilization. Different types of eggs on the basis of yolk.

UNIT II: Early embryonic development

Cleavage: Definition, types, patterns & mechanism Blastulation: Process, types & mechanism Gastrulation: Morphogenetic movements— epiboly, emboly, extension, invagination, convergence, delamination. Formation & differentiation of primary germ layers, Fate Maps in early embryos.

UNIT III: Embryonic Differentiation

Differentiation: Cell commitment and determination- the epigenetic landscape: a model of determination and differentiation, control of differentiation at the level of genome, transcription and post-translation level Concept of embryonic induction: Primary, secondary & tertiary embryonic induction, Neural induction and induction of vertebrate lens.

UNIT IV: Organogenesis

Neurulation, notogenesis, development of vertebrate eye. Fate of different primary germ layers Development of behaviour: constancy & plasticity, Extra embryonic membranes, placenta in Mammals.

S.No.	CLASS	PAPER NAME	PAPER CATEGORY	CREDIT
BT- 602	BSc. BIOTECHNOLOGY SEM-6	Forensic Science	DSE	04

FORENSIC SCIENCE

Unit I

Introduction and principles of forensic science, forensic science laboratory and its organization and service, tools and techniques in forensic science, branches of forensic science, causes of crime, role of modus operandi in criminal investigation. Classification of injuries and their medico-legal aspects, method of assessing various types of deaths.

Unit II

Classification of fire arms and explosives, introduction to internal, external and terminal ballistics. Chemical evidence for explosives. General and individual characteristics of handwriting, examination and comparison of handwritings and analysis of ink various samples.

Unit III

Role of the toxicologist, significance of toxicological findings, Fundamental principles of fingerprinting, classification of fingerprints, development of finger print as science

B.Sc. (Hon's) BIOTECHNOLOGY

for personal identification,

Unit IV

Principle of DNA fingerprinting, application of DNA profiling in forensic medicine, Investigation Tools, eDiscovery, Evidence Preservation, Search and Seizure of Computers, Introduction to Cyber security.

S.No.	CLASS	PAPER NAME	PAPER CATEGORY	CREDIT
BT- 603	BSc. BIOTECHNOLOGY SEM-6	Medical Microbiology	DSE	04

MEDICAL MICROBIOLOGY

UNIT I

Introduction: Normal microflora of human body, nosocomial infections, carriers, septic shock, septicemia, pathogenicity, virulence factors, toxins, biosafety levels.

B.Sc. (Hon's) BIOTECHNOLOGY

Morphology, pathogenesis, symptoms, laboratory diagnosis, preventive measures and chemotherapy of gram positive bacteria: *S.aureus*, *S.pyogenes*, *B.anthraxis*, *C.perferinges*, *C.tetani*, *C.botulinum*, *C.diphtheriae* *M.tuberculosis*, *M. leprae*.

UNIT II

Morphology, pathogeneis, symptoms, laboratory diagnosis, preventive measures and chemotherapy caused by gram negative bacteria: *E.coli*, *N. gonorrhoea*, *N. meningitidis*, *P. aeruginosa*, *S. typhi*, *S. dysenteriae*, *Y. pestis*, *B. abortus*, *H. influenzae*, *V. cholerae*, *M. pneumoniae*, *T. pallidum* *M. pneumoniae*, *Rickettsiaceae*, *Chlamydiae*.

UNIT III

Diseases caused by viruses- Picornavirus, Orthomyxoviruses, Paramyxoviruses, Rhabdoviruses, Reoviruses, Pox virus, Herpes virus, Papova virus, Retro viruses (including HIV/AIDS) and Hepatitis viruses.

UNIT IV

Fungal and Protozoan infections. Dermatophytoses (*Trichophyton*, *Microsporun* and *Epidermophyton*) Subcutaneous infection (*Sporothrix*, *Cryptococcus*), systemic infection (*Histoplasma*, *Coccidoides*) and opportunistic fungal infections (*Candidiasis*, *Aspergillosis*), Gastrointestinal infections (Amoebiasis, Giardiasis), Blood-borne infections (Leishmaniasis, Malaria)

S.No.	CLASS	PAPER NAME	PAPER CATEGORY	CREDIT
BT-701	BSc. BIOTECHNOLOGY SEM-7	Enzymology	MAJOR	06

ENZYMOLGY

UNIT - I

Isolation, crystallization and purification of enzymes, test of homogeneity of enzyme preparation, methods of enzyme analysis.

Enzyme classification (rationale, overview and specific examples) Zymogens and their activation (Proteases and Prothrombin).

Enzyme substrate complex: concept of E-S complex, binding sites, active site, specificity, Kinetics of enzyme activity, Michaelis-Menten equation and its derivation,

Different plots for the determination of K_m and V_{max} and their physiological significance, factors affecting initial rate, E, S, temp. & pH. Collision and transition state theories, Significance of activation energy and free energy.

UNIT – II

Two substrate reactions (Random, ordered and ping-pong mechanism) Enzyme inhibition types of inhibition, determination of K_i , suicide inhibitor.

Mechanism of enzyme action: General mechanistic principle, factors associated with catalytic efficiency: proximity, orientation, distortion of strain, acid-base, nucleophilic and covalent catalysis. Techniques for studying mechanisms of action, chemical modification of active site groups, specific examples-: chymotrypsin, Lysozyme, GPDH, aldolase, RNase, Carboxypeptidase and alcohol dehydrogenase.

Enzyme regulation: Product inhibition, feed backcontrol, covalent modification.

UNIT – III

Allosteric enzymes with special reference to aspartate transcarbomylase and phosphofructokinase.

