Curriculum for M. Sc Biotechnology

For the Candidates admitted in 2022-2023 onwards
Under Autonomous, CBCS & OBE pattern

DEPARTMENT OF BIOTECHNOLOGY

VIVEKANANDHA
COLLEGE OF ARTS AND SCIENCES FOR WOMEN
[AUTONOMOUS]

An ISO 9001:2015 Certified Institution | Affiliated to Periyar University
Approved by AICTE | Re-accredited with "A" Grade by NAAC|
Recognized Under 2(f) and 12 (b) of UGC Act, 1956.
Elayampalayam, Tiruchengode-637 205, Namakkal Dt., Tamil Nadu, India

M.Sc BIOTECHNOLOGY

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO: 1	Biotechnology graduate students shall attain professional/industrial expertise by developingcompetent, creative and ever ready personality to accept recent, innovative and challenging roles in Industry and Academic and Research sectors
PEO: 2	Students shall inculcate in the development of entrepreneurial traits in order to cuddle innovative opportunities by adapting emerging biotechnological concepts in terms of techniques with subsequent development of leadership in the course of start-up of small-medium scale biotech based industry
PEO: 3	Students shall progressively adapt, follow and learn the concepts of biotechnologycontinuously by aiding modern teaching tools
PEO: 4	Imparting the basic and outstanding knowledge in all terms of biotechnology
PEO: 5	Students shall acquire the concepts to disseminate the advanced biotechnological aspects andits cutting edge developments in specific and developing area in the field of Biotechnology

PROGRAMME OUTCOMES (POs)

GRADE	OUTCOME
PO: 1	To train and develop students with the much needed biotechnological education, so that they develop added competitive skill metrics (CSM) for industrial employment higher education and employment upon graduation
PO: 2	To comprehend the assorted knowledge of biotechnical concepts domains and their applicability in the development of value added products for the welfare of the society
PO: 3	To develop a broad range of biotechnological skills and knowledge, development of general and specific competences to meet-out current expectations and requirements of medical, pharmaceutical, bio-molecular and agricultural sectors
PO: 4	To understand and merge the knowledge and concepts of biochemical, biophysical and bio statistical domains
PO: 5	To clarify various challenges in health care by integrating different biological domains including clinical, immunological, pharmaceutical and cancer genomics

PROGRAMME SPECIFIC OUTCOMES (PSOs)

GRADE	SPECIFIC OUTCOME
PSO: 1	To provide solutions for the challenges faced by pharmaceutical and molecular diagnostic Sectors
PSO: 2	To provide technical products with high frequency of reproducibility to the society
PSO: 3	To gain vertical mobility in career that will make students more competent to face national/international qualifying exams with practical knowledge acquaintance and in modern biotechnology field
PSO: 4	To solve complex problems in the field of Biotechnology with an understanding of social, ethical, legal and cultural aspects of the society
PSO: 5	To understand the over-all theme/concepts of each specialization in biotechnology and analyzing the frequency of its applicabili[2]ty in industry, research and for the goodness of Society

VIVEKANANDHA COLLEGE OF ARTS AND SCIENCES FOR WOMEN (AUTONOMOUS)

Elayampalayam – 637 205, Tiruchengode, Tamilnadu

DEPARTMENT OF BIOTECHNOLOGY

M.Sc., Biotechnology Curriculum (Autonomous, CBCS & OBE pattern)

SCHEME OF EXAMINATION

(For the Candidates admitted during the academic year 2022-2023 onwards)

Course Code	Title of the Course	Credits	Hours		Maximum Marks		
			Theory	Practical	Int	Ext	Total
Semester - I							
Core Courses							
22P1BT01	Cell and Molecular Biology	5	5	-	25	75	100
22P1BT02	Biological Chemistry	5	5	-	25	75	100
22P1BT03	Microbiology	5	5	-	25	75	100
22P1BT04	Genetics	5	5	-	25	75	100
Core Practical -I							
22P1BTP01	Basic Biotechnology (Practical - 1)	3	-	6	40	60	100
Elective course							
22P1BTE01	Bioinstrumentation	3	4	-	25	75	100
22P1BTE02	Evolution and Behavior						
Total		**26**	**24**	**6**	**165**	**435**	**600**
Semester - II							
Core Courses							
22P2BT05	Genetic Engineering	5	5	-	25	75	100
22P2BT06	Immunology	5	5	-	25	75	100
22P2BT07	Microbial Technology	5	5	-	25	75	100
22P2BT08	Developmental Biology	5	5	-	25	75	100
Core Practical -I							
22P2BTP02	Applied biotechnology (Practical -II**)**	3	-	6	40	60	100
Elective course							
22P2BTE03	Genomics and Proteomics	3	4	-	25	75	100
22P2BTE04	Diversity of Life Forms						
Total		**26**	**24**	**6**	**165**	**435**	**600**
		52	**48**	**12**	**330**	**870**	**1200**

(For the Candidates admitted during the academic year 2022-2023)

Course Code	Title of the Course	Credits	Hours		Maximum Marks		
			Theory	Practical	Int	Ext	Total
Semester – III							
Core Courses							
22P3BT09	Plant Biotechnology	5	5	-	25	75	100
22P3BT10	Animal Biotechnology	5	5	-	25	75	100
22P3BT11	Environmental Biotechnology	5	5	-	25	75	100
22P3BT12	Bioinformatics	5	5		25	75	100
Core Practical –III							
22P3BTP03	Advanced Biotechnology (Practical -III)	3	-	6	40	60	100
Elective course							
22P3BTE05	Nanotechnology	3	5	-	25	75	100
22P3BTE06	Pharmaceutical Biotechnology						
Extra Disciplinary Course							
22P3BTED01	Nanotechnology	2	2	-	25	75	100
22P3BTED02	Bioinformatics						
Mandatory Course							
18P3HR01	Human Rights	1	1	-	25	75	100
21P3BTEX01	Internship	1	1		40	60	100
Total		**28**	**24**	**6**	**190**	**570**	**800**
Semester – IV							
Core Courses							
22P4BT12	Research Methodology	5	5	-	25	75	100
Project Work							
22P4BT13	Project work	5	-	21	25	75	100
Total		**10**	**9**	**21**	**75**	**225**	**300**
		90	**81**	**39**	**595**	**1665**	**2300**

M.Sc., Biotechnology Curriculum

(Autonomous, CBCS & OBE pattern)

(For the Candidates admitted during the academic year 2022-2023 onwards)

SEMESTER - I

Course Code	22P1BT01	CORE – I CELL AND MOLECULAR BIOLOGY	Hours/ WK		Marks	
Credits	5					
Total Hours	75		T	P	Int	Ext
Max. Mark	100		5	-	25	75

Course Objectives:

The main objectives of this course are:

1. To familiarize the student in various aspects of cell and molecular biology streams including cellular organization and their interactions in DNA replication, and protein biosynthesis and translational regulation
2. To develop comprehensive understanding on the complete cellular and molecular functions of cell organelles in terms of cell to cell interaction, gene regulation, cellular signaling.
3. To impart the molecular biology knowledge in applications of various human health care

Course outcomes

On the successful completion of the course, student will be able to:

CO1	Understand and apply the principles and techniques of molecular biology which prepares students for further education and/or employment in teaching, basic research, or the health professions.	K1
CO2	Exhibit a knowledge base in cell and molecular biology, anatomy and physiology and biomedical sciences	K2
CO3	Advanced laboratory practices in cell and molecular biology will render them chose their techniques in molecular biology research and further will help them to get job opportunities	K3
CO4	To conduct independent work in a laboratory with basis of cell biology	K4
CO5	The theoretical knowledge gained from this paper will help the student to apply these concepts in their future research	K5&K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

UNIT I	THE STRUCTURE AND FUNCTION	13 Hrs

Cell structure and function, cell Membrane structure and function, structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, ion pumps, mechanism of sorting and regulation of intracellular transport electrical properties of membranes.

UNIT II	CELL ORGANELLES, CELL DIVISION AND CELL CYCLE	13 Hrs

Cell wall, Nucleus, Mitochondria, Golgi bodies, Lysosomes, Endoplasmic Reticulum, Peroxisomes, Plastids, Chloroplast, Vacuoles, Cytoskeleton and its role in motility. Cell Cycle, Molecular mechanisms of Mitosis and Meiosis, Control of cell cycle, Cancer and Cell Cycle. Bacterial Cell

division and Stress Response

UNIT III	DNA REPLICATION AND REPAIR	14 Hrs

Central dogma. DNA replication: Meselson & Stahl experiment. Bi-directional DNA replication. Okazaki fragments. Proteomics of DNA replication, fidelity of DNA replication, Inhibitors of DNA replication. Overview of differences in prokaryotic and eukaryotic DNA replication. Telomere replication in eukaryotes. D-loop and rolling circle mode of replication, mutagens.DNA mutation and their mechanisms. Various types and mechanisms of DNA repair models.

UNIT IV	TRANSCRIPTION	15 Hrs

Structure and function of mRNA, rRNA & tRNA. Characteristics of promoter and enhancer sequences, RNA synthesis. Initiation, Elongation and termination. Inhibitors of transcription. Difference between prokaryotic and eukaryotic transcription. Basic concepts of RNA world. Ribozymes, RNA processing: 5' capping, Splicing-alternative splicing, Poly A tail addition and base modification.

UNIT V	TRANSLATION AND REGULATION	15 Hrs

Introduction to genetic code: Elucidation of genetic code, codon degeneracy, Wobble hypothesis and its importance, prokaryotic and eukaryotic ribosomes. Steps involved in translation: Initiation, elongation and termination of protein synthesis. Inhibitors of protein synthesis. Post-translational modifications and its importance. Regulation of gene expression in prokaryotes: lac and trp operons. Regulation of gene expression in eukaryotes. Organization of genes in prokaryotic and eukaryotic chromosomes.

UNIT VI	VIDEO LECTURES, SEMINARS AND WEBINARS	5 Hrs

REFERENCES:

1. Paul, A. 2007. Text book of cell and molecular biology, Books and Allied (P) Ltd. 2nd edition, Kolkata 700 009, pp-1310.
2. Lodish et al Molecular Cell biology 8th ed. Freeman, 2016.
3. Alberts et al Molecular biology of the cell. 6th ed. Garland Sci. 2014.
4. Watson. Molecular Biology of the Gene. 7th ed. Pearson Edu, 2013.
5. Genes and Genomes by M Singer, and P Berg, Blackwell Scientific Pub.
6. George M. Malacinski& David Freifelder. 1998. Essentials of Molecular Biology, 3rd Edition. Jones and Bartcett Publishers
7. R.C. Rastogi. 2010. Cell and Molecular Biology. New Age International Publishers
8. PragyaKhana. 2008. Cell and Molecular Biology. IK International Publishing House

Course Code	22P1BT02	CORE – II BIOLOGICAL CHEMISTRY	Hours/ WK		Marks	
Credits	5					
Total Hours	75		T	P	Int	Ext
Max. Mark	100		5	-	25	75

Course Objectives:

The main objectives of this course are:

1. To gain a basic working knowledge of biochemical concepts and techniques this will be necessary for future scientific endeavors.
2. To give an idea on different biological molecules, their origin, biological role and its degradation according to the needs and demand of the system under various conditions.
3. The interrelation of each of these metabolic pathways and their contribution in various metabolic disorders

Course outcomes

On the successful completion of the course, student will be able to:

CO1	Recognize the structures and functions of biomolecules such as carbohydrate that form the basis of what we understand to be living organisms	K1
CO2	Provide with a firm foundation in the biochemical aspects of cellular functions with different proteins and proteomics	K2
CO3	Get information pertaining to role of enzymes, co-enzyme and cofactor in catalytic reaction as a properties of biochemical pathways regulation	K3
CO4	Acquire knowledge base of metabolic pathways occurring inside living cells in respect to lipids and fat.	K4
CO5	Understand the limitations of biomolecules in regulation of molecular functions in mammals especially in humans.	K5&K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

UNIT I	BASIC PHYSICAL AND CHEMICAL CONCEPTS IN BIOLOGY	12 Hrs

Structure of Atom, molecules and chemical bonds. Stabilizing interactions (Vander waal's, Electrostatic force, Hydrogen Bonding, Hydrophobic interaction, etc) principles of Biophysical chemistry (PH, Buffer, Reaction kinetics. Thermodynamics and Colligative properties.

