KERALA UNIVERSITY OF FISHERIES AND OCEAN STUDIES

Panangad, Kochi- 682506, Kerala

M. Sc. Biotechnology

OBE Syllabus

2024

Regulations, Eligibility, Scheme and Syllabus For M. Sc. Biotechnology
(Effective from 2020 Admission onwards)

All the general rules and regulations laid down by the Kerala University of Fisheries and Ocean Studies PG Curriculum shall be applicable.

I. ELIGIBILITY CRITERIA

Those students who possess B.Sc./B.Tech Degree in Biological/Chemical including Biotechnology/Microbiology, Biochemistry/ Chemistry/Lifesciences/ Zoology/ Botany/ Veterinary/ Fishery Science / Pharmacy are eligible for admission to this Programme.

II. PROCESS OF ADMISSION

Candidates for admission will be selected on the basis of entrance examination conducted by Kerala University of Fisheries & Ocean Studies

III. PROGRAMME AND SCHEME OF EXAMINATIONS

1. M.Sc. Biotechnology programme shall have 5 core courses and 4 core practical courses in 1st semester, 4 core courses and 3 core practical courses and 1 elective courses in 2nd semester; 4 core course, 4 core practical courses and 1 elective courses in 3rd semester. In 4th semester viva-voce, evaluation of project work/ dissertation/viva voce and journal credit seminar will be conducted at the end of 4th semester.
2. There shall be external university examination of 3 hour duration for each theory courses at the end of each semester, to be conducted after the completion of 80 working days.
3. Each theory shall have 3 credits and practical course 2 credits.
4. Practical examination will be in the mode of continuous evaluation. There will be 2 internal practical examinations during each semester for each course. Each practical exam will be evaluated for 90 marks and 10 marks for the records.
5. There will be a pass minimum of 40% for theory and practical examination. Students who fail to get pass minimum of 40% in theory or in practical examination will be given another chance to reappear for 1 additional test in theory of practical examination. The marks of which will be taken into account for averaging in the case of theory or totalling in the case of practical.
6. For external, supplementary examination will be conducted as per the university regulations.

IV. EVALUATION

7. Project / dissertation evaluation/ viva-voce shall be conducted at the end of the programme only.
8. Project / dissertation, journal seminar and viva voce shall carry 22 credits in total.
9. Combined field studies and study tours may be carried out at any time during the entire period of the programme.
10. Each theory question paper may contain 10 short answer types, of weightage 1, 4 short essays out of 6 questions of weightage 5. Two long essays out of 4 questions of weightage 10.

V. EVALUATION AND GRADING

The evaluation scheme for each course shall contain two parts (a) Internal evaluation and (b) external evaluation. 50 marks shall be given to internal evaluation and the remaining 50 to external evaluation.

Internal evaluation: The internal evaluation shall be based on predetermined transparent system involving periodic written tests, assignments, seminars, classroom participation and attendance. Theory courses will be based on written tests while lab skill/records/viva/ attendance will be considered in the case of practical courses. The weightage assigned to various components for internal evaluation is a follows.

VI. TABULATION OF RESULTS

1. Marks obtained in each course will be entered separately.
2. For a pass the student should score a minimum of 40% in each course and 50% in aggregate (theory and practical) 4
3. Note: A paper wise minimum of 40% in each course and a 50% aggregate in each semester as stipulated for a student to pass the examination. If a candidate has scored 50% aggregate but failed to get the paper minimum of 40% in any papers, such candidate shall reappear for the concerned paper only to get the paper minimum (40%).

4. COMPONENTS OF INTERNAL EVALUATION

	Component	Weightage
A	Assignment	10
B	Seminar	5
C	Attendance	5
D	Class room participation	5
E	Test paper	25

To ensure transparency of the evaluation process, the internal assessment grade awarded to the students in each course in a semester shall be published on the notice board at least one week before the commencement of external examination. There shall not be any chance for improvement for internal grade.
The course teacher shall maintain the academic record of each student registered for the course, which shall be forwarded to the University, through the Director of the School.

External evaluation:

The external Examination in theory courses is to be conducted by the University with question papers set by external experts. The evaluation of the answer scripts shall be done by examiners based on a well-defined scheme of valuation. The external evaluation shall be done immediately after the examination preferably in a Centralized Valuation Camp.

VII. GRIEVANCE CELL

Students grievances pertaining to the award of internal marks shall be brought to the notice of the teacher concerned. In the case of failure to settle the grievances, the matter shall be placed in a three member departmental committee consisting of School director, HOD and the concerned teacher. School Director/HOD will be the chairman of the committee and the decision of the committee shall be final.

VIII. EVALUATION OF PROJECT REPORT/ DISSERTATION

Dissertation will be valued by two examiners who conduct the viva voce/dissertation evaluation (external) at the end of 4th semester. Valuation schedule is as given below.

Distribution of 15 weightage allotted for dissertation will be as follows

Methodology	4 weightage
Content	4 weightage
Presentation	2 weightage
Answering question	2 weightage
Originality or overall outlook	3 weightage
Total	15 weightage

IX. JOURNAL SEMINAR/CREDIT SEMINAR

All students need to present an internal journal seminar based on the project work done by them. Students should have to present using power point presentations and must be able to present the research work and answer the questions posed by the internal examiner.

Journal seminar	5 weightage
Total	**5 weightage**

M.Sc Biotechnology Programme

Program Specific Out Comes (PSO)

This Biotechnology program typically aims to equip students with a blend of biological sciences, technology, and application principles. At the end of the two year programme the student will be able to understand the following;

(1) **Fundamental Knowledge**: Students will understand the core concepts of biotechnology, including molecular biology, genetics, microbiology, and biochemistry.

(2) **Laboratory Skills**: Students will gain proficiency in essential laboratory techniques such as PCR, gel electrophoresis, cloning, and cell culture.

(3) **Bioprocessing**: Students will learn the principles of bioprocessing, including fermentation technology, bioreactor design, and scale-up processes.

(4) B**iotechnological Applications**: Students will explore various applications of biotechnology in fields such as healthcare, agriculture, environmental science, and food production.

(5) **Data Analysis**: Students will be able to analyze and interpret experimental data, utilizing bioinformatics tools and statistical methods.

(6) **Regulatory Knowledge**: Students will understand the regulatory environment governing biotechnology products, including FDA and EMA guidelines.

(7) **Ethical Considerations**: Students will discuss ethical issues related to biotechnology, such as genetic engineering, bioweapons, and biosecurity.

(8) **Research and Development**: Students will learn the process of developing biotechnological products, from conception through research, development, and commercialization.

(9) **Problem-Solving Skills**: Students will develop critical thinking and problem-solving abilities to address challenges in biotechnological research and application.

(10) **Collaboration and Teamwork**: Students will work effectively in teams, recognizing the interdisciplinary nature of biotechnology projects.

(11 **Communication Skills**: Students will be able to communicate complex biotechnological concepts effectively, both in writing and orally.

(12) **Current Trends and Innovations**: Students will stay informed about recent advancements and emerging trends in biotechnology, such as CRISPR technology, synthetic biology, and personalized medicine.

These outcomes ensure that students are well-prepared for careers in biotechnology, research, pharmaceuticals, and related fields.