B.Sc. (Hon's) BIOTECHNOLOGY

Qualitative description of concerted and sequential models. Negative co- operativity and half site reactivity. Enzyme - Enzyme interaction, Protein ligand binding, measurements analysis of binding isotherm, cooperativity, Hill and scatchard plots, kinetics of allosteric enzymes. Isoenzymes– multiple forms of enzymes with special reference to lactate dehydrogenase. Multienzyme complexes. Ribozymes. Multifunctional enzyme-eg Fatty Acid synthase.

UNIT – IV

Enzyme Technology: Methods for large scale production of enzymes.

Immobilized enzyme and their comparison with soluble enzymes, Methods for immobilization of enzymes. Immobilized enzyme reactors. Application of Immobilized and soluble enzyme in health and industry. Application to fundamental studies of biochemistry. Enzyme electrodes.

Thermal stability and catalytic efficiency of enzyme, site directed mutagenesis and enzyme engineering– selected examples, Delivery system for protein pharmaceuticals, structure function relationship in enzymes, structural motifs and enzyme evolution.

Methods for protein sequencing. Methods for analysis of secondary and tertiary structures of enzymes. Protein folding *invitro* & *invivo*.

S.No.	CLASS	PAPER NAME	PAPER CATEGORY	CREDIT
BT-702	BSc. BIOTECHNOLOGY SEM-7	Bioethics & Bio-safety	DSE	04

Bioethics & Bio-safety

UNIT-I

Introduction to Indian Patent Law. World Trade Organization and its related intellectual property provisions. Intellectual/Industrial property and its legal protection in research, design and development. Patenting in Biotechnology, economic, ethical and depository considerations.

B.Sc. (Hon's) BIOTECHNOLOGY

UNIT II

Entrepreneurship: Selection of a product, line, design and development processes, economics on material and energy requirement, stock the product and release the same for making etc. The basic regulations of excise: Demand for a given product, feasibility of its production under given constraints of raw material, energy input, financial situations export potential etc.

UNIT III

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

UNIT IV

Biosafety– Introduction to biosafety and health hazards concerning biotechnology. Introduction to the concept of containment level and Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).

B.Sc. (Hon's) BIOTECHNOLOGY

S.No.	CLASS	PAPER NAME	PAPER CATEGORY	CREDIT
BT-703	BSc. BIOTECHNOLOGY SEM-7	Research Methodology	Minor	04

Research Methodology

Unit 1.

Identification and defining of the Research Problem:

Familiarization of research areas; Review of literature using appropriate resources – reviews, research papers, books and patents; Use of tools for searching literature through electronic databases; Defining a research problem.

Unit 2.

Experimental Approaches and Methodology

Experimental designs to address the research problem; different experimental strategies; Finalization of experimental design; Tools and techniques to execute experiments; Means to validate and analyze data;

Unit 3.

Ethics in Biological Research

Guidelines for Biosafety and Bioethics; Institutional Biosafety Committee – Handling of Genetically modified organisms, Institutional Human and Animal Ethics Committee - compliance, concerns and approval

Unit 4.

Presentation, Publication and Protection of Research Data.

Skills for scientific writing and research presentation – Term paper, Research project, Research report, Thesis, Research article and Review; Organization of the research document in to different sections (Introduction, Methodology, Results, Discussion, and Summary and Conclusions, Bibliography); Use of electronic tools for bibliographic

B.Sc. (Hon's) BIOTECHNOLOGY

formatting and checking Plagiarism; Oral presentation skills; Patents and Intellectual property rights

Unit 5.

Statistical analysis and Biosafety in research

Safety practices and disposal of Bio-waste in the laboratory; Radioactivity and safety precautions; Handling and disposal of flammable and hazardous chemicals.

Use of statistical tools for analyzing the significance and interpretation of the data; Methods of recording observations and documentation

S.No.	CLASS	PAPER NAME	PAPER CATEGORY	CREDIT
BT-801	BSc. BIOTECHNOLOGY SEM-8	Medical Biotechnology	MAJOR	06

Medical Biotechnology

UNIT I

Biotechnology in medicine: History, scope & importance of Biotechnology in medicine Disease Diagnosis (DNA, RNA probes, Monoclonal Antibodies auto Antibodies), 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 II

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

B.Sc. (Hon's) BIOTECHNOLOGY

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 pharmacogenomics.

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

Biological Database : Introduction, History and applications of Bio-Informatics, Sequences and Nomenclature (DNA sequences, Amino acid sequences of proteins, Types of sequences in nucleotide sequence database), Database and search tool (FASTA, BLASTA Nucleotide sequence database, protein database), GCG: The Wisconsin package of sequence analysis programme, Detection of genes, Protein structure prediction, Large scale Bio-informatics genome projects.

S.No.	CLASS	PAPER NAME	PAPER CATEGORY	CREDIT
BT-802	BSc. BIOTECHNOLOGY SEM-8	Biostatistics & Bioinformatics	MINOR	04

Biostatistics & Bioinformatics

UNIT I

Types of Data, Collection of data; Primary & Secondary data, Classification and Graphical representation of Statistical data. Measures of central tendency and Dispersion. Measures of Skewness and Kurtosis.

UNIT II

Probability classical & axiomatic definition of probability, Theorems on total and compound probability), Elementary ideas of Binomial, Poisson and Normal distributions.

UNIT III

Methods of sampling, confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test. Problems on test of significance, t-test, chi-square test for goodness of fit and analysis of variance (ANOVA)

UNIT IV

Correlation and Regression. Emphasis on examples from Biological Sciences.

UNIT V

Sequence and Phylogeny analysis, Detecting Open Reading Frames, Outline of sequence Assembly, Mutation/Substitution Matrices, Pairwise Alignments, Introduction to BLAST, using it on the web, Interpreting results, Multiple Sequence Alignment, Phylogenetic Analysis, Sequence Similarity Searches-BLAST,FASTA, Data Submission.