UNIT II	CHEMISTRY OF BIOMOLECULES	13 Hrs

Composition, structure and functions of Biomolecules: Carbohydrates, Lipids, Proteins, Nucleic acids and Vitamins. Conformation of proteins: Ramachandran plot, secondary, tertiary and quaternary structure of proteins. Conformation of Nucleic acids: A DNA, B DNA, Z DNA and Types of RNA

UNIT III	BIOENERGETICS AND CATALYSIS	13 Hrs
Bioenergetics, Glycolysis, Oxidative phosphorylation, Coupled reaction, Group transfer, Biological energy transducers. Principles of catalysis, Enzymes, Mechanism of enzyme action, Isozymes, Enzyme kinetics, Enzyme Inhibition and Enzyme Regulation.		
UNIT IV	**METABOLISM OF CARBOHYDRATES**	**16 Hrs**
Carbohydrate Metabolism: Biosynthesis: Gluconeogenesis, Pyuvate oxidation, TCA Cycle, Glyoxylate Cycle). Lipid Metabolism: Biosynthesis of fatty acids, Beta-oxidation of fatty acids and Cholesterol Biosynthesis		
UNIT V	**METABOLISM OF BIOMOLEULES**	**16 Hrs**
Amino acid Metabolism: Amino acids classification, Overview of Amino acid catabolism in Mammals. Urea Biosynthesis. Pathways of Amino Acid degradation, Nucleic acid Metabolism: Nucleotide Biosynthesis and degradation, Salvage and *de novo* pathways. Vitamins: Water and Fat soluble.		
UNIT VI	**VIDEO LECTURES, SEMINARS AND WEBINARS**	**5 Hrs**

REFERENCES:

1. Principles of Biochemistry – Smith et al., McGraw Hill International book Company 8th ed 1998.
2. Principles of Biochemistry – Lehninger, Nelson, Cox, CBS publishers. 2005.
3. Fundamentals of Biochemistry – Voet et al., Jhon Wiley and Sons Inc. 2000.
4. Biochemistry – Zubay, WCB Publishers. 4th edition, 1998.
5. Harpers Biochemistry, R.K. Murray, D.K.Granner, P.A Mayes and V.W. Rodwell, Practise Halt International. 1993.

Course Code	22P1BT03	CORE – III MICROBIOLOGY	Hours/ WK		Marks	
Credits	5					
Total Hours	75		T	P	Int	Ext
Max. Mark	100		5	-	25	75

Course Objectives:

The main objectives of this course are:

1. To impart knowledge on Microbial diversity and Molecular taxonomy with special reference to Bacteria, besides fungi and viruses.
2. To introduce the concept polyphonic taxonomy which eventually lead to report a novel organism.
3. To enlighten on culture independent techniques and anaerobic cultivation.
4. To obtain overall holistic knowledge on Agricultural, Food, Medical Microbiology with introduction to Molecular Diagnostics

Course outcomes

On the successful completion of the course, student will be able to:

CO1	Learn the importance of microbiology at basic level with laboratory level understanding	K1
CO2	Get introduced to terms related to Polyphasic taxonomy and apply them during reporting them as a novel species.	K2
CO3	Obtain knowledge on NGS and culture independent techniques	K3
CO4	Understand on cultivation of Anaerobic organisms	K4
CO5	Apply the knowledge towards Molecular Diagnostics	K5&K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

UNIT I	INTRODUCTION TO MICROBIOLOGY AND MICROBES	13 Hrs

History & scope of microbiology, microbial characteristics, morphology, growth and nutrition of bacteria, bacterial growth curve, bacterial culture methods; bacterial genetics: mutation and recombination in bacteria, plasmids, transformation, transduction and conjugation. Sterilization, disinfection and antisepsis: physical and chemical methods for control of microorganisms, antibiotics, antiviral and antifungal drugs, antimicrobial resistance

UNIT II	MICROBIAL TAXONOMY AND EVOLUTION OF DIVERSITY	12 Hrs

Criteria for classification; classification of microbes - bacteria, fungi, algae and viruses; Current methods of microbial identification, Microbial Identification through physiological and biochemical

methods (BIOLOG, Vitex); MALDI TOF- Polyphasic approach –16S rRNA gene sequencing, Phylogenetic grouping.

UNIT III	MEDICAL MICROBIOLOGY	15 Hrs

Host-pathogen interaction, epidemiology, pathogenesis, prevention and treatment – (*Staphylococcus, Streptococcus, Mycobacterium, Salmonella and Yersinia*). Infections caused by yeast: Candida. Filamentous Fungi: Aspergillus sp. and protozoal diseases (Malaria, Leishmaniasis and Ascaris infection). Virus and bacteriophages, general properties of viruses, viral structure, taxonomy of virus, viral replication, cultivation and identification of viruses; sub-viral particles – viroids and prions; Viral diseases (H1N1, Corona, Polio, Rabies and AIDS).

UNIT IV	INDUSTRIAL MICROBIOLOGY	15 Hrs

Biology of microbes of commercial importance: Escherichia coli, Bacillus subtilis, Rhizobium species, Agrobacterium tumefaciens and Saccharomyces cerevisiae. Cyanobacteria, acetic acid bacteria, Pseudomonas, lactic and propionic acid bacteria, endospore forming bacteria, Mycobacteria and Mycoplasma. Archaea: Halophiles, Methanogens, Hyper-thermophilic archae, Thermoplasm; eukaryote: algae, fungi, slime molds and protozoa; extremophiles and un-culturable microbes

UNIT V	Environmental Microbiology	15 Hrs

Ecological impact of microbes; environment-nutrient cycles-carbon, nitrogen, sulphur and phosphorus cycles. Bacterial photosynthesis, symbiotic and non-symbiotic nitrogen fixation. Plant microbe interactions. microbial communication system; bacterial quorum sensing; microbial fuel cells; prebiotics and probiotics

UNIT VI	VIDEO LECTURES, SEMINARS AND WEBINARS	5 Hrs

REFERENCES:

1. Lansing M. Prescott, John P Harley, Donald A. Klein; Microbiology, McGraw Hill. Ed. 6; 2005.
2. Ananthanarayanan R & CK Jeyaram Paniker; Textbook of Microbiology; Orient Longman. Ed. 7; 2005.
3. Michael T, Madigan, John M Martinko; Brock's Biology of Microorganisms, Pearson Prentice Hall, Ed, 11; 2006.
4. Roger Y, Stainer, John L. Ingraham, Mark L. Wheelis. Page R. Painter. General Microbiology, MacMillan Press. Ed. 5; 2004.
5. Topley & Wilson's: Principles of Bacteriology, Virology & Immunology, Edward Arnold. Ed.9; 2002.

Course Code	22P1BT04	CORE – IV GENETICS	Hours/ WK		Marks	
Credits	5					
Total Hours	75		T	P	Int	Ext
Max. Mark	100		5	-	25	75

Course Objectives:

The main objectives of this course are:

1. The course offers basic knowledge of genetics encompassing prokaryotic/phage genetics, and higher eukaryotic domains and over all concepts of Mendelian genetics.
2. It makes the students understand the relationship between phenotype and genotype in human genetic traits
3. It also imparts knowledge of basics of human genetics and disease gene mapping.
4. Students gain knowledge of the various techniques on cytogenetics, Epigenetics

Course outcomes

On the successful completion of the course, student will be able to:

CO1	Students will gain knowledge about the genetics of prokaryotic and phage genetics	K1
CO2	Gain knowledge on Mendelian and Non Mendelian genetics	K2
CO3	The students will understand the inheritance of genes and the diseases in the Human	K3
CO4	The students learn various techniques related to cytogenetics and molecular and immunogenetics for disease diagnosis	K4
CO5	Students understand the concept of genetic variation, epigenetics and Transgenerational epigenetics	K5&K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

UNIT I	BASIC PRINCIPLES OF GENETICS	13 Hrs

Mendelian principles- Concept of gene, Co-dominance, Gene interactions, Pleiotropy, Penetrance and Expressivity, Linkage & Crossing over, Sex linkage. Gene mapping methods, Linkage mapping by using somatic cell hybrids and Cytoplasmic and Maternal inheritance.

UNIT II	QUANTITATIVE GENETICS & GENETIC VARIANTS	12 Hrs

Human genetics- Pedigree analysis- Karyotypes- Genetic disorders- Polygenic inheritance- Heritability and its measurements- QTL mapping. Mutation - types, causes, detection, structural and numerical alteration in chromosomes.

UNIT III	MOLECULAR GENETICS	15 Hrs

Origin of Molecular Genetics-Structure of DNA-Mutations-Luria and Delbruck‟s Fluctuation Test-

Spontaneous mutations-nonsense, missense, frame-shift mutations-Induced mutagenesis-Physical agents-UV,X-Rays-Chemical agents-NTG, Base Analogues etc., Reversion-AMES Test-DNA Replication-Messelson and Stahl‟s Experiment-Okazaki‟s fragment-DNA polymerases-DNA damage-SOS response-DNA repair

UNIT IV	GENE TRANSFER METHODS	15 Hrs

Gene transfer in bacteria-Transformation-discovery and its significance-competence and factors involved-joint transformation and its uses-Conjugation-F+ and F- nature of E.coli-Origin of Hfr and F‟ strains-Zygotic induction -Chromosome transfer by Hfr - circular nature of E.coli DNA -Use of Hfr strains in genetic mapping-Transduction - λ phage and specialized transduction - Generalised transduction-P1 phage-origin of transducing particlespre zygotic and post zygotic exclusion-Co-transduction-fine structure mapping of genes by P1 transduction-Wu‟s Formula-Ratio Test, C-value paradox

UNIT V	REGULATION OF GENE EXPRESSION	15 Hrs

Elucidation of genetic code- Benzer, Khorana and Crick’s contributions-Triplet nature of the Genetic code and Adaptor hypothesis-Wobble hypothesis- Bacterial translation, Suppression of nonsense, missense and frame-shift mutations-Intragenic and extragenic suppressions of mutations-modern aspects-structure and function relationship-Gene expression-RNA polymerase-σ factors-other accessory transcription factors-small RNAs- Concept of Gene and operon-Regulation of gene expression- well studied operon models-lac, trp and ara operon.

UNIT VI	VIDEO LECTURES, SEMINARS AND WEBINARS	5 Hrs

REFERENCES:

1. Molecular Genetics: An introductory narrative, Second Edition - Gunther.S.Stent and Richard Calendar, 2002. CBS Publishers and distributors
2. A Short Course in Bacterial Genetics: A Laboratory Manual and Handbook for Escherichia coli and Related Bacteria- Jeffrey. H. Miller, 1992.CSHL Press
3. Fundamental Bacterial Genetics - Nancy Trun and Janine Trempy, 2004. Blackwell publishing
4. From Genes to Genomes: Concepts and Applications of DNA Technology, Second Edition- Jeremy.W.Dale and Malcolm Von Schantz, 2007. John Wiley & Sons Ltd.