M.Sc. Biotechnology-Course Structure, Scheme & Syllabus

(Credit semester System-2020 Admission onwards)

Semester I

Course	Course code	Course Title	Lecture hours	Tutorial hours	Practical hours	Credit	Exam duration (hrs).	Internal (%)	External (%)
core	BIT2101	Biochemistry	3			3	3	50	50
core	BIT2102	Microbiology	3	1		3	3	50	50
core	BIT2103	Cell biology & Genetics	3	1		3	3	50	50
core	BIT2104	Bioinformatics	3			3	3	50	50
core	BIT 2105	Biophysics and Biostatistics.	3			2	3	50	50
Practical courses	BIT2106	Practicals Biochemistry			3	2	3	100	--
	BIT2107	Practicals Microbiology			3	2	3	100	--
	BIT2108	Practicals Cell biology and genetics			4	2	3	100	--
	BIT2109	Statistical Analysis			2	2	3	100	--
Total credits for I Semester = 22.									
Semester II									
core	BIT2201	Molecular Biology	3			3	3	50	50
core	BIT2202	Immunology	3	1		3	3	50	50
core	BIT2203	Genomics and proteomics	3			3	3	50	50
core	BIT2204	Plant Biotechnology	3	1		3	3	50	50
One Elective course	BIT2205	Nanotechnology	3		2	2	3	50	50
	BIT2206	Environmental Biotechnology	3		2		3	50	50
Practical courses.	BIT2207	Practicals Molecular Biology			4	2	3	100	--

	BIT2208	Practical in immunology		4	2	3	100	--
	BIT2209	Practical Plant Biotechnology		4	2	3	100	--
Open Elective Courses								
.	BIT 2210	General Oceanography	3 50 50			2	3	
	BIT 2211	Environment and Biodiversity						
	BIT 2212	Maine Drugs						
	BIT 2213	Marine chemistry						
	BIT 2214	IPR and GI						
	BIT 2215	Climate change and polar sciences						
Total credits for II semester = 22								

Semester III

core	BIT2301	Animal Biotechnology	3			3	50	50
core	BIT2302	Genetic Engineering & rDNA Technology	3	1		3	50	50
core	BIT2303	Bioprocess Technology	3	1		3	50	50
core	BIT2304	Aquaculture Biotechnology	3			3	50	50
Practical Courses	BIT2305	Practical Animal Biotechnology			3	2	50	50
Practical courses.	BIT2306	Practicals Genetic Engineering & rDNA Technology			4	2	50	50
	BIT2307	Practicals Bioprocess Technology			3	2	50	50
	BIT2308	Practical Aquaculture Technology			3	2	50	50
Elective Courses .								

.	BIT 2309	Research methodology and Scientific writing	3		2	3	50	50
	BIT 2310	Biopharmaceutical						
	BIT 2311	Biodiversity						
Open Elective Courses /MOOC	BIT2312	Coastal Oceanography	3	3	2	3	50	50
	BIT 2313	Instrumentation techniques						
	BIT 2314	Marine Geology						
	BIT 2315	Marine Chemistry						
Total Credit for III Semester = 24								
Semester IV								
Core	Dissertation	----		20	----	----	100	
Core	Recent Advances in Biotechnology- Journal seminar	-----	--- -	2	----	100		
Total credit for IV semester = 22								

Total credits for M.Sc. Biotechnology Course (22+22+24+ 22) = 90

FIRST SEMESTER

Course Name	**BIOCHEMISTRY**		
Type of Course	**CORE COURSE**		
Course code	**BIT2101**		
CO. NO	**EXPECTED COURSE OUTCOME**	**LEARNING DOMAINS**	**PSO NO**
CO 1.	Understanding of Biomolecules**:** Students will be able to describe the structure and function of proteins, nucleic acids, carbohydrates, and lipids.	R/U	1
CO 2.	Metabolic Pathways**:** Students will understand major metabolic pathways, including glycolysis, the Krebs cycle, and oxidative phosphorylation, and how they interconnect.	R/U	1
CO 3.	Enzyme Function**:** Students will learn the mechanisms of enzyme action, enzyme kinetics, and factors that affect enzyme activity.	R/U/An	1,4
CO 4.	Energy Production**:** Students will understand how cells generate, store, and utilize energy through processes like ATP production, oxidative phosphorylation, and substrate-level phosphorylation	R/U	1,5
CO 5.	Regulation of Metabolism: Students will learn about the regulatory mechanisms that control metabolic pathways, including enzyme regulation, allosteric control, and hormonal influences.	R/U	1,4
R- Remembering U-Understanding AP-Applying A-Analyzing E-Evaluating C-Creating			
Unit-I Biomolecules: micromolecules, macromolecules, water, buffer systems and importance. Carbohydrates-structure, classification- monosaccharaides (trioses, tetroses, pentoses, hexoses, aldoses, ketoses), disaccharides and polysaccharides (homo and hetero polysaccharides); biological functions of carbohydrates. Lipids-classification-simple lipids, (neutral fats and waxes), conjugated lipids (phospholipids, sphingolipids, glycolipids, lecithins, cephalins, cerebrosides, gangliosides), derived lipids (fatty acids, essential fatty acids, Omega 3 fatty acids, steroids, prostaglandins),			

biological functions of lipids. Carbohydrate metabolism – glycogenesis, glycogenolysis, hexose monophosphate shunt, metabolic pathway of glucose-glycolysis, Kreb's cycle, electron transport cycles, chemiosmosis, hormonal control of carbohydrate metabolism.

Unit-II

Proteins - classification of proteins, amino acids- basic structure, structure of protein-primary, secondary, tertiary and quaternary structures, haemoglobin as atypical protein, biological functions of proteins. Proteins as Enzymes – classification and nomenclature, general properties of enzymes; mechanism of enzyme action, enzyme kinetics (basics); enzyme specificity, isoenzyme, co-enzyme, co-factors, lysozyme, zymogen. Enzyme activation and Inhibition and different types of inhibitors.

Unit-III

Lipid metabolism – hydrolysis of lipid, beta oxidation, mention alpha and omega oxidation of fatty acids, hormonal control of lipid metabolism. Protein metabolism – deamination, transamination, formation of urea, hormonal control of protein metabolism. Nucleic acid metabolism- biosynthesis, catabolism and regulation of purine and pyrimidine metabolism.

Unit-IV

Enzyme kinetics -Enzyme catalysis- General principles of catalysis : quantitation of enzyme activity and efficiency; enzyme characterization/kinetics, Michaelis-Menten equation, Km, Vmax efficiency of enzymes, enzyme inhibition- types and their kinetics, relevance of enzyme in metabolic regulation, activation, inhibition and co-valent modification, single substrate enzyme, metaloenzyme and allosteric enzyme.

Reference Books:

1. Donald Voet, Judith G. Voet(2010) Biochemistry, 4thEdition,Wiley.
2. David L. Nelson , Michael M. Cox (2013) Lehninger Principles of Biochemistry, 6thEdition, Macmillan.
3. Jeremy M. Berg, John L.Tymoczko and LubertStryer(2012) Biochemistry,7thEdition.W.H.Freeman and Co New York.
4. Robert Murray, David Bender, Kathleen M. Botham, Peter J. Kennelly, Victor Rodwell, P. Anthony Weil (2012) Harpers Illustrated Biochemistry, 29thEdition.McGraw-Hill Medical.

Course Name	MICROBIOLOGY		
Type of Course	CORE COURSE		
Course code	BIT2102		
CO. NO	Expected Course outcome	Learning Domains	PSO No
CO 1.	Knowledge in the use of different kinds of microscopes	R/U	1
CO 2.	Understand the structural details of bacteria and viruses	U	1
CO 3.	Describe the factors affecting the growth and resistance of microbes to various antibiotics.	An/E	1
CO 4.	Evaluate the important microbial genes and its application	E/C/S	1,5
CO 5.	Analyse the environmental impact on waste accumulation and its effective disposal	An/E	1,5

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Unit I

Introduction to Microbiology: Discovery of microorganisms: spontaneous generation, Koch's postulates, pure culture methods, microscope: light microscope, dark field, phase contrast, fluorescence microscope, confocal microscope, electron microscope: transmission and scanning electron microscope.

Unit II

Bacterial cell structure: pili, flagella- structure and fuction, plasma membrane cell walls, peptidoglycan layer, biosynthesis of peptidoglycan layer, cell inclusions, PHB,carboxysomes, gas vesicles, magnetosomes, nucleoid, endospore and sporulations. Archeal cell structure, flagella and motility, cell envelope, plasma membrane, cell walls cytoplasm, ribosome nucleoid. Viruses- structure, multiplication, lytic and lysogenic cycle. Examples of microbial, plant, and animal

viruses. Microbial taxonomy. Classification of microorganisms, criteria for classification, polyphasic identification molecular and biochemical characterization.

Unit III

Microbial growth, factors influencing growth, solutes, PH, temperature, uptake of nutrients; Passive diffusion, facilitated diffusion, group translocation. different phases of growth, growth curve, measurement of growth, synchronous growth, autotrophic and heterotrophic growth. Media: selective and different types of media, preservation of cultures. Viable count. microbial respiration- Embden-Myerhof pathway, Enter-Doudroff pathway, Pentose phosphate pathway, tricarboxylic acid cycle, ETC , Oxidative phosphorylation, anaerobic respiration, control of microorganism- sterilization, heat, radiation, chemical agents: phenolic, alcohol, halogens, heavy metals. Antimicrobial activity, susceptibility test, disk diffusion test. Antimicrobial drugs and its action: penicillins, cephalosporins, tetracylins, cholramphenicols, sulphonamides, quinolones, antiviral drugs and antifungal drugs. Drug resistance in Bacteria.

Unit IV

Microbial Genetics: Bacterial transformation, conjugation, transduction. Mutations, types of mutations, mutagens, isolation of mutants, Ames test, transposable elements, Plasmids. Bacterial diseases: Diptheria, tuberculosis, Chickenpox, small pox, HIV, SARS, NIPPA, CORONA (SARS-2)

Unit V

Environmental Microbiology: Microbiological analysis of water, waste water treatment,- primary and secondary treatment, measuring water quality, total organic carbon, chemical oxygen demand, biochemical oxygen demand, Rhizosphere, mycorrhiza, symbiosis,(Nitrogen fixation)Bioremediation , microbial fuel cell, prebiotics and probiotics, microbial quorum sensing.

Reference Books.

1. Willey, J.M.Sherwood, L., Woolverton, C.J, Prescott, L.M (2011). Precott,s Microbiology, New york: Mc Graw Hill
2. Michael Pelczar (2001) Microbiology. Mc Graw Hill
3. Jeffrey C. Pommerville,Jeffrey Pommerville (2010) Alcamo,s Fundamentals of Microbiology. Jones and Bartlett Learning.
4. David Wessner, Chritine Dupont, Trevor Charles (2013) Microbiology. Wiley.

Course Name	**CELL BIOLOGY AND GENETICS**		
Type of Course	**CORE COURSE**		
Course code	**BIT2103**		
CO. NO	**EXPECTED COURSE OUTCOME**	**LEARNING DOMAINS**	**PSO NO**
CO 1.	To outline an awareness on basics of cell biology and Genetics. Detailed understanding of cellular level organization of cell organelles, their morphology structure and functions.	U	1
CO 2.	Illustrating the various molecular level structure, organization, transport at cellular level and detailed explanation of stages of cell cycle, apoptosis and cancer	U	1
CO 3.	Demonstrating the cell signalling pathway and various cell trafficking pathways in detail.	U	1
CO 4.	Recalling the basics of genetics, terminology and Mendelian principles. Summarizing various gene interactions, linkage, crossing over, Chromosome mapping techniques and cytoplasmic inheritance.	R/U	1
CO 5.	Outline the basics of population genetics and various terminology relating to it and summarizing the karyotyping and chromosome banding and various chromosomal anomalies in man.	U	1
R- Remembering U-Understanding AP-Applying A-Analyzing E-Evaluating C-Creating			
Unit-I Discovery of cells, cell theory and its modern version. Prokaryotic and eukaryotic			

cells, nature and comparison. Structural organization and functions: Plasma membrane- structure/composition – lipid bilayer, protein associations within the fluid-mosaic arrangement, functions of plasma membrane, trans-membrane transport – pumps, carriers, channels, glycocalyx - membrane carbohydrates and their significance in cellular recognition. Mitochondria- structure, functions, oxidative phosphorylation and electro transport chain. Endoplasmic reticulum - morphology, types, functions and formation. Golgi bodies - morphology, types, functions (role in secretion) and formation. Lysosomes- morphology, major groups of enzymes, classification, polymorphism and functions. Microbodies - morphology, major enzymes, peroxisomes and glyoxisomes functions. Ribosomes - different types, subunits, functions. Proteasomes - structure, ubiquitin - tagged protein degradation. Centrioles and basal bodies- structure and functions. Cytoskeleton structure / function - microtubules, actin and intermediate filaments, MAPs, actin-binding proteins. Types of cell junctions, cell adhesion proteins, extracellular matrix in animals and plant cell wall.

Unit-II

Nucleus – structure and function, nuclear envelope, pore-complexes, nuclear lamina, nucleolus - structure, nucleolar cycle, ribosome biogenesis, nucleoporins and macromolecular transport. Chromatin organization - euchromatin and heterochromatin, nucleosome organization (solenoid / zig-zag) condensation and coiling (condensins / cohesions / remodelling complexes). Chromosome structure - typical metaphase chromosome; endomitosis and polytene chromosomes; lamp brush chromosome. Cell cycle and its regulation: G0 / G1, S, G2, and M phases, cdk /cyclin complexes, checkpoints; Mitosis and Meiosis: description of all stages, synaptonemal complex. Apoptosis – intrinsic and extrinsic pathways. Cancer and metastasis.

Unit-III

Cell signalling and signal transduction, structure and electrical properties of neurons, electrical impulses and their transmission, resting potential, action potential, propagation of action potential, voltage gated and ligand gated channels, synaptic transmission, membrane analyses and patch clamp techniques, chemical signals and receptors, second messengers: cAMP, Ca^{2+} ions, Ras pathway, glycogen breakdown by epinephrine. Molecular mechanisms of membrane transport, nuclear transport, transport across mitochondria and chloroplasts, intracellular vesicular trafficking from endoplasmic reticulum through Golgi apparatus to lysosomes/ cell exterior.