Course Code	22P1BTP01	CORE PRACTICAL– I BASIC BIOTECHNOLOGY	Hours/ WK		Marks	
Credits	5		T	P	Int	Ext
Max. Mark	100		-	6	40	60

Course Objectives:

The main objectives of this course are to:

1. Train the students on basic tools and techniques required to understand biotechnology.
2. Provide them a base on diverse areas like microbiology, plant and animal science related advanced biology.
3. Ascertain them that subsequent practical would be understandable based on these experiments.

List of Practicals

1. Preparation of Solution **(**Normal, Molar, Percentage solution and calculation) and Microscope (oil immersion100X, Ocular and stage micrometers).
2. Analysis of sugars (Glucose, Fructose, Galactose, Pentose, Sucrose, Maltose, Lactose and Starch tests) and Amino acids (Histidine, Tyrosine, Tryptophan, Methionine, Cysteine and Arginine)
3. Estimation of glucose, protein, cholesterol, DNA and RNA by ortho toluidine method, Lowry's method, Zak's method, Diphenylamine method and Oricinal method respectively.
4. Enumeration of cells (cell counting by Neubauer chamber) & buccal smear preparation.
5. Preparation of mitotic cells stages from onion root tip squash and meiosis from grasshopper testis cells.
6. Purification of bacteria by pour plate, spread plate and streak plate methods.
7. Differential staining (Gram's, Acid fast, Capsule & Spore) , Fungal Staining (LCB) and hanging drop method.
8. Biochemical characterization of microorganisms**:** TSI test, Carbohydrate fermentation test, Urease test and Catalase test and (IMViC) test
9. Antibiotic sensitivity test using bacteria culture (Kirby-Bauer method).
10. Separation of amino acids(paper chromatography) and protein(Column chromatograph)

Course Code	22P1BTE01	ELECTIVE – I BIOINSTRUMENTATION	Hours/ WK		Marks	
Credits	5					
Total Hours	62		T	P	Int	Ext
Max. Mark	100		5	-	25	75

Course Objectives:

The main objectives of this course are:

1. Enrich the student intelligentsia in all the biological observations which are explainable in terms of physical principles.
2. Emphasize the working skill in basic and advanced analytical instruments
3. Enhance the ability of understating and working methods of various instruments

Course outcomes

On the successful completion of the course, student will be able to:

CO1	Understand the analytical techniques and the principles of equipment used in different fields.	K1
CO2	Have complete insight in these techniques for the possible applications in various research areas	K2
CO3	Handle basic and advanced instruments with trouble shooting in the biological and medical industries	K3
CO4	Increase the knowledge on result output analysis and interpretations.	K4
CO5	Comprehend the impact of hazardous material and handling of the materials	K5&K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

UNIT I	PHYSICAL TECHNIQUES IN SEPARATION OF BIOMOLECULES	12 Hrs

Centrifugation: Basic principles of sedimentation, types of centrifuges and rotors. Preparative and Analytical Centrifuges, Differential and, Density Gradient Centrifugation and ultra centrifugation. Chromatography Techniques: Theory and Application of Paper Chromatography, TLC, Gel Filtration Chromatography, Ion Exchange Chromatography, Affinity Chromatography, GLC, HPLC, Nano LC and HPTLC.

UNIT II	ELECTROPHORETIC TECHNIQUES AND CELL ANALYSIS	12 Hrs

Theory and Application of PAGE, SDS PAGE, Agarose Gel Electrophoresis 2DE, Iso-electric Focusing, pulse field gel electrophoresis, Immuno diffusion, Immuno Electrophoresis. ELISA. Cell analysis: Principles and Applications of Light, Phase Contrast, Fluorescence Microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy, Confocal Microscopy, Atomic force microscopy and Electron Cryo microscopy.

UNIT III	STRUCTURAL ANALYSIS OF BIOMOLECULES	12 Hrs
UV- visible, IR, NMR, LASER Raman Spectroscopy, Mass Spectroscopy, Fluorescence Spectroscopy, Surface Plasmon Resonance (SPR) and Electron Paramagnetic Resonance (EPR). Differential colorimetry, X ray crystallography, X ray computer tomography and patch clamping.		
UNIT IV	**MOLECULAR TECHNIQUES**	**12 Hrs**
PCR, Real Time PCR, Cytophotometry, Flow Cytometry, FACS, MACS and Microarray. Circular dichroism and optical rotatory dispersion, Polarography and Manometry – theory and application, Biosensors.		
UNIT V	**TRACER AND RADIOACTIVE METHODS**	**12 Hrs**
Tracer and other techniques – Radioactive decay, units of radioactivity, detection – Geiger Muller counter, Scintillation counter, Autoradiography. Applications of radio isotopes in biological and medical sciences - RIA. Safety aspects in handling radioactive isotope.		
UNIT VI	**VIDEO LECTURES, SEMINARS AND WEBINARS**	**2 Hrs**

REFERENCES:

1. Instrumental methods of chemical analysis – P.K. Sharma
2. Biophysical chemistry – Upadhyay and Nath (2009)
3. Handbook of Biomedical Instrumentation – R.S. Khandpur, Tata (2003). McGraw Hill
4. A Biologist's guide to principle and techniques of practical biochemistry – Brigan L. Williams.
5. Experimental methods in Biophysical chemistry- Nicolau, C.
6. PCR - The Basics (Garland Science, 2nd Edition). McPherson. M. J. & Moller S. G. (2006). Taylor & Francis
7. Introduction to Spectroscopy- DonaldL.Pavia Gary M.Lipman, George S Kriz

Course Code	22P1BTE02	ELECTIVE – 2 EVOLUTION AND BEHAVIOR	Hours/ WK		Marks	
Credits	5		T	P	Int	Ext
Total Hours	62		5	-	25	75
Max. Mark	100					

Course Objectives:

The main objectives of this course are:

1, The course objective of this paper is to impart students an in-depth knowledge and make them competent in the field of biodiversity and bioprospecting.

2. To impart sufficient information and scientific knowledge about natural products from plant and microbes

3. To facilitate the students to understand about the bioprospecting aspects related to product production and their regulation

Course outcomes

On the successful completion of the course, student will be able to:

CO1	Familiarize the students in major areas of bioprospecting and biodiversity.	K1
CO2	Obtain a comprehensive knowledge about natural products from plants	K2
CO3	Gain information's on drug discovery, product development, and modern tools involved in drug discovery	K3
CO4	Apprehend the bioprospecting aspects related to microorganisms and plants	K4
CO5	Familiar with regulatory legislation and convention in bioprospecting for commercialization.	K5&K6

K1 - Remember; **K2 -** Understand; **K3 -** Apply; **K4 -** Analyze; **K5 -** Evaluate; **K6** – Create

UNIT I	**EMERGENCE OF EVOLUTIONARY THOUGHTS**	**12 Hrs**

Lamarck; Darwin–concepts of variation, adaptation, struggle, fitness and natural selection; Mendelism; Spontaneity of mutations; The evolutionary synthesis.

UNIT II	**ORIGIN OF CELLS AND UNICELLULAR EVOLUTION**	**12 Hrs**

Origin of basic biological molecules; Abiotic synthesis of organic monomers and polymers; Concept of Oparin and Haldane; Experiement of Miller (1953); The first cell; Evolution of prokaryotes; Origin of eukaryotic cells; Evolution of unicellular eukaryotes; Anaerobic metabolism, photosynthesis and aerobic metabolism.

UNIT III	**PALEONTOLOGY AND EVOLUTIONARY HISTORY AND MOLECULAR EVOLUTION**	**12 Hrs**

The evolutionary time scale; Eras, periods and epoch; Major events in the evolutionary time scale;

Origins of unicellular and multi cellular organisms; Major groups of plants and animals; Stages in primate evolution including Homo. Concepts of neutral evolution, molecular divergence and molecular clocks; Molecular tools in phylogeny, classification and identification; Protein and nucleotide sequence analysis; origin of new genes and proteins; Gene duplication and divergence.

UNIT IV	**THE MECHANISMS OF EVOLUTION**	**12 Hrs**

Population genetics – Populations, Gene pool, Gene frequency; Hardy-Weinberg Law; concepts and rate of change in gene frequency through natural selection, migration and random genetic drift; Adaptive radiation; Isolating mechanisms; Speciation; Allopatricity and Sympatricity; Convergent evolution; Sexual selection; Co-evolution

UNIT V	**BRAIN, BEHAVIOR AND EVOLUTION**	**12 Hrs**

Approaches and methods in study of behavior; Proximate and ultimate causation; Altruism and evolution-Group selection, Kin selection, Reciprocal altruism; Neural basis of learning, memory, cognition, sleep and arousal; Biological clocks; Development of behavior; Social communication; Social dominance; Use of space and territoriality; Mating systems, Parental investment and Reproductive success; Parental care; Aggressive behavior; Habitat selection and optimality in foraging; Migration, orientation and navigation; Domestication and behavioral changes

UNIT VI	**VIDEO LECTURES, SEMINARS AND WEBINARS**	**2 Hrs**

REFERENCES:

1. Biology by Campbell and Reece, 7th Edition

M.Sc., Biotechnology Curriculum

(Autonomous, CBCS & OBE pattern)

(For the Candidates admitted during the academic year 2022-2023 onwards)

SEMESTER – II

Course Code	22P2BT05	CORE – V GENETIC ENGINEERING	Hours/ WK		Marks	
Credits	5					
Total Hours	75		T	P	Int	Ext
Max. Mark	100		5	-	25	75

Course Objectives:

The main objectives of this course are:

3. To illustrate creative use of modern tools and techniques for manipulation and analysis of genomic sequences.
4. To expose students to application of recombinant DNA technology in biotechnological research.
5. To train students in strategizing research methodologies employing genetic engineering techniques.

Course outcomes

On the successful completion of the course, student will be able to:

CO1	To know about DNA manipulating enzymes and its role in rDNA Technology	K1
CO2	To gain knowledge on different types plasmid vectors and theirUsage	K2
CO3	To acquire knowledge on basic gene cloning strategies	K3
CO4	To evaluate the usage and applications of gene cloning for the development value added products	K4
CO5	To know-how on versatile techniques in recombinant DNA technology.	K5&K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

UNIT I	INTRODUCTION AND TOOLS FOR GENETIC ENGINEERING	13 Hrs

Impact of genetic engineering in modern society; general requirements for performing a genetic engineering experiment; restriction endonucleases and methylases; DNA ligase, Klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase; cohesive and blunt end ligation; linkers; adaptors; homopolymeric tailing; labelling of DNA: nick translation, random priming, radioactive and non-radioactive probes, hybridization techniques: northern, southern, south-western and far-western and colony hybridization, fluorescence *in situ* hybridization.

UNIT II	DIFFERENT TYPES OF VECTORS	13 Hrs

Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, hagemids; Lambda

vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Principles for maximizing gene expression expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag *etc.*; Intein-based vectors; Inclusion bodies; methodologies to reduce formation of inclusion bodies; mammalian expression and replicating vectors; Baculovirus and *Pichia* vectors system, plant based vectors, Ti and Ri as vectors, yeast vectors, shuttle vectors**.**

UNIT III	**DIFFERENT TYPES OF PCR TECHNIQUES**	**14 Hrs**

Principles of PCR: primer design; fidelity of thermostable enzymes; DNA polymerases; types of PCR – multiplex, nested; reverse-transcription PCR, real time PCR, touchdown PCR, hot start PCR, colony PCR, asymmetric PCR, cloning of PCR products; T-vectors; proof reading enzymes; PCR based site specific mutagenesis; PCR in molecular diagnostics; viral and bacterial detection; sequencing methods; enzymatic DNA sequencing; chemical sequencing of DNA; automated DNA sequencing; RNA sequencing; chemical synthesis of oligonucleotides; mutation detection: SSCP, DGGE, RFLP.