Unit-IV

History of Genetics; Pre-Mendelian genetic concepts, Inheritance of acquired characters, Germplasm theory. Mendel and his experiments, genetic terminology-gene, allele, genotype, phenotype, genome; wild type and mutant type, test cross, back cross and reciprocal cross. Interaction of genes: allelic, incomplete dominance, lethal and co-dominance, non- allelic, complementary gene action; Co-epistasis, dominant (feather coat) and recessive (coat colour), polygenic action (skin colour), pleiotropism, multiple alleles, ABO blood group system, Rh group and its

inheritance. Linkage, crossing over and recombination: Linked genes, linkage groups, chromosome theory of linkage, factors affecting linkage, crossing over and recombination, mechanism, kinds and factors affecting crossing over and its significance. Chromosome mapping. Sex Linkage: characteristics of sex linked inheritance, sex linked inheritance of man (colour blindness and haemophilia), incompletely sex linked genes, holandric genes, sex limited genes and sex influenced genes, protogynous, protoandrous. Cytoplasmic inheritance: Mitochondrial DNA, kappa particles in paramecium, maternal effects in Drosophila.

Unit-V

Population genetics- Hardy-Weinberg Equilibrium, selection, genetic drift, Genetic variation, Allele frequencies and its changes, mutation , gene flow, random mating, migration, inbreeding, outbreeding, assortive mating, hybrid vigor. Human Genetics: Karyotyping and chromosome banding techniques, FISH, normal chromosome compliment, pedigree analysis, chromosomal anomalies in man, autosomal (eg. Down syndrome, Edwards syndrome), allosomal (eg. Klinefelters syndrome, Turner's syndrome)

Reference Books:

1. Lodish*et al.* (2012) Molecular Cell Biology, 7th Edition. W H Freeman & Co.
2. Gerald Karp (2013) Cell Biology, 7thEdition.Wiley.
3. Geoffrey M. Cooper, Robert E.Hausman(2013) The Cell: A Molecular Approach, 6thEdition. Sinauer Associates, Inc.
4. Bruce Alberts, Dennis Bray, Karen Hopkin, Alexander D Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter(2013) Essential Cell Biology, 4th Edition. Garland Science.
5. D. PeterSnustadand Michael J. Simmons (2011) Principles of Genetics, 6thedition.John Wiley and Sons.
6. Peter J. Russell (2009) *i*Genetics: A Molecular Approach, 3rd Edition. Benjamin Cummings.

Monroe W. Strickberger (2008) Genetics, 3rdEdition.Prentice-Hall.

Course Name	BIOINFORMATICS		
Type of Course	CORE COURSE		
Course code	BIT2104		
CO. NO	Expected Course outcome	Learning Domains	PSO No
CO 1.	An insight into the fundamental aspects of bioinformatics and computational technology along with its needs and applications. Outlines various data structures, algorithms design and management systems in the field of bioinformatics	R	1
CO 2.	Explain the concepts, infrastructure and organization of data and database. Classification of and explores its data retrieval tools	U	1
CO 3.	Examine and interpret the sequence alignment method using pairwise alignment algorithms and identify tools for similarity search and scoring matrices.	U/AP	1,5
CO 4.	Analyze multiple sequence alignment using various profile methods and identify its applications in phylogenetic analysis, gene prediction, genome analysis and mapping, genetic linkage analysis and comparative genomics	AP/A	1,4,5
CO 5.	An insight into the fundamental aspects of bioinformatics and computational technology along with its needs and applications. Outlines various data structures, algorithms design and management systems in the field of bioinformatics	R	1,5
R- Remembering U-Understanding AP-Applying A-Analyzing E-Evaluating C-Creating			
Unit-I			

Need and use of bioinformatics; computer fundamentals – networking, hardware and internet. Biological information access, storage and retrieval; database management system. Data structures: array, stack, queue and linked List. Sorting and searching techniques: bubble sort, merge sort and insertion sort binary search. Introduction to algorithm design and analysis, sorting and searching algorithms, divide and conquer, dynamic programming: introduction and applications.

Unit-II

Database concepts and organization: data, metadata, data dictionary, ontologies, B-trees, hah indices, relational databases; infrastructure: data warehouse, OLAP technology. Primary databases - Nucleotide sequence database - NCBI, EMBL, EBI, DDBJ; Protein sequence databases - Swissprot, Protein Information Resource (PIR); Structural database - Protein Data Bank (PDB). Secondary databases - KEGG, Prosite, SCOP, CATH; Marine microbial genome databases; Marine biodiversity databases- GBIF, CoML, IO-CoML; Data retrieval tools - Entrez, SRS, Pubmed, Medline, OMIM.

Unit-III

Sequence alignment; Needleman and Wunsch; Smith and Waterman algorithms for pairwise alignments; dynamic programming; gap penalties; use of pairwise alignments for analysis of nucleic acid and protein sequences and interpretation of results; tools for similarity search and sequence alignment - FASTA, BLAST, E-value; scoring matrices -BLOSUM, PAM matrices.

Unit-IV

Multiple sequence alignment and applications, methods available - interactive alignment, progressive alignment – ClustalW, T - Coffee; Profile methods - Gribskov profile, PSI-BLAST, phylogenetic analysis; dendrogram and cladogram; various methods used in generating evolutionary tree; tree evaluation; Hidden Markov Models (HMMs); gene prediction methods; genome analysis and mapping - DNA fragment assembly, genetic linkage analysis. Comparative genomics: concepts of synteny, orthology, paralogy; tools and methods.

Reference Books:

1. David W. Mount (2001) Bioinformatics – Sequence and Genome analysis, Cold Spring Harbor Laboratory Press.
2. Stephen A. Krawetz& David D. Womble(2003) Introduction to Bioinformatics A Theoretical and Practical Approach. Humana Press.
3. Jiawei Han, MichelineKamber. Data Mining: Concepts and Techniques. The Morgan Kaufmann Series in Data Management Systems.
4. Bioinformatics: A Practical Guide to the Analysis of Genes & Proteins, 2005, John Wiley &Sons, Inc
5. David Hand, HeikkiMannila, Padhraic Smyth. Principles of Data Mining. Prentice Hall India.

Course Name	BIOPHYSICS AND BIOSTATISTICS		
Type of Course	CORE COURSE		
Course code	BIT2105		
CO. NO	EXPECTED COURSE OUTCOME	LEARNING DOMAINS	PSO NO
CO 1.	To recall the laws of thermodynamics and to relate the concept of thermodynamics in the field of biology.	R/U	1
CO 2.	To illustrate the various levels of protein structure, interaction of proteins with DNA, RNA and histones. To compare the physical aspects of nucleic acids.	U/A	1
CO 3.	To develop an insight on various instrumentation technique like photometry, spectroscopy and chromatography used in the field of biology and their applications.	AP/A	1,4,5

R- Remembering U-Understanding AP-Applying A-Analyzing E-Evaluating C-Creating

Unit-I

Laws of thermodynamics, the concept of enthalpy, entropy and free energy, thermodynamic equilibrium, redox potential, high energy molecules, examples of redox potential in biological system.

Unit-II

Protein structure, globular and fibrous protein; protein stability; protein folding. Structural implication of peptide bond, Ramachandran plot, protein families, alpha domains, beta domains. Physics of nucleic acids: Forces stabilizing structures; double helical structures; properties; helix – coil transitions. DNA polymorphism, GC content, re-association kinetics and Cot, Rot curves, DNA- Protein interaction-Interactions of transcription factors(Helix turn helix, Leucine Zipper, Cys-His, Zinc fingers,). Histone-DNA interaction, RNA protein interactions.

Unit-III

Electromagnetic spectrum, Beer Lambert's Law. Photometry, UV/VIS Spectrophotometry, X-ray crystallography , Circular dichroism, Infrared and Raman spectroscopy, Atomic absorption spectroscopy, ESR and NMR spectroscopy. Chromatographic techniques (HPLC), Mass spectroscopy (LC-MS, GC-MS).Fluorescent spectroscopy.Applications of different Spectroscopic techniques in Biology.

Module I

Bivariate data, Scatter diagram, measures of relationship, covariance and correlation, types of correlation, Simple linear correlation –Pearson's coefficient of correlation, Spearman's Rank Correlation Coefficient. Regression - types of regression, Fitting of simple linear regression equations using the least square method, properties of correlation and regression coefficients, coefficient of determination, applications of correlation and regression in Biology.

Module II:

Basic concepts of probability, classical, empirical and subjective theories of probability. Random variables and probability distributions – Binomial, poisson and normal distributions (definitions, properties and uses only. Point and interval estimation, confidence interval for the mean of a normal population. Tests concerning means (one sample and two sample cases).Chi-square test for goodness of fit and independence.

Suggested Readings:

1. Roland Glaser (2012) Biophysics: An Introduction, 2ndEdition.Springer.

2. William Bialek (2012) Biophysics:Searching for Principles.Princeton University Press.

3. T.M Nordlund(2011) Quantitative Understanding of Biosystems: An Introduction to Biophysics.CRC Press.

4. V. Raicu and A. Popescu (2008) Integrated Molecular and Cellular Biophysics. Springer.

5. Agarwal B.L. (2000) Basics Statistics, New Age International (p) Ltd.

6 Rengasamy R. (2013) A Text book of Agricultural New Age International (p) Ltd.

7. Zar, J.H. (1995) Bio statistical Analysis, Pearson Edn.

8. Croxton, F.E., Cowden, D.J. Klenis, S. Applied General Statistics, Prentice Hall.

9. Gupta, S.C. and Kapoor, V.K. (1978) Fundamentals of Mathematical Statistics, Sultan Chand & Sons.

10. Nabendu Pal and Sahadeb Sarkar (2013) . Statistics - Concepts and Applications. PHI Learning Private Limited , New Delh

11. Elhance, D. N. and Elhance, V. (1988). Fundamentals of Statistics, KitabMahal.

Course Name	PRACTICALS IN BIOCHEMISTRY		
Type of Course	PRACTICAL COURSE		
Course code	BIT2106		
CO. NO	EXPECTED COURSE OUTCOME	LEARNING DOMAINS	PSO NO
CO 1.	Laboratory Skills: Students will develop proficiency in key laboratory techniques, such as pipetting, centrifugation, spectrophotometry, chromatography, and electrophoresis.	U/A/An	1,2,5
CO 2.	Experimental Design: Students will learn to design and conduct experiments, formulating hypotheses and identifying appropriate methods for investigation	U/A/E/C	1,2,5
CO 3.	Biochemical Assays: Students will conduct various biochemical assays to measure enzyme activity, substrate concentration, and other metabolic parameters.	U/A/An/E	1,2,5
CO 4.	Documentation and Reporting: Students will learn to accurately document laboratory procedures and results, and effectively communicate findings in written reports and oral presentations.	U/A/An/E	1,2,5
CO 5.	Problem-Solving: Students will develop critical thinking and problem-solving skills by troubleshooting experimental issues and optimizing protocols.	U/A/A/E/C	9
CO 6.	Safety and Ethics: Students will understand and apply laboratory safety protocols and ethical considerations in biochemistry research.	U/A/A/E/C	1,2,6
R- Remembering U-Understanding AP-Applying A-Analyzing E-Evaluating C-Creating			

1. Units and Measurements
2. Preparation of buffers, pH measurement.
3. Quantitative estimation of Carbohydrates (Anthrone method/enzymatic methods)
4. Quantitative estimation of Protein (Lowry's / Bradford's methods)
5. Quantitative estimation of amino acids (ninhydrin method)
6. Quantitative estimation of Lipids (Floch method)
7. Estimation of DNA and RNA (Diphenyl amine method/Orcinol method)
8. Cholesterol estimation
9. Salivary amylase activity
10. Thin layer chromatography (Lipids)
11. Paper chromatography (Aminoacids)
12. Native PAGE and SDS- PAGE

13. Agarose Electrophoresis (DNA/RNA)
14. Purification and characterization of any suitable enzyme.
    a) Preparation of cell-free lysate
    b). Ammonium sulphate precipitation
    c) Ion exchange chromatography
    d) Dialysis of purified protein (enzyme) solution
    e) Assessing purity of samples from each step of purification by SDS-PAGE Gel Electrophoresis,
    f) Enzyme kinetics: Km, Vmax,

Core Practical Paper

Course Name	PRACTICALS IN MICROBIOLOGY		
Type of Course	PRACTICAL COURSE		
Course code	BIT2107		
CO. NO	Expected Course outcome	Learning Domains	PSO No
CO 1.	Gain the expertise in the preparation of different media for the growth and isolation of microbes.	A/U	1,2
CO 2.	Analyse the biochemical characters of Bacteria	An/E	1,2,5
CO 3.	Evaluate the resistance factors in microbes	A/E	1,2,5
CO 4.	Genetic modification in microbes	E/A	1,2
CO 5.	Creation of depository for microorganisms.	A/E	1,2, 6,8

R- Remembering U-Understanding AP-Applying A-Analyzing E-Evaluating C-Creating

1. Sterilization techniques
2. Preparation of Media (Solid, Liquid)
3. Culturing of microorganisms (Streak plate method, pour plate method, spread plate method, slant preparation)
4. Staining techniques (Simple, Differential-Grams, Specialized - spore and capsular)
5. Biochemical tests for identification of microorganisms (IMViC, Carbohydrate fermentation test)
6. Antimicrobial susceptibility test of microorganism, (Kirby-Baur method)
7. Growth curve of microorganisms (Turbidimetry method)
8. Preservation of bacterial cultures.
9. Bacterial transformation
10. Bacterial conjugation

Course Name	PRACTICALS IN CELL BIOLOGY AND GENETICS		
Type of Course	**PRACTICAL COURSE**		
Course code	**BIT2108**		
CO. NO	**EXPECTED COURSE OUTCOME**	**LEARNING DOMAINS**	**PSO NO**
CO 1.	To understand the basic etiquettes in laboratory and make use of microscope to observe the various cellular structures and cell organelles,	U/AP	1,2, 4,5
CO 2.	To prepare the slide and make use of microscope to examine the barr body. To understand the vital staining of mitochondria and examine it under the microscope.	U/AP/A	1,2,4,5
CO 3.	To prepare and make use of microscope to examine the salivary gland chromosome of Drosophila/chironomous larvae	U/AP/A	1,2,5
CO 4.	To prepare the slide, and observe the various stages of cell division by examining it under microscope.	U/AP/A	1,2,5
CO 5.	The ability to solve problems in basic Mendelian genetics, pedigree analysis, linkage and karyotyping.	U/AP	1,2,9,10
R- Remembering U-Understanding AP-Applying A-Analyzing E-Evaluating C-Creating			