UNIT IV	**GENE MANIPULATION AND PROTEIN-DNA INTERACTION**	**15 Hrs**

Insertion of foreign DNA into host cells; transformation, electroporation, transfection; construction of libraries; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; construction of microarrays – genomic arrays, cDNA arrays and oligo arrays; study of protein-DNA interactions: electrophoretic mobility shift assay; DNase footprinting; methyl interference assay, chromatin immune precipitation; protein-protein interactions using yeast two-hybrid system; phage display.

UNIT V	**GENE SILENCING AND GENOME EDITING TECHNOLOGIES**	**15 Hrs**

Gene silencing techniques; introduction to siRNA; siRNA technology; Micro RNA; construction of siRNA vectors; principle and application of gene silencing; gene knockouts and gene therapy; creation of transgenic plants; debate over GM crops; introduction to methods of genetic manipulation in different model systems *e.g.*,fruit flies.(*Drosophila*), worms (*C. elegans*), frogs (*Xenopus*), fish (zebra fish) and chick; Transgenics - gene replacement; gene targeting; creation of transgenic and knock-out mice; disease model; introduction to genome editing by CRISPR-CAS with specific emphasis on Chinese and American clinical trials.

UNIT VI	**VIDEO LECTURES, SEMINARS AND WEBINARS**	**5 Hrs**

REFERENCES:

9. Old, R. W., Primrose, S. B., & Twyman, R. M. (2001). *Principles of Gene Manipulation: an*

Introduction to Genetic Engineering. Oxford: Blackwell Scientific Publications.

10. Green, M. R., & Sambrook, J. (2012). *Molecular Cloning: a Laboratory Manual*. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
11. Brown, T. A. (2006). *Genomes* (3rd ed.). New York: Garland Science Pub.
12. Selected papers from scientific journals, particularly Nature & Science.
13. Technical Literature from Stratagene, Promega, Novagen, New England Biolab *etc.*.
14. Biotechnology-Fundamentals andApplicationsS.S. Purohit & .KMathurAgrobotanica India.
15. AgriculturalBiotechnologyS.S. Purohit Agrobotanica , India.
16. Biotechnology-Fundamentals andApplicationsS.S. Purohit &S.KMathurS.S. Purohit & S.K Mathur.
17. Molecular Biotechnology S.B. Primrose PanimaPublishingCorporation, New Delhi.
18. Text Book ofBiotechnologyC.R. Chhatwal Anmol Publications pvtLtd,New Delhi.
19. Applied MolecularGeneticsR .L. Miesfeld , Wiley Liss ,New York.

Course Code	22P2BT06	CORE – VI IMMUNOLOGY	Hours/ WK		Marks	
Credits	5					
Total Hours	75		T	P	Int	Ext
Max. Mark	100		5	-	25	75

Course Objectives:

The main objectives of this course are:

1. This course is designed to impart the students the importance of immunology and its theoretical aspects and on the principles of immunology and immune-technology
2. The application of immunology in medicines is also dealt with.
3. It also explains the various antigen-antibody reactions involved in diseases, stem cell technology and vaccine development.

Course outcomes

On the successful completion of the course, student will be able to:

CO1	Evaluate the usefulness of immunology in different pharmaceutical companies.	K1,K2
CO2	Acquire knowledge on antibodies and their commercial importance in diagnosis and treatment of human diseases.	K1,K2
CO3	Apply their knowledge and design immunological experiments to demonstrate innate, humoral or cytotoxic T lymphocyte responses and figure out the kind of immune responses in the setting of infection (viral or bacterial) by looking at cytokine profile.	K1,K2
CO4	Understand the importance of vaccine development and identify the proper research lab working in the area of vaccine production.	K1,K4
CO5	Distinguish and characterize the CD4+ and other T helper cell lineages in the regulatory T cell.	K1,K2

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

UNIT I	IMMUNOLOGY: FUNDAMENTAL CONCEPTS AND OVERVIEW OF THE IMMUNE SYSTEM	13 Hrs

Components of innate and acquired immunity; phagocytosis; complement and inflammatory responses; pathogen recognition receptors (PRR) and pathogen associated molecular pattern (PAMP); innate immune response; mucosal immunity; antigens: immunogens, haptens; Major Histocompatibility Complex: MHC genes, MHC and immune responsiveness and disease susceptibility, Organs of immune system, primary and secondary lymphoid organs.

UNIT II	IMMUNE RESPONSES GENERATED BY B AND T	13 Hrs

	LYMPHOCYTES	
Immunoglobulins - basic structure, classes & subclasses of immunoglobulins, antigenic determinants; multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily; principles of cell signaling; basis of self & non-self-discrimination; kinetics of immune response, memory; B cell maturation, activation and differentiation; generation of antibody diversity; T-cell maturation, activation and differentiation and T-cell receptors; functional T Cell subsets; cell-mediated immune responses, ADCC; cytokines: properties, receptors and therapeutic uses; antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; cell-cell co-operation, Hapten-carrier system.		
UNIT III	**ANTIGEN-ANTIBODY INTERACTIONS**	**14 Hrs**
Precipitation, agglutination and complement mediated immune reactions; advanced immunological techniques: RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence microscopy, flow cytometry and immunoelectron microscopy; surface plasmon resonance, biosensor assays for assessing ligand – receptor interaction; CMI techniques: lympho proliferation assay, mixed lymphocyte reaction, cell cytotoxicity assays, apoptosis, microarrays, transgenic mice, gene knock outs.		
UNIT IV	**CLINICAL IMMUNOLOGY**	**15 Hrs**
Immunity to infection: bacteria, viral, fungal and parasitic infections (with examples from each group); hypersensitivity: Type I-IV; autoimmunity; types of autoimmune diseases; mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; treatment of autoimmune diseases; transplantation: iimmunological basis of graft rejection; clinical transplantation and immunosuppressive therapy; tumor immunology: autoimmune disorder, anaphylactic shock.		
UNIT V	**VACCINOLOGY**	**15 Hrs**
Active and passive immunization; live, killed, attenuated, subunit vaccines; vaccine technology: role and properties of adjuvants, recombinant DNA and protein-based vaccines, plant-based vaccines, reverse vaccinology; peptide vaccines, conjugate vaccines; antibody genes and antibody engineering: chimeric, generation of monoclonal antibodies, idiotypic vaccines and marker vaccines, viral-like particles (VLPs), dendritic cell-based vaccines, vaccine against cancer and therapeutic vaccine.		

UNIT VI	VIDEO LECTURES, SEMINARS AND WEBINARS	5 Hrs

REFERENCES:

1. Kindt, T. J., Goldsby, R. A., Osborne, B. A., &Kuby, J. (2006). *Kuby Immunology*. New York: W.H. Freeman.
2. Brostoff, J., Seaddin, J. K., Male, D., &Roitt, I. M. (2002). *Clinical Immunology.*London: Gower Medical Pub.
3. Murphy, K., Travers, P., Walport, M., &Janeway, C. (2012). *Janeway'sImmunobiology.* New York: Garland Science.
4. Paul, W. E. (2012). *Fundamental Immunology*. New York: Raven Press.
5. Goding, J. W. (1996). *Monoclonal Antibodies: Principles and Practice: Production and Application of Monoclonal Antibodies in Cell Biology, Biochemistry, and Immunology.* London: Academic Press.
6. Parham, P. (2005). *The Immune System*. New York: Garland Science.
7. Immunology Joshi. OsmaAgro Botanica New Delhi
8. Instant notes inImmunologyLydyard, helean,FangerViva Books N.Delhi
9. An introduction toImmunologyCV Rao NarosaN.Delhi
10. Immunology Janus Kuby Freeman NY
11. Principles of cellular andmolecularImmunologyJonathanAustin,KathyrynWoodOxford NY
12. Immunology Goldsby, Kindt,Osborne, Janus KubyFreeman NY
13. Medical Immunology Parslow, Stites, Tera,ImbodenMc Graw Hill NY
14. Cellular and molecularImmunologyAbbas, Lichman,Pobea,Harcourt& Brace Co.

Course Code	22P2BT07	CORE – VII MICROBIAL TECHNOLOGY	Hours/ WK		Marks	
Credits	5					
Total Hours	75		T	P	Int	Ext
Max. Mark	100		5	-	25	75

Course Objectives:

The main objectives of this course are:

1. The objectives of this course are to introduce students to developments/ advances made in field of microbial technology for use in human welfare and solving problems of the society.

Course outcomes

On the successful completion of the course, student will be able to:

CO1	To know about DNA manipulating enzymes and its role in rDNA Technology	K1
CO2	To gain knowledge on different types plasmid vectors and theirUsage	K2
CO3	To acquire knowledge on basic gene cloning strategies	K3
CO4	To evaluate the usage and applications of gene cloning for the development value added products	K4
CO5	To know-how on versatile techniques in recombinant DNA technology.	K5&K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

UNIT I	INTRODUCTION TO MICROBIAL TECHNOLOGY	13 Hrs

Microbial technology in human welfare; Isolation and screening of microbes important for industry – advances in methodology and its application; Advanced genome and epigenome editing tools (*e.g.*, engineered zinc finger proteins, TALEs/TALENs, and the CRISPR/Cas9 system as nucleases for genome editing, transcription factors for epigenome editing, and other emerging tools) for manipulation of useful microbes/strains and their applications; Strain improvement to increase yield of selected molecules, *e.g.*, antibiotics, enzymes, biofuels.

UNIT II	ENVIRONMENTAL APPLICATIONS OF MICROBIAL TECHNOLOGY	13 Hrs

Environmental application of microbes; Ore leaching; Biodegradation - biomass recycle and removal; Bioremediation - toxic waste removal and soil remediation; Global Biogeochemical cycles; Environment sensing (sensor organisms/ biological sensors); International and National guidelines regarding use of genetically modified organisms in e2n6vironment, food and pharmaceuticals.

UNIT III	PHARMACEUTICAL APPLICATIONS OF MICROBIAL TECHNOLOGY	14 Hrs
Recombinant protein and pharmaceuticals production in microbes – common bottlenecks and issues (technical/operational, commercial and ethical); Attributes required in industrial microbes (*Streptomyces* sp., Yeast) to be used as efficient cloning and expression hosts (biologicals production); Generating diversity and introduction of desirable properties in industrially important microbes (*Streptomyces*/Yeast); Microbial cell factories; Downstream processing approaches used in industrial production process (*Streptomyces* sp., Yeast).		
UNIT IV	**FOOD APPLICATIONS OF MICROBIAL TECHNOLOGY**	**15 Hrs**
Application of microbes and microbial processes in food and healthcare industries – food processing and food preservation, antibiotics and enzymes production, microbes in targeted delivery application – drugs and vaccines (bacterial and viral vectors); Nonrecombinant ways of introducing desirable properties in Generally recognized as safe (GRAS) microbes to be used in food (*e.g.*, Yeast) - exploiting the existing natural diversity or the artificially introduced diversity through conventional acceptable techniques (mutagenesis, protoplast fusion, breeding, genome shuffling, directed evolution).		
UNIT V	**ADVANCES IN MICROBIAL TECHNOLOGY**	**15 Hrs**
Microbial genomics for discovery of novel enzymes, drugs/ antibiotics; Limits of microbial genomics with respect to use in human welfare; Metagenomics and metatranscriptomics – their potential, methods to study and applications/use (animal and plant health, environmental clean-up, global nutrient cycles & global sustainability, understanding evolution), Global metagenomics initiative - surveys/projects and outcome, metagenomic library construction and functional screening in suitable hosts –tools and techniques for discovery/identification of novel enzymes, drugs (*e.g.*, protease, antibiotic).		
UNIT VI	**VIDEO LECTURES, SEMINARS AND WEBINARS**	**5 Hrs**

REFERENCES:

1. Lee, Y. K. (2013). Microbial Biotechnology: Principles and Applications.Hackensack, NJ: World Scientific.
2. Moo-Young, M. (2011). Comprehensive Biotechnology. Amsterdam: Elsevier.
3. Nelson, K. E. (2015). Encyclopedia of Metagenomics. Genes, Genomes andMetagenomes: Basics, Methods, Databases and Tools. Boston, MA: Springer US.
4. The New Science of Metagenomics Revealing the Secrets of Our Microbial Planet.(2007). Washington, D.C.: National Academies Press.
5. Journals: (a) Nature, (b) Nature Biotechnology, (c) Applied microbiology andbiotechnology, (d) Trends in Biotechnology, (e) Trends in Microbiology,(f) Current opinion in Microbiology, (g) Biotechnology Advances,(h) Genome Research).
6. Websites: http://jgi.doe.gov/our-science/

Course Code	22P2BT08	CORE – VIII DEVELOPMENTAL BIOLOGY	Hours/ WK		Marks	
Credits	5					
Total Hours	75		T	P	Int	Ext
Max. Mark	100		5	-	25	75

Course Objectives:

The main objectives of this course are:

1. The objectives of this course are to introduce students to developments/ advances made in field of microbial technology for use in human welfare and solving problems of the society.

Course outcomes

On the successful completion of the course, student will be able to:

CO1	Learn the importance of embryology (historical review) and more recently developmental biology as an emerging discipline and science.	K1
CO2	Identify several unifying themes and differences in developmental biology with respect to anatomy, physiology and evolution in selected Invertebrates and Vertebrates species.	K5
CO3	Learn the process and the mechanisms of early embryonic development (fertilization, early cleavage, blastula, gastrula, neurula) in Vertebrates including frog, chicken and mouse and Invertebrates e.g. Drosophila melanogaster and Sea Urchin.	K2
CO4	Identify the molecular pathways controlling axis formation (anterior-posterior, dorsalventral and left-right axes) in amphibians (frog), mammals (mouse, humans) and fly (Drosophila) including the signalling molecules and key gene regulators.	K4
CO5	To be able to communicate scientific information about key concepts in developmental biology.	K3

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

UNIT I	BASIC CONCEPTS OF DEVELOPMENT	13 Hrs

Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development.

UNIT II	GAMETOGENESIS, FERTILIZATION AND EARLY DEVELOPMENT	13 Hrs

Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis,

establishment of symmetry in plants; seed formation and germination.		
UNIT III	**MORPHOGENESIS AND ORGANOGENESIS IN ANIMALS**	**14 Hrs**
Cell aggregation and differentiation in *Dictyostelium*; axes and pattern formation in *Drosophila*, amphibia and chick; organogenesis – vulva formation in *Caenorhabditis elegans*, eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development- larval formation, metamorphosis; environmental regulation of normal development; sex determination.		
UNIT IV	**MORPHOGENESIS AND ORGANOGENESIS IN PLANTS**	**15 Hrs**
Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in *Arabidopsis* and *Antirrhinum.*		
UNIT V	**CANCER AND PROGRAMMED CELL DEATH**	**15 Hrs**
Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth. Programmed cell death, aging and senescence.		
UNIT VI	**VIDEO LECTURES, SEMINARS AND WEBINARS**	**5 Hrs**

REFERENCES:

1. Human Embryology & Developmental Biology (2019), 6th edition by Bruce M. Carlson.
2. Principles of Development (2019), 6th edition by Cheryll Tickle; Lewis Wolpert; Alfonso Martinez Arias.

Course Code	22P2BTP02	CORE PRACTICAL– II APPLIED BIOTECHNOLOGY	Hours/ WK		Marks	
Credits	5					
Max. Mark	100		T	P	Int	Ext
			-	6	40	60

Course Objectives:

The main objectives of this course are to:

1. Train the students on basic tools and techniques required to understand biotechnology.
2. Provide them a base on diverse areas like microbiology, plant and animal science related advanced biology.
3. Ascertain them that subsequent practical would be understandable based on these experiments.

List of Practical's

1. Isolation of Genomic DNA from Bacteria,plants, animals and Separation of DNA by Agarose Gel Electrophoresis
2. Isolation of Plasmid DNA mini prep and maxi prep from E.coli
3. Separation of Proteins by SDS PAGE
4. Southern blotting – Demonstration
5. Micro propagation of callus culture
6. ABO Blood grouping (Rh typing) (Agglutination)
7. WIDAL and Pregnancy test (Agglutination)
8. Production and Estimation of alcohol from grapes
9. Production and estimation of citric acid from Aspergillus species
10. Azolla ,Spirullina, Vermiculture and Mushroom cultivation
11. Separation of amino acids by paper chromatography
12. Separation of proteins by Column chromatography

Course Code	22P2BTE03	Elective – **III** **GENOMICS AND PROTEOMICS**	Hours/ WK		Marks	
Credits	5					
Total Hours	75		**T**	**P**	**Int**	**Ext**
Max. Mark	100		5	-	25	75

Course Objectives:

The main objectives of this course are:

1. To understand the basic concepts in genomics and various techniques applied to enumerate genome sequences and its functions.
2. To understand the fundamentals of proteomics and various techniques supporting the protein sequence and functional analysis.

Course outcomes

On the successful completion of the course, student will be able to:

CO1	To know about DNA manipulating enzymes and its role in rDNA Technology	K1
CO2	To gain knowledge on different types plasmid vectors and theirUsage	K2
CO3	To acquire knowledge on basic gene cloning strategies	K3
CO4	To evaluate the usage and applications of gene cloning for the development value added products	K4
CO5	To know-how on versatile techniques in recombinant DNA technology.	K5&K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

UNIT I	**GENOMICS**	**13 Hrs**

Prokaryotic &Eukaryotic Genomes Organization- Nuclear Genomes- - Organelle genomes-origin- Repetitive DNA contents-Tandem repeats – DNA transposons- Comparative genomics and application of genomics in understanding genetic disease of humans.

UNIT II	**TRADITIONAL APPROACHES TO EXPRESSION PROFILING TO STUDY GENES**	**13 Hrs**

SAGE for large scale gene expression and analysis- DNA sequencing- shot gun sequencing – Contig assembly-techniques for gene location – ORF- Next generation sequencing (NGS)- RT-PCR-RACE-S1nuclease mapping – exon trapping- transcriptome analysis-DNA chips and Microarrays, Real time PCR

UNIT III	GENOME MAPPING	14 Hrs
Human genome project Genetic Mapping –SNP AFLP-Human pedigree analysis–FISH – STS mapping –Gene therapy for inherited disorders and infectious diseases.		
UNIT IV	**PROTEOMICS**	**15 Hrs**
Definition, Characterization of proteins using 2-D gel electrophoresis, Multidimensional liquid chromatography and Mass spectrometry Tools of Proteomics- MALDI-TOF-ESI – tandem Mass analyzers-peptide Mass finger printing-protein identification with MS data.		
UNIT V	**METABOLOMICS & GLOBAL BIOCHEMICAL NETWORKS**	**15 Hrs**
Different levels of metabolite analysis, basic mass spectrometry metabolomics analysis, sample selection and handling for analysis of metabolites, methodology to construct global biochemical network. Protein mining - SALSA algorithm for mining specific features- protein microarrays protein expression profiling.		
UNIT VI	**VIDEO LECTURES, SEMINARS AND WEBINARS**	**5 Hrs**

REFERENCES:

1. Terence A Brown, 2002, Genomes, 2nd Edition, Bios Scientific Publishers.
2. Tom Strachan and Andrew P Read, 1999, Human Molecular Genetics, 2nd edition, Bios Scientific Publishers.
3. Daniel C. Liebler, 2002, Introduction to Proteomics, tools for the new biology- Humana press. Totowa, NJ.
4. Pennington. S, M. Dunn, 2001, Proteomics: From Protein Sequence toFunction, 1st edition, Bios Scientific Publishers.

Course Code	22P3BTE04	Elective – **IV** **DIVERSITY OF LIFE FORMS**	Hours/ WK		Marks	
Credits	5					
Total Hours	75		**T**	**P**	**Int**	**Ext**
Max. Mark	100		5	-	25	75

Course Objectives:

The main objectives of this course are:

1. It gives introduction to the various transformation techniques employed in plant systems.
2. It also describes the application of genetically modified plants in the various fields of science.

Course outcomes

On the successful completion of the course, student will be able to:

CO1	Learn the importance of embryology (historical review) and more recently developmental biology as an emerging discipline and science.	K1
CO2	Identify several unifying themes and differences in developmental biology with respect to anatomy, physiology and evolution in selected Invertebrates and Vertebrates species.	K2
CO3	Learn the process and the mechanisms of early embryonic development (fertilization,early cleavage, blastula, gastrula, neurula) in Vertebrates including frog, chicken andmouse and Invertebrates e.g. Drosophila melanogaster and Sea Urchin.	K3
CO4	To be able to communicate scientific information about key concepts in developmental biology	K4
CO5	Identify the molecular pathways controlling axis formation (anterior-posterior, dorsalventral and left-right axes) in amphibians (frog), mammals (mouse, humans) and fly (Drosophila) including the signalling molecules and key gene regulators	K5&K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

UNIT I	**PRINCIPLES & METHODS OF TAXONOMY**	**13 Hrs**

Concepts of species and hierarchical taxa, biological nomenclature, classical &Quantitative methods of taxonomy of plants, animals and microorganisms.

UNIT II	**LEVELS OF STRUCTURAL ORGANIZATION**	**13 Hrs**

Unicellular, colonial and multicellular forms. Levels of organization of tissues, organs & systems. Comparative anatomy, adaptive radiation, adaptive modifications.