1. Cell-Structure (microscopy)
2. Buccal smear study and staining methods for Barr bodies
3. Vital Staining of Mitochondria
4. Salivary gland Chromosome (Drosophila/Chironomous larva)
5. Preparation of onion root tip for the stages of mitosis
6. Preparation of stages of meiosis (Grass Hopper)
7. Mono hybrid Cross
8. Di hybrid Cross
9. Pedigree analysis of Mendelian traits
10. Karyotyping
11. Problems in genetics- Linkage / Crossing over, Selection index

Course Name	**PRACTICAL IN STATISTICAL ANALYSIS**		
Type of Course	**PRACTICAL COURSE**		
Course code	**BIT2109**		
CO. NO	**EXPECTED COURSE OUTCOME**	**LEARNING DOMAINS**	**PSO NO**
CO 1.	Learn to summarize and describe data sets using measures of central tendency, dispersion, and graphical representations.	U/Ap	1,2,5,9
CO 2.	Understand concepts such as hypothesis testing, confidence intervals, and p-values to make inferences about populations from sample data.	U/Ap	1,2,5,9
CO 3.	Learn to analyze variance and design experiments to test hypotheses involving multiple groups or conditions.	U/Ap	1,2,5,9
CO 4.	Develop the ability to critically evaluate statistical results, understand limitations, and communicate findings effectively.	U/Ap	1,2,5,9
R- Remembering U-Understanding AP-Applying A-Analyzing E-Evaluating C-Creating			

1. Data analysis using SPSS and MS-Excel in the following topics :
2. Graphical representation of data, computation of various measures of central tendency and dispersion.Computation of correlation coefficient, fitting of simple linear regression.
3. Construction of confidence intervals concerning mean.
4. Parametric tests of Hypothesis concerning mean.
5. Chi-square tests for goodness of fit and independence.

SECOND SEMESTER

Course Name	**MOLECULAR BIOLOGY**		
Type of Course	**CORE COURSE**		
Course code	**BIT2201**		
CO. NO	**Expected Course outcome**	**Learning Domains**	**PSO No**
CO 1.	Understanding Molecular Structures**:** Students will be able to describe the structure and function of nucleic acids (DNA and RNA), proteins, and other biomolecules	**R/U**	1
CO 2.	Genetic Principles**:** Students will grasp key concepts of genetics, including gene expression, regulation, and inheritance patterns.	**R/U**	1
CO 3.	Molecular Techniques**:** Students will develop proficiency in laboratory techniques such as PCR, DNA sequencing, cloning, and gel electrophoresis.	**R/U/A/An**	1,2,4,5
CO 4.	Gene Regulation**:** Students will understand the mechanisms of transcription and translation, including the roles of promoters, enhancers, and transcription factors.	**R/U**	1
CO 5.	Biological Processes**:** Students will be able to explain essential processes such as DNA replication, repair, and recombination.	**R/U**	1
R- Remembering U-Understanding AP-Applying A-Analyzing E-Evaluating C-Creating			

Unit-I

Introduction to Molecular biology, DNA as genetic material, mechanism of DNA replication, prokaryotic DNA replication, initiation of DNA replication, proof reading and editing, DNA repair systems – direct and indirect repair – photoreactivation, alkyl transferases, base and nucleotide excision repair, recombination repair, mismatch repair, SOS repair; termination of DNA replication; gene mutation, point mutation, insertion, deletion, suppressor mutation, chemical and physical mutagens. Homologous, non-homologous, site-specific recombination, DNA transposition.

Unit-II

Transcription and Transcriptional control: Structure of bacterial RNA polymerase, Transcription events, and sigma factor cycle, Eukaryotic RNA polymerases,

Promoter elements, TATA box, Hogness Box, CAAT box, Enhancers and Silencers, upstream and downstream activating sequences, initiation and termination of transcription in prokaryotes and eukaryotes, mRNA, rRNA and tRNA processing in prokaryotes and eukaryotes. Transcriptional and post-transcriptional gene-silencing.

Unit-III

Prokaryotic and eukaryotic translation, genetic code and wobble hypothesis, the translation machinery, mechanisms of initiation, elongation and termination, regulation of translation. Post-translational modifications.

Unit-IV

Control of gene expression in prokaryotes and eukaryotes. Operon model- lac and trp operon. Autogenous regulation, feedback inhibition, Lytic cascades and lysogenic repression. Molecular biology of cancer - causes and genetics of cancer, onco genes (ras, myc) and tumor suppressor genes (p53 and pRB).Molecular biology of stress; Stress proteins-heat and cold shock protein, molecular chaperones, salt and starvation stress tolerances.

Reference Books:

1. Lodish*et al.* (2012) Molecular Cell Biology, 7th Edition. W H Freeman & Co.
2. Geoffrey M. Cooper, Robert E. Hausman (2013) The Cell: A Molecular Approach, Sixth Edition. Sinauer Associates, Inc.
3. James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick (2013) Molecular Biology of the Gene, 7th Edition. Cold Spring Harbor Laboratory Press.
4. Jocelyn E. Krebs, Stephen T. Kilpatrick, Elliott S. Goldstein (2013) Lewin's Genes XI.Jones and Bartlett Publishers, Inc.

Course Name	IMMUNOLOGY		
Type of Course	CORE COURSE		
Course code	BIT2202		
CO. NO	EXPECTED COURSE OUTCOME	LEARNING DOMAINS	PSO NO
CO 1.	Define the historical development of Immunology.	R/U	1
CO 2.	Explain the different organs, tissues and development of immune cells.	U	1
CO 3.	Describe different immunoglobulin's and its application.	A/E	1,4,5
CO 4.	Evaluate various immunological diseases and its prevention strategies.	An/E	1,4,5
CO 5.	Design and development of vaccines for the effective control of diseases.	C/E	6,7,8,12

R- Remembering U-Understanding AP-Applying A-Analyzing E-Evaluating C-Creating

Unit-I

Introduction, history, development and scope. Immunity, classification of immunity. Innate (non-specific), acquired (specific) and passive immunity. Clonal nature of immune response. Immune system, organs and tissues of the immune system. Primary (central) - thymus, bone marrow, bursa of Fabricius; secondary (peripheral) - spleen, lymph nodes, mucosa associated lymphoid tissue (MALT). Organization and structure of lymphoid organs.

Unit-II

Lymphocytes – T cells and B cells – formation, development and maturation; plasma cells and null cells – natural killer cells, killer cells, lymphokine - activated killer cells; phagocytes / macrophages; antigen presenting cells – macrophages, B-lymphocytes, dendrite cells, langerhans cells; follicular dendrite cells, neutrophils, eosinophils, basophils, mast cells.

Unit-III

Antigens (immunogens) (Ag): definition, complete antigens, haptens, antigenic determinants or epitopes; antibodies (Immunoglobulins)- definition, general structure

of Ig, Ig determinants, physico-chemical properties of Ig, classes of Ig- G, M, A, D, E; mention abnormal Igs; antigen – antibody reactions- mechanism, precipitation reactions, agglutination reactions, complement fixation, neutralization, opsonisation. Complement system: definition, general features, major histocompatibility complex (MHC). Immune response-definition, types of immune responses- humoral immune response (antigen mediated immunity - AMI) and cellular immune response (cell mediated immunity - CMI), immunological memory, immunological tolerance and immune suppression. Polyclonal and monoclonal antibodies. Hybridoma techniques- T cell cloning and their applications. ELISA, RIA, Western blotting, Fluorescent techniques, Fluorescent activated cell sorting (FACS).

Unit-IV

Hyper sensitivity / allergy: definitions, classification- types I, II and III;Immuno deficiency diseases (ID)- definition, primary IDs, disorders of immune mechanism (humoral, cellular and combined IDs), disorders of complements, disorders of phagocytosis, secondary IDs, Acquired Immune Deficiency Syndrome (AIDS); auto immunity-definition, mechanism, auto immune diseases; transplantation immunity-definition, classification of transplants, graft versus host reactions; graft rejection, mechanism of graft rejection, factors affecting graft survival; Immunisation and vaccination- definitions, vaccines; types of immunization- active immunization- killed and live attenuated vaccines, microbial extracts, vaccine conjugates, toxoids, recombined vaccines, DNA/RNA vaccines, subunit vaccines; passive immunization-pooled normal human Igs, specific Igs (hyper antisera); combined immunization.

Reference Books:

1. Judy Owen, Jenni Punt, Sharon Stranford (2013) Kuby Immunology, 7thEdition. W. H. Freeman.
2. David Male, Jonathan Brostoff, David Roth, Ivan Roitt (2012) Immunology, 8th Edition. Saunders.
3. William E. Paul (2012) Fundamental Immunology,7th Edition. LWW.
4. Kenneth M. Murphy (2011) Janeway'sImmunobiology, 8thEdition.GarlandScience.

Course Name	GENOMICS AND PROTEOMICS		
Type of Course	CORE COURSE		
Course code	BIT2203		
CO. NO	EXPECTED COURSE OUTCOME	LEARNING DOMAINS	PSO NO
CO 1.	Fundamental Concepts: Students will understand the basic principles of genomics and proteomics, including the structure and function of DNA, RNA, and proteins.	R/U	1
CO 2.	Genomic and proteomic Techniques: Students will gain proficiency in techniques such as DNA sequencing (e.g., next-generation sequencing), genome mapping, and gene expression analysis. Students will learn methods for protein extraction, quantification, separation (e.g., SDS-PAGE, 2D gel electrophoresis), and mass spectrometry.	R/U	1
CO 3.	Gene Regulation: Students will understand the mechanisms of gene regulation and expression, including epigenetics and post-transcriptional modifications.	R/U	1
CO 4.	Protein Function: Students will be able to describe the relationship between protein structure and function, including the role of post-translational modifications.	R/U	1
CO 5.	Integration of Omics and Current Research Trends: Students will learn how genomics and proteomics can be integrated to provide insights into cellular functions and disease mechanisms. Students will be aware of current advancements and applications in genomics and proteomics, including personalized medicine and biomarker discovery.	R/U	1,8,9
R- Remembering U-Understanding AP-Applying A-Analyzing E-Evaluating C-Creating			
Unit-I Structure and organization of genomes; genome mapping and sequencing methods;			

assembly of DNA sequences- methods; genomic libraries of marine organisms; marine organisms - comparative genomics including phylogenomics, structural genomics, functional genomics - differential gene expression, digital gene expression, DNA microarray, cDNA and intragenic array, protein array; transcriptomics. Assigning gene function;

Unit-II

Gene silencing techniques; introduction to siRNA technology; micro RNA; Construction of siRNA vectors; gene knockouts; gene therapy - somatic and germ-line therapy, suicide gene therapy; gene replacement; gene targeting; transgenics; genomics of model organisms; marine metagenomics; marine genomics – advances and applications; advances in genomics- introduction to epigenomics, medical genomics and personal genomics.

Unit –III

Genomic Sequencing Projects- Human Genome Project, genome sequencing projects for microbes, plants and animals, accessing and retrieving genome project information from the web. Identification and classification of organisms using molecular markers- 16S rRNA typing/sequencing, SNPs; use of genomes to understand evolution of eukaryotes, track emerging diseases and design new drugs; determining gene location in genome sequence

Unit IV

Introduction to Proteomics, strategies and challenges in proteomics; proteomics technologies- Protein structure; sample preparation, protein purification and separation methods;2D-PAGE, isoelectric focusing, mass spectrometry, MALDI-TOF, yeast 2-hybrid system, proteome databases. Transcriptome analysis for identification and functional annotation of gene.

Reference Books:

1. Arthur M. Lesk (2012) Introduction to Genomics, 2nd Edition. Oxford University Press.
2. Richard Twyman (2013) Principles of Proteomics, 2nd Edition. Garland Science.
3. Malcolm Campbell and Laurie J. Heyer (2006) Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Benjamin Cummings.
4. Haleem J. Issaq and Timothy D. Veenstra (2013) Proteomic and Metabolomic Approaches to Biomarker Discovery. Elsevier.

Course Name	**PLANT BIOTECHNOLOGY**		
Type of Course	**CORE COURSE**		
Course code	**BIT2204**		
CO. No	**EXPECTED COURSE OUTCOME**	**LEARNING DOMAINS**	**PSO NO**
CO 1.	To outline the basics of Plant cell and tissue culture techniques, various tissue culture media and media components. Contrast the various culture types and preservation techniques	U/A	1,5
CO 2.	Relating various transformation technology available for plants and their mechanisms and summarize the various methods available for transformation	U	1
CO 3.	Summarizing the application of plant transformation techniques in various domains of agriculture mainly crop improvement, yield and quality	U/AP	1,4
CO 4.	To understand, relate and contrast the role of genetic manipulation of various metabolic pathways in metabolic engineering or molecular farming	U/AP	1,4
CO 5.	Summarizing and get an insight into the application of Molecular assisted breeding technique and molecular markers associated with it.	U/AP	1,4
R- Remembering U-Understanding AP-Applying A-Analyzing E-Evaluating C-Creating			
Unit I Introduction to plant cell and tissue culture, tissue culture as a technique to produce novel plant and hybrids. Plasticity, and totipotency, the culture environment, tissue culture media (composition and preparation) plant growth regulators, various culture types: Callus, cell suspension cultures, Protoplasts isolation, culture and fusion, root cultures, Shoot tip and			

meristem culture, Embryo culture, Microspore culture, anther, pollen and ovary culture for production of haploid plants. Culture preservation methods.

Unit II

Plant transformation technology: The basis of tumour formation, hairy root, features of T1 and R1 plasmids, mechanism of DNA transfer, role of virulence gene, use of T1 and R1 as vectors, binary vectors. Basic features of vectors for plant transformations: promoters and terminators, 35S promoter, inducible promoters, selectable markers, reporter genes, origin of replication, co-integrative and binary vectors. Methods of nuclear transformation; multiple gene transfers, direct gene transfer, particle bombardment, electroporation, polyethylene glycol (PEG) mediated transformation. Agrobacterium mediated gene transfer.

Unit III

Application of plant transformation: improvement of crop yield and quality; the genetic manipulation of fruit ripening, ripening related genes, manipulation of fruit softening, significance of olden rice. Long shelf life of fruits and flowers, use of ACC synthase, poly-galactrunase, ACC oxidase. Carbohydrate composition and storage, ADP glucose pyrophosphatase. Herbicide resistance, glyphosate resistance, insect resistance,- Bt – genes, Protease inhibitors, alpha amylase inhibitor, diseases resistance, Chitinase, glucanase, RIP antifungal proteins, PR proteins.

UnitIV

Metabolic engineering/ molecular farming: Plant secondary metabolite, control mechanisms and manipulation of phenylpropanoid pathway, shikimate pathway, alkaloid and industrial enzymes, antibodies and edible vaccine/biopharmaceuticals.

Unit V

Molecular marker assisted breeding / selection: RAPD markers, AFLP, linkage analysis, RFLP, STS, microsatellites, SCAR (sequence characterized amplified region), SSCP (single strand conformational polymorphism, MAS (molecular assisted selection)

Reference Books.

1. Plant Biotechnology J. Hammond P McGarvey and V. Yusibov, eds. Springer Verlag.
2. Plant propagation part I and II. E.F. George, exegetics, England
3. Plant Tissue culture, S.S. Bhojwani and M.K. Razdan, Elsevier, Amerstdam
4. Plant Cell culture- A practical approach, Dixon et al, IRL press, Oxford.
5. Gene transfer to plants, I Porykus and G Spangerberg, springer-verlag, Berlin.
6. Plant Biotechnology. The genetic manipulation of plants. Salater, A, Scott, N And Fowler M. Oxford University press.
7. Introduction to plant Biotechnology. Chawla H.S. Oxford and IBH publishing Co. pvt. Ltd.

Course Name	NANOTECHNOLOGY		
Type of Course	ELECTIVE COURSE		
Course code	BIT2205		
CO. No	EXPECTED COURSE OUTCOME	LEARNING DOMAINS	PSO NO
CO 1.	The basic concepts, scope and historical perspective of nanobiotechnology. List out various types and design strategies of nanomaterials for improved applications.	R/U	1
CO 2.	Outline various nanoparticles used for drug delivery system and its applications. Interpret its scalability potential, cellular internalization, long circulation, improved permeation and sustained drug release.	U	1
CO 3.	Application of nanomaterials in drug delivery system in various fields of diagnostics and imaging, cancer therapy, biosensors, catalysis.	U/AP	1,4
CO 4.	Understand the basics of nanotoxicity and ecotoxicity studies. Examine various models and assays for its assessment in different stratas of environment; containment of nanotoxicity.	U/A	1

R- Remembering U-Understanding AP-Applying A-Analyzing E-Evaluating C-Creating

Unit I

Introduction: Introduction to Nanobiotechnology; Concepts, historical perspective; Different formats of nanomaterials and applications with example for specific cases; Cellular Nanostructures; Nanopores; Biomolecular motors; Bio-inspired Nanostructures,
Synthesis and characterization of different nanomaterials.

Unit II

Biofilms and Nanoparticles: Introduction to Biofilms; Thin films; Colloidal nanostructures; Self Assembly, Nanovesicles; Nanospheres; Nanocapsules and their characterisation.Nanoparticles and applications Nanoparticles for drug delivery, concepts, optimization of nanoparticle properties for suitability of administration through various routes of delivery, advantages, strategies for cellular internalization and long circulation, strategies for enhanced permeation through various anatomical barriers.

Unit III

Applications of Nanomaterials: Nanoparticles for diagnostics and imaging (theranostics); concepts of smart stimuli responsive nanoparticles, implications in cancer therapy, nanodevices for biosensor development. : Nanomaterials for catalysis, development and characterization of nanobiocatalysts, application of nanoscaffolds in sythesis, applications of nanobiocatalysis in the production of drugs and drug intermediates.

Unit IV

Nanotoxicity: Introduction to Safety of nanomaterials, Basics of nanotoxicity, Models and assays for Nanotoxicity assessment; Fate of nanomaterials in different stratas of environment; Ecotoxicity models and assays; Life Cycle Assessment, containment of nanotoxicity.

Reference Books:

1. GeroDecher, Joseph B. Schlenoff, (2003); Multilayer Thin Films: Sequential Assembly of Nanocomposite Materials, Wiley-VCH Verlag GmbH & Co. KGaA
2. David S. Goodsell, (2004); Bionanotechnology: Lessons from Nature; Wiley-Liss
3. Neelina H. Malsch (2005), Biomedical Nanotechnology, CRC Press
4. Greg T. Hermanson, (2013); Bioconjugate Techniques, (3rd Edition); Elsevier
5. Recent review papers in the area of Nanomedicine.

Course Name	ENVIRONMENTAL BIOTECHNOLOGY		
Type of Course	ELECTIVE COURSE		
Course code	BIT2206		
CO. No	**EXPECTED COURSE OUTCOME**	**LEARNING DOMAINS**	**PSO NO**
CO 1.	Gain a comprehensive understanding of major environmental challenges such as pollution (air, water, soil), waste management, and climate change.	U/R	1
CO 2.	Understand the basic principles of biotechnology and its application in environmental processes	U/R	1
CO 3.	Understand the scientific basis of environmental degradation and the role of biotechnology in addressing these challenges.	U/R	1
CO 4.	Study the processes of bioremediation, phytoremediation, and biofiltration in pollution control.	U/An	1,4
CO 5.	Learn how genetically engineered microbes, enzymes, and other biotechnological tools can be used to degrade pollutants and hazardous substances	U/An/A	1,4
R- Remembering U-Understanding AP-Applying A-Analyzing E-Evaluating C-Creating			

Unit-I

Status and Scope of Biotechnology in environmental protection. Non-conventional energy sources. Environment protection Acts, environmental laws, environmental policies, environmental ethics. UN declaration. Environmental protection and conservation. Environmental Impact Assessment, Eco planning, Sustainable development and Green technologies.

Unit-II

Physicochemical and bacteriological analysis of soil and water-microbial ecology, Problems associated with soil: alkali soils, sodic soils, and solid waste, Insecticide, fungicide, pesticide cycle in soil, use of genetically modified (insect, pest and pathogen resistant) plants. Ecotoxicology of soil pollutants, Solid Waste Management.

Unit-III

Effluent water constituents, analysis and selection of flow rates and loadings, process selection, Physical unit operations / Chemical unit operations, fundamentals of biological treatment, Role of biotechnology in water purification systems. Biological treatment –types and kinetics. Biological Processes for Industrial and domestic effluent treatment, Aerobic Biological Treatment-Trickling filter, UASB, Anaerobic Biological Treatment-Lagoons, Activated sludge process.

Unit-IV

Bioremediation-Biotechnology for clean environment, bio-indicators and biosensors for detection of pollution. Biomaterials as substitutes for non-degradable materials (Bio plastics). Metal microbe interactions: heavy metal pollution and impact on environment, Microbial systems for heavy metal removal, biosorption, molecular mechanisms of heavy metal tolerance, Phytoremediation. Xenobiotic, oil spills, biological detoxification of Polycyclic Aromatic Hydrocarbons (PAH). Role of biopesticides, biofertilizers, vermiculture.

Reference Books:

1. Gareth G. Evans and Judy Furlong (2010) Environmental Biotechnology: Theory and Application, 2nd Edition. Wiley-Blackwell.
2. Bruce E. Rittmann, Perry L. McCarty (2001) Environmental Biotechnology: Principles and Applications. McGraw-Hill.
3. John C. Crittenden, R. Rhodes Trussell, David W. Hand, Kerry J. Howe,George Tchobanoglous