UNIT III	**OUTLINE CLASSIFICATION OF PLANTS, ANIMALS & MICROORGANISMS**	**14 Hrs**

Important criteria used for classification in each taxon. Classification of plants, animals and

microorganisms. Evolutionary relationships among taxa.		
UNIT IV	**NATURAL HISTORY OF INDIAN SUBCONTINENT**	**15 Hrs**
Major habitat types of the subcontinent, geographic origins and migrations of species. Common Indian mammals, birds. Seasonality and phenology of the subcontinent.		
UNIT V	**ORGANISMS OF HEALTH & AGRICULTURAL IMPORTANCE AND CONSERVATION OF BIODIVERSITY**	**15 Hrs**
Common parasites and pathogens of humans, domestic animals and crops. Rare, endangered & extinct species. Conservation strategies.		
UNIT VI	**VIDEO LECTURES, SEMINARS AND WEBINARS**	**5 Hrs**

REFERENCES:

1. Plant Diversity I and II by Pandey
2. Invertebrates and Vertebrates by Verma and Agarwal

M.Sc., Biotechnology Curriculum

(Autonomous, CBCS & OBE pattern)

(For the Candidates admitted during the academic year 2022-2023 onwards)

SEMESTER – III

Course Code	22P3BT09	CORE – IX PLANT BIOTECHNOLOGY	Hours/ WK		Marks	
Credits	5					
Total Hours	75		T	P	Int	Ext
Max. Mark	100		5	-	25	75

Course Objectives:

The main objectives of this course are:

6. To familiarize the student in various aspects of cell and molecular biology streams including cellular organization and their interactions in DNA replication, and protein biosynthesis and translational regulation
7. To develop comprehensive understanding on the complete cellular and molecular functions of cell organelles in terms of cell to cell interaction, gene regulation, cellular signaling.
3. To impart the molecular biology knowledge in applications of various human health care

Course outcomes

On the successful completion of the course, student will be able to:

CO1	Acquire a complete knowledge about molecular marker-aided breeding and apply that for effective crop improvement.	K3, K6
CO2	Obtain a comprehensive knowledge about the concepts of plant tissue culture and its applications.	K1, K2
CO3	Understand the methods of plant genetic transformation and use such acquaintance to develop transgenic plants with improved traits.	K2, K3, K6
CO4	Know and apply advanced technologies for improving plant performance	K1, K5
CO5	Demonstrate the application of transgenic technology and apply that knowledge effectively in relevant areas.	K3, K4

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

UNIT I	PLANT TISSUE CULTURE	13 Hrs

History - principle - media composition, types Sterilisation, preparation and application. Micropropagation, meristems culture, callus cultures, suspension cultures, Organogenesis,

somatic hybridization & somatic embryogenesis - shoot formation, Root formation & hardening, protoplast isolation and fusion. Somaclonalvariation. Germplasm storage and cryopreservation

UNIT II	PLANT MOLECULAR BIOLOGY	13 Hrs

Plant genomic DNA-organelle DNA: Mitochondrial DNA & chloroplast DNA. Gene expression in higher plants: post transcription processing of plant RNA. Communication in plant cells: nucleus - mitochondria interaction and chloroplast - mitochondria evolved by endosymbiosis. Plant transformation technology: agrobacterium mediated gene transfer, Direct transfer and particle bombardment.

UNIT III	MEDICINAL PLANTS APPLICATION	14 Hrs

Diversity of medicinal plants in India**:** *Phyllanthusamarus, Casiaaugustifolia, Aloe verra, Bacopamonnieri, Saracaasoca, Withaniasomnifera, Ocimumtenuiflorum, Allium cepa , Piper betle and Cinnamomumzeylanicum.* Molecular pharming - concept of plants as biofactories, production of industrial enzymes and pharmaceutically important compounds

UNIT IV	AGRICULTURE & FOREST BIOTECHNOLOGY	15 Hrs

Seed production technology. Genetically modified plant: Resistances: herbicides- insect pest –pathogen . Metabolic engineering: secondary metabolic production, molecular farming. Risk assessment of transgenic plants**:** impact on agriculture development and insect protected crops. Agroforesty. Transgenictrees. Biotechnology production of wood composites. Biological control of forest pest.

UNIT V	INTELLECTUAL PROPERTY RIGHTS	15 Hrs

IPR in context with PBT, Patenting in PBT. International treaty on plant genetic resources for food and agriculture.IPR on biological resources & access to germplasm. Agriculture legislations. National biodiversity authority. Plant biotechnology in developing countries: Asia and India. Revocation of turmeric and neem patent

REFERENCES:

1. Modern Concepts of Biotechnology H.D. Kumar Vikas Publishing House Pvt. Ltd., New Delhi .
2. Role of Biotechnology in Medicinal and Aromatic Plants Irfan A. Khan and AtiyaKhanumUkaaz Publications, Hydreabad

3. Plant Tissue Culture Kalyan Kumar D. New Central Book Agency (P) Ltd, Calcutta
4. An introduction to Plant tissue Culture M.K. Razdan Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi
5. Biotechnology B.D. Sigh Kalyan Publishers New Delhi
6. Introduction to Plant Biotechnology H.S. Chawla Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi
7. Plant Biotechnology Recent Advances P.C. TrivediPanima Publishing Corporation, New Delhi
8. Biotechnology J.E. Smith Cambridge University Press
9. Plant Biochemistry and Molecular Biology Hans, Walter Held Oxford, NY 10. Plant Cell, Tissue, and Organ Culture- Fundamental Methods.
19.

Course Code	22P3BT10	CORE – X ANIMAL BIOTECHNOLOGY	Hours/ WK		Marks	
Credits	5		T	P	Int	Ext
Total Hours	75		5	-	25	75
Max. Mark	100					

Course Objectives:

The main objectives of this course are:

1.To familiarize the student in various aspects of cell and molecular biology streams including cellular organization and their interactions in DNA replication, and protein biosynthesis and translational regulation

2.To develop comprehensive understanding on the complete cellular and molecular functions of cell organelles in terms of cell to cell interaction, gene regulation, cellular signaling.

3. To impart the molecular biology knowledge in applications of various human health care

Course outcomes

On the successful completion of the course, student will be able to:

CO1	Gain fundamental knowledge in stem cell biology and tissue engineering.	K1
CO2	Describe sources, selection, potential manipulations and challenges of using stem cells for tissue engineering.	K2
CO3	Explain significance, current status and future potential of tissue engineering	K3
CO4	Identify key challenges in tissue engineering of different human tissues.	K4
CO5	Describe design, fabrication and biomaterials selection criteria for tissue engineering scaffolds	K5&K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

UNIT I	ANIMAL TISSUE CULTURE	12 Hrs

Animal Tissue culture history, Laboratory design, aseptic conditions, methodology and Media: Balanced salt solutions and simple growth medium, Chemical, physical and metabolic functions of different constituents of culture medium. Role of Carbon di oxide, Role of serum, and supplements. Serum & protein free defined media and their applications: equipments and materials for animal cell culture technology. Basic techniques of mammalian cell culture in vitro

UNIT II	BIOLOGY AND CHARACTERIZATION OF THE CULTURED CELLS	13 Hrs

Biology and characterization of the cultured cells, measuring parameters of growth. Cell synchronization. Somatic cell fusion, organ and histotypic Culture. Tissue engineering. Applications of animal cell culture, stem cell cultures, embryonic stem cells and their applications .cell culture based vaccines.

UNIT III	IVF & CLONING	13 Hrs

Invitro fertilization and embryo transfer, Sex determination or sex specific markers, Assisted reproductive technology, Intracytoplasmic sperm injection, Cryopreservation of gametes and embryo. Animal cloning – reproductive cloning, therapeutic cloning, Xenotransplantation, Animal genes and their regulation, some specific promoters for tissue specific expression.

UNIT IV	COMMERCIAL ASPECTS	16 Hrs

Improvements of animals using transgenic approach with specific examples, Animals as bioreactors: applications of biotechnology in sericulture, production of transgenic fishes. General steps to make and analyze transgenic fish .Genetically improved tilapia, Genetic engineering for production of regulatory proteins and blood products. Hormone production, Invitro culture of tissues and organs, Stem cell technology, Embryonic stem cells, maintenance of stem cell culture, Characterization of stem cells.

UNIT V	GENE THERAPY	15 Hrs

Gene therapy, Cancer Gene therapy, mechanism of gene therapy, Somatic versus germ line gene therapy, Immunotherapy. Vaccinology: history of development of vaccines, introduction to the concept of vaccines, conventional methods of animal vaccine production, recombinant approaches to vaccine production, modern vaccines.

UNIT VI	VIDEO LECTURES, SEMINARS AND WEBINARS	5 Hrs

REFERENCES:

1. Freshney RI. (2005). Culture of animal cells: A manual of basic techniques, 5th Edition, John Wiley and Sons.
2. John R W Masters. (2000). Animal cell culture, 3rd Edition, Oxford University Press.
3. Florence PR. (2006). Animal Biotechnology, Dominant Publishers and Distributors.
4. Sandy Primrose, RichardTwyman and Bob Old. (2001). Principles of Gene Manipulation, 6th Edition, Blackwell Science Ltd. p: 174-319.
5. Ranga MM. (2006). Animal Biotechnology.
6. Animal Biotechnology by Professor P.K. Gupta
7. Text Book of Animal biotechnology - **B Singh, S K Gautam and M S Chauhan**

Course Code	22P3BT11	CORE –XI ENVIRONMENTAL BIOTECHNOLOGY	Hours/ WK		Marks	
Credits	5					
Total Hours	75		T	P	Int	Ext
Max. Mark	100		5	-	25	75

Course Objectives:

The main objectives of this course are:

1.To familiarize the student in various aspects of cell and molecular biology streams including cellular organization and their interactions in DNA replication, and protein biosynthesis and translational regulation

2.To develop comprehensive understanding on the complete cellular and molecular functions of cell organelles in terms of cell to cell interaction, gene regulation, cellular signaling.

3. To impart the molecular biology knowledge in applications of various human health care

Course outcomes

On the successful completion of the course, student will be able to:

CO1	Acquire a complete knowledge about bio-fuel and bio-energy and its future needs	K1
CO2	Understand dangerous effects of environmental pollution and its methods of control and management which make them to create more remediation methods in future.	K1, K2
CO3	Familiarize the different methods of environmental pollution using biotechnological approaches	K3
CO4	Obtain a comprehensive knowledge about global environmental problem and disasters management which help to think about environmental protection	K4
CO5	This course is important in the era of industrialization leading to environmental hazards and hence will help students to take up a career in tackling industrial pollution	K5, K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

UNIT I	ENVIRONMENTAL ISSUES	13 Hrs

Climate change, Conservation Energy, Environmental degradation, Environmental Health Genetic engineering Intensive farming Land degradation soil, Land use. Nanotechnology Nuclear issues Over population, Burial, Ozone depletion-CFCP pollution, Water pollution, Air pollution, Reservoirs Resources depletion Consumerism-Fishing, Logging, Mining Toxins, Waste.

UNIT II	BIOREMEDIATION AND BIO-LEACHING	13 Hrs

Environmental impact of pollution and measurement methods- Composting of organic wastes, microbial bioremediation of oil spills; Waste water treatment- sewage treatment and common industrial effluent treatment; Concepts of bioremediation (in-situ and ex-situ), Bioremediation of toxic metal ions-biosorption and bio accumulation principles. Concepts of phytoremediation; Microbial biotransformation of pesticides and xenobiotics: Microbial leaching of ores- direct and indirect mechanisms.

UNIT III	BIOFUEL TECHNOLOGY	14 Hrs

Classification of biofuel, First generation biofuels, Bioalcohols, Biodiesel, Green diesel, Vegetable oil, Bioethers, Biogas, Syngas, Solid biofuels, Second generation biofuels (advanced biofuels), Biofuels by region, Issues with biofuel production and use.

UNIT IV	WASTE WATER TREATMENT	15 Hrs

Definition, source, types and composition of waste water, domestic sewage and industrial waste water. Methods of analysis of waste water- Std. parameters for physical, chemical and biological analysis, microbiological analysis, rationales and methods, their significance and limitations. Primary treatment: (Chemical/Physical) sedimentation, screening, coagulation, flocculation, dilution, neutralization, equalization etc. Secondary treatment: (Biological/ biochemical) Activated sludge process, Trickling filters, anaerobic filters, sludge digestion, Aerated lagoons, Algal ponds, Evapo- transpiration system.

UNIT V	ALTERNATE SOURCE OF ENERGY	15 Hrs

Biomass as a source of energy. Biocomposting, Vermiculture, Biofertilizers, Organic farming, Biomass project, Biomass centre & Species used for Biomass production.s Biomineralization, Bioelectricity through microbial fuel cell. Energy management and safety.

REFERENCES:

Text Books

1. Alan, S. (1999). Environmental Biotechnology. Pearson Education Limited, England.
2. Allsopp, D. and Seal, K.J. (1986). Introduction to Biodeterioration. ELBS/Edward Arnold, London.
3. Athie, D and Ceri, C.C. (1990). The use of Macrophytes in Water Pollution Control. Pergamon Press, Oxford.
4. Chin, K.K. and Kumarasivam, K. (1986). Industrial Water Technology Treatment-Reuse and Recycling. Pergamon Press, Oxford.

5. Dart, R.K. and Stretton, R.J. (1994). Microbiological aspects of pollution control. Elsevier Pub. Co., Amsterdam, New York.
6. Fry, F.C. and Gadd, G.M. Herbert, R.A. Jones, C.W. and Watson-Crick, J.A. (1982). Microbial Control of Pollution. Cambridge University Press, New York.
7. Henze, M and Gujer, W. (1992). Interactions of waste water: Biomat and Reactor Configurations in Biological Treatment Plan. Pergamon Press, Oxford.
8. Jenkins, D. and Olson, B. H. (1989). Water and Waste water Microbiology. Pergamon Press, Oxford.
9. John, C. and Todd, V.C. (1990). Integrated environmetal Management. Lewis Publishers Inc., Chel.
10. Kaul, T.N. and Trrivedy, R.K. (1993). Pollution Control in Distilleries. Enviromedia, Karad, India.
11. McEldowney, Sharon, Hardman, David, J. and Waite, S. (1993). Pollution, Ecology Biotreatment. Longman Scientific and Technical, Harlow, England.
12. Technoglous, G. Burton, F.L. and Stensel, H.D. (2004). Wastewater Engineering-Treatment, Disposal and Reuse. Metcalf and Eddy Inc., TataMcGraw Hill, New Delhi.

Publications

1. De, A. K. (2004). Environmental Chemistry . Wiley Eastern Ltd., New Delhi.
2. Jogdand, S.N. (1995). Environmental Biotechnology. Himalaya Publishing House, Bombay. Sastry, C.A. Hashim, M.A. and Angamuthu, P. (1995). Waste Treatment Plants. Narosa Publishing House, New Delhi, India.

Course Code	22P3BT12	CORE – XII BIOINFOMRATICS	Hours/ WK		Marks	
Credits	5					
Total Hours	75		T	P	Int	Ext
Max. Mark	100		5	-	25	75

Course Objectives:

The main objectives of this course are:

1. To gain basic knowledge in the concept of essential of bioinformatics.
2. To understand the usage of prediction tools that are used to predict the biological system
3. To understand basic concepts of drug designing

UNIT I	BIOLOGICAL DATABASES	13 Hrs

Biological Databases, Nucleic acid sequence databases– GenBank/NCBI, EMBL, and DDBJ. Protein sequence databases – UniprotKB and PIR, Structure databases – PDB, CATH and SCOP. Specialized Databases- PUBMED, OMIM and KEGG.

UNIT II	SEQUENCES ANALYSIS	12 Hrs

Sequence alignment, Pairwise Sequence Alignment- Local alignment and Global alignments- Dynamic programming algorithm, Scoring matrices, gap penalties. Multiple Sequence Alignment- Clustal X, Phylogenetic Analysis- Tree construction methods- Maximum likelihood and maximum parsimony- NJ methods, UPGMA and WPGMA, Database Similarity Search – BLAST and types

UNIT III	PREDICTION AND ANALYSIS TOOLS	15 Hrs

Gene Prediction methods – ORF Finder, Genscan, Restriction Site Analysis, PRIMER Designing, RNA Secondary Structure Predictions, Protein Secondary Structure Methods- Chau-Fasman and GOR.

UNIT IV	MOLECULAR MODELING	15 Hrs

Molecular Mechanics – force fields; Bond length, Torsion angle, Non- bonded interactions electrostatic and van der Waals interactions, energy minimization- local and global, Homology Modeling, Molecular dynamics and simulation.

UNIT V	DRUG DESIGNING	15 Hrs

Drug Discovery – Deriving and using 3D pharmacophore; Molecular Docking; Structure-based methods to identify lead compounds; de novo ligand design, Structure Activity Relationship - QSARs

REFERENCES:

1. Bioinformatics – Sequence and Genome analysis By David W. Mount.
2. Introduction to Bioinformatics – T.K. Atwood and Parry Smith.
3. Biological sequence analysis – R. Durbin, S. Eddy, A. Krogh and G. Mitchison
4. Andrew R. Leach (2001) “Molecular Modeling – Principles and Applications”; Second Edition,Prentice Hall, USA.

Course Code	22P3BTP03	LAB IN ADVANCED BIOTECHNOLOGY	Hours/ WK		Marks	
Credits	5					
Total Hours	75		T	P	Int	Ext
Max. Mark	100		5	-	25	75

Course Objectives:

The main objectives of this course are:

1. To familiarize the student in various aspects of cell and molecular biology streams including cellular organization and their interactions in DNA replication, and protein biosynthesis and translational regulation
2. To develop comprehensive understanding on the complete cellular and molecular functions of cell organelles in terms of cell to cell interaction, gene regulation, cellular signaling.
3. To impart the molecular biology knowledge in applications of various human health care

Course outcomes

1. Micro propagation of callus culture
2. Separation of Proteins by thin layer chromatography
3. Amplification of Genomic and ligated plasmid by PCR
4. Program to convert DNA to RNA/Protein
5. BLAST and Multiple Sequence and Phylogenetic Analysis
6. Western Blotting- Demonstration
7. Establishment of virus free plant using MS media
8. Establishment and maintenance of callus culture and Preparation of synthetic seeds
9. Isolation of auxotrophic mutants by replica plating technique
10. Gene and Protein Structure prediction (Secondary and tertiary)-bioinformatics tools.
11. Transformation & Selection of recombinant clones by (IPTG-X-gal: Blue white selection)

REFERENCES:

1. Molecular Cloning: A Laboratory Manual. Michael R. Green. 2014, Fourth Edition.
2. 2. Nucleic Acid Detection: Methods and Protocols (Methods in Molecular Biology) Dmitry M. Kolpashchikov and Yulia V. Gerasimova, 2013.
3. PCR Primer Design. Basu and Chhandak. 2015.
4. Measurement of Antioxidant Activity & Capacity: Recent Trends and Applications. ResatApakEsraCapanogluFereidoonShahidi, 2017.
5. Cytogenetics. P.K. Gupta. Rastogi publications. 2018.

Course Code	22P3BTE06	ELECTIVE –V NANOTECHNOLOGY	Hours/ WK		Marks	
Credits	5					
Total Hours	75		T	P	Int	Ext
Max. Mark	100		5	-	25	75

Course Objectives:

The main objectives of this course are:

1. To familiarize the student in various aspects of nano particle synthesis
2. To develop comprehensive understanding on the functions of nanoparticles.
3. To impart the knowledge in applications of various nanoparticles and materials

Course outcomes

On the successful completion of the course, student will be able to:

CO1	Know basic concepts of nanotechnology and nano materials	K1
CO2	Know the concepts of fabrication of bio molecular structures	K2
CO3	Develop miniaturized nano elements	K3,K5
CO4	Analysis of nano materials and robots	K4,K5
CO4	Understand various applications of nanotechnology in the field medicine, health care and drug discovery	K2,K3

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

UNIT I	INTRODUCTION TO NANOBIOTECHNOLOGY	13 Hrs

Definition, prospects and challenges; Topology of DNA, protein and lipids and self-assembly from Natural to artificial structures. Top up and bottom down approaches in nanomaterial fabrication.

UNIT II	NANOMATERIALS AND ITS PROPERTIES	13 Hrs

Carbon nanotubes and nanorods, Quantom dots, metal based nanostructures (Iron oxide nanoparticles), nanowires, polymer based nanostructures (dendrimers), Gold nanostructures (nanorods, nanocages, nanoshells), nanocomposites.

UNIT III	FABRICATION AND ANALYSIS OF BIOMOLECULAR NANOSTURUCTURES	14 Hrs

AtomicForce Microscopy, Scanning Probe Electron Microscopy and Lithography. Nanoscale detection: Lab on a Chip. Fabrication ofbionanochip & microarray technology.

UNIT IV	MINIATURIZED DEVICES IN NANOBIOTECHNOLOGY	15 Hrs
Types and applications; Nanobiosensors: different classes, molecular recognition elements (MRE), transducing elements, applications of MRE in nano sensing of different analytes..		
UNIT V	**APPLICATIONS OF NANOBIOTECHNOLOGY**	**15 Hrs**
Nanomedicine, Diagnosis and treatment of infectious diseases, cancer research and therapy, tissue engineering and regenerative therapy; Nanostructures in drug discovery & drug delivery..		

REFERENCES:

1. Nanobiotechnoogy: concepts, applications and perspectives. Christ of M. Niemayer, chad A. Mirkin, Wiley VCH publishers 2004.
2. Bionanotechnology: Lessons from Nature, David. S. Goodshell, Jhonwiley 2006.
3. Buddy, D.R. Allan, S.H. Frederick, J.S. and Jack, E.L. Biomaterials Sciences: An Introduction to Materials in Medicine. 2nd edition.
4. David, L.N. and Michael, M.C. (2006). Lehninger‟s principles of Biochemistry. 4th edition.
5. David, S. and Goodshell, J. (2006). Bionanotechnology: Lessons from Nature.
6. Molecular Design and Synthesis of Biomaterials. (2005). Biological Engineering Division, MIT Open Course Ware

Course Code	22P3BTE06	ELECTIVE –VI PHARMACEUTICAL BIOTECHNOLOGY	Hours/ WK		Marks	
Credits	5					
Total Hours	75		T	P	Int	Ext
Max. Mark	100		5	-	25	75

Course Objectives:

The main objectives of this course are:

4. To familiarize the student in various aspects of cell and molecular biology streams including cellular organization and their interactions in DNA replication, and protein biosynthesis and translational regulation
5. To develop comprehensive understanding on the complete cellular and molecular functions of cell organelles in terms of cell to cell interaction, gene regulation, cellular signaling.
3. To impart the molecular biology knowledge in applications of various human health care

Course outcomes

On the successful completion of the course, student will be able to:

CO1	Acquire knowledge about natural sources of drugs, interaction of drugs	K2
CO2	The students will get an insight about how various biological systems can be used for biopharmaceutical production.	K5
CO3	Obtain comprehensive knowledge about vital facets of clinical testing in obtaining approval for new drugs.	K4
CO4	Learn about emerging powerful tools employed for efficient and safe delivery of drugs into the host system.	K6
CO5	Understand the roles, responsibilities and organizational structure of regulatory bodies..	K5

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

UNIT I	INTRODUCTION TO PHARMACOLOGY	13 Hrs

History & development in pharmacology. Principles of pharmacology. – Pharmacology in the 20th century – Drugs – Sources, dosage forms and routes of administration

UNIT II	DRUG NAMES & CLASSIFICATION SYSTEMS	13 Hrs

General Principles of Drug action Pharmacokinetics, Pharmacodynamics, measurement of drug action.

UNIT III	DIAGNOSIS AND CHEMOTHERAPY	14 Hrs

Prenatal diagnosis: Invasive Techniques- Amniocentesis, Fetoscopy, Non Invasive Techniques – Ultra Sonography. Diagnosis using protein & enzymes markers, DNA/RNA based diagnostics. Therapeutic drugs – Protein synthesis inhibitors, Antibacterial,

antifungal, anti protozoal, antiviral, anti helmithic, anticancer, anti-inflammatory drugs.		
UNIT IV	**INTRODUCTION TO R-DNA TECHNOLOGY**	**15 Hrs**
Production of biological: Human Insulin, HGH, GRF, Erythropoietins, IFN, TNF, Interleukins, Clotting factor VIII. Synthetic therapy**:** Synthetic DNA, therapeutic ribozymes, synthetic drugs.		
UNIT V	**PRODUCTION AND APPLICATIONS**	**15 Hrs**
Probiotics, anticancer and anti-inflammatory agents. Biochips, biofilms and biosurfactants. Tissue Engineering, Recombinant vaccines and Cell adhesion based therapy.		

REFERENCES:

A Text Book of Biotechnology. R.C. Dubey. S.Chand& Co Ltd, New Delhi.

1. Pharmacology – H.P. Rang, M.M. Pale, J.M. Moore, and Churchill Livingston.
2. Basic Pharmacology – Foxter Cox. Butterworth‟s 1980
3. Pharmacology and Pharmacotherapeutics – R.S.Satoskar, S.D. Bhandhakam and S.S. Alinapure
5. Pharmaceutical Biotechnology – S.S. Purohit, Kaknani, Saleja
6. Pharmacology – Mary J. Myuk, Richard A.Hoarey, Pamala Lippinwitt, Williams Edition.
7. Integrated pharmacology – Page, Curtis, Sulter, Walker, Halfman. Mosby Publishing Co.

M.Sc., Biotechnology Curriculum

(Autonomous, CBCS & OBE pattern)

(For the Candidates admitted during the academic year 2022-2023 onwards)

SEMESTER – III

Extra disciplinary courses (EDC)

offered to other departments

Course Code	Title of the Course	Credits	Hours		Maximum Marks		
			Theory	Practical	Int	Ext	Total
Semester – III							
Extra Disciplinary Courses offered to other departments							
22P3BTED01	Nanotechnology	2	2	-	25	75	100
22P3BTED02	Bioinformatics						

Course Code	22P3BTED01	Extra Disciplinary Course NANOTECHNOLOGY	Hours/ WK		Marks	
Credits	5					
Total Hours	75		T	P	Int	Ext
Max. Mark	100		5	-	25	75

Course Objectives:

The main objectives of this course are:

1. To familiarize the student in various aspects of nano particle synthesis
2. To develop comprehensive understanding on the functions of nanoparticles.
3. To impart the knowledge in applications of various nanoparticles and materials

Course outcomes

On the successful completion of the course, student will be able to:

CO1	Know basic concepts of nanotechnology and nano materials	K1
CO2	Know the concepts of fabrication of bio molecular structures	K2
CO3	Develop miniaturized nano elements	K3,K5
CO4	Analysis of nano materials and robots	K4,K5
CO4	Understand various applications of nanotechnology in the field medicine, health care and drug discovery	K2,K3

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

UNIT I	INTRODUCTION TO NANOBIOTECHNOLOGY	13 Hrs

Definition, prospects and challenges; Topology of DNA, protein and lipids and self-assembly from Natural to artificial structures. Top up and bottom down approaches in nanomaterial fabrication.

UNIT II	NANOMATERIALS AND ITS PROPERTIES	13 Hrs

Carbon nanotubes and nanorods, Quantom dots, metal based nanostructures (Iron oxide nanoparticles), nanowires, polymer based nanostructures (dendrimers), Gold nanostructures (nanorods, nanocages, nanoshells), nanocomposites.

UNIT III	FABRICATION AND ANALYSIS OF BIOMOLECULAR NANOSTURUCTURES	14 Hrs

AtomicForce Microscopy, Scanning Probe Electron Microscopy and Lithography. Nanoscale detection: Lab on a Chip. Fabrication ofbionanochip & microarray technology.

UNIT IV	MINIATURIZED DEVICES IN NANOBIOTECHNOLOGY	15 Hrs

Types and applications; Nanobiosensors: different classes, molecular recognition elements (MRE), transducing elements, applications of MRE in nano sensing of different analytes..

UNIT V	APPLICATIONS OF NANOBIOTECHNOLOGY	15 Hrs

Nanomedicine, Diagnosis and treatment of infectious diseases, cancer research and therapy, tissue engineering and regenerative therapy; Nanostructures in drug discovery & drug delivery..

REFERENCES:

1. Nanobiotechnoogy: concepts, applications and perspectives. Christ of M. Niemayer, chad A. Mirkin, Wiley VCH publishers 2004.
2. Bionanotechnology: Lessons from Nature, David. S. Goodshell, Jhonwiley 2006.
3. Buddy, D.R. Allan, S.H. Frederick, J.S. and Jack, E.L. Biomaterials Sciences: An Introduction to Materials in Medicine. 2nd edition.
4. David, L.N. and Michael, M.C. (2006). Lehninger‟s principles of Biochemistry. 4th edition.
5. David, S. and Goodshell, J. (2006). Bionanotechnology: Lessons from Nature.
6. Molecular Design and Synthesis of Biomaterials. (2005). Biological Engineering Division, MIT Open Course Ware

Course Code	22P3BTED02	Extra Disciplinary Course BIOINFOMRATICS	Hours/ WK		Marks	
Credits	5					
Total Hours	75		T	P	Int	Ext
Max. Mark	100		5	-	25	75

Course Objectives:

The main objectives of this course are:

4. To gain basic knowledge in the concept of essential of bioinformatics.
5. To understand the usage of prediction tools that are used to predict the biological system
6. To understand basic concepts of drug designing

UNIT I	BIOLOGICAL DATABASES	13 Hrs

Biological Databases, Nucleic acid sequence databases– GenBank/NCBI, EMBL, and DDBJ. Protein sequence databases – UniprotKB and PIR, Structure databases – PDB, CATH and SCOP. Specialized Databases- PUBMED, OMIM and KEGG.

UNIT II	SEQUENCES ANALYSIS	12 Hrs

Sequence alignment, Pairwise Sequence Alignment- Local alignment and Global alignments- Dynamic programming algorithm, Scoring matrices, gap penalties. Multiple Sequence Alignment- Clustal X, Phylogenetic Analysis- Tree construction methods- Maximum likelihood and maximum parsimony- NJ methods, UPGMA and WPGMA, Database Similarity Search – BLAST and types

UNIT III	PREDICTION AND ANALYSIS TOOLS	15 Hrs

Gene Prediction methods – ORF Finder, Genscan, Restriction Site Analysis, PRIMER Designing, RNA Secondary Structure Predictions, Protein Secondary Structure Methods- Chau-Fasman and GOR.

UNIT IV	MOLECULAR MODELING	15 Hrs

Molecular Mechanics – force fields; Bond length, Torsion angle, Non- bonded interactions electrostatic and van der Waals interactions, energy minimization- local and global, Homology Modeling, Molecular dynamics and simulation.

UNIT V	DRUG DESIGNING	15 Hrs

Drug Discovery – Deriving and using 3D pharmacophore; Molecular Docking; Structure-based methods to identify lead compounds; de novo ligand design, Structure Activity Relationship - QSARs

REFERENCES:

5. Bioinformatics – Sequence and Genome analysis By David W. Mount.
6. Introduction to Bioinformatics – T.K. Atwood and Parry Smith.
7. Biological sequence analysis – R. Durbin, S. Eddy, A. Krogh and G. Mitchison
8. Andrew R. Leach (2001) “Molecular Modeling – Principles and Applications”; Second Edition,Prentice Hall, USA.

M.Sc., Biotechnology Curriculum

(Autonomous, CBCS & OBE pattern)

(For the Candidates admitted during the academic year 2022-2023 onwards)

SEMESTER – IV

Course Code	22P4BT12	CORE – IX RESEARCH METHODOLOGY AND BIOSTATISTICS	Hours/ WK		Marks	
Credits	5					
Total Hours	75		T	P	Int	Ext
Max. Mark	100		5	-	25	75

Course Objectives:

The main objectives of this course are:

4. To familiarize the student in various aspects of cell and molecular biology streams including cellular organization and their interactions in DNA replication, and protein biosynthesis and translational regulation
5. To develop comprehensive understanding on the complete cellular and molecular functions of cell organelles in terms of cell to cell interaction, gene regulation, cellular signaling.
3. To impart the molecular biology knowledge in applications of various human health care

Course outcomes

On the successful completion of the course, student will be able to:

CO1	Acquire a complete knowledge about collection of research paper	K3, K6
CO2	Obtain a comprehensive knowledge about the concepts of research work	K1, K2
CO3	Classified and identified of research work	K2, K3,
CO4	Know and apply for the various statistical theory	K1, K5
CO5	Demonstrate the application of production and applied for various statically calculation methods	K3, K4

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

UNIT I	RESEARCH DEFINITION	13 Hrs

Types of Research: Descriptive vs. Analytical Research, Applied vs. Fundamental Research, Quantitative vs. Qualitative Research, Conceptual vs. Empirical Research, Formulating the Research Problem, Research Methods vs. Research Methodology, Literature Review, Review Concepts and Theories, Current trends in Research, Mono,Trans, Inter- disciplinary Research, Computer & Internet: Its Role in Research, Threats and Challenges to Good Research.

UNIT II	**HYPOTHESIS**:	13 Hrs
Formulation, Sources, Characteristics, Role, Test, Research Design, Legal Research, Clinical Trials, Evolutive and Evaluative, Identificatory and Impact studies, Projective and Predictive, Writing an: Article, Essay, Research Paper, Research Project, Legislation Drafting, Judgment Writing, Thesis, Dissertation, Book, Reviews - Book Review; Case Review, Criteria of Good Research, Research Ethics, Citation Methods: Foot Note, Text Note, End Note, Bibliography, Citation Rules		
UNIT III	**PRINCIPLE AND APPLICATION OF RESEARCH METHODS**	**14 Hrs**
Spectrophotometer, Visible, UV, Fluorescence Flame photometer, Atomic absorption spectrophotometer, IR, NMR. Laboratory Safety Methods: Biohazardous Agents – Risk Groups and Biosafety levels – Laboratory safety measures.		
UNIT IV	**STATISTICS IN RESEARCH**	**15 Hrs**
Sampling Design, Data Collection- Primary and Secondary data, Processing and Analysis of Data, Limitation and uses of Statistics, Graphs, mean, Median, Mode, Standard deviation, Standard error.		
UNIT V	**BIOLOGICAL DATA ACQUISITION**	**15 Hrs**
Access, Retrieval and Submission methods for DNA sequence, protein sequence and protein structure information; Databases –Annotated sequence databases, Organism specific databases; Sequence Similarity Searches: Local versus global. Distance metrics, Scoring matrices, Dynamic programming algorithms, Needleman-wunsch and Smith-waterman.		

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2. Practical Research: Planning and Design (10th Edition) 10th Edition by Paul D. Leedy, Jeanne Ellis Ormrod
3. Developing Research Proposals (Success in Research) by Pam Denicolo, Lucinda Becker
4. Research Methodology – C.R.Kothari
5. 1.B.K. Mahajan, (1997)Methods in Biostatistics, Sixth Edition, Jaypee Brothers Medical Publishers(p)Ltd
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7. Gurumani, N.1943.Research Methodology for Biological Sciences.MJP Publications
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11. Burdan R.H.Knippenbergh P.H. 1989.Techniques in Biochemistry and Molecular Biology 2nd Ed,Elsevier.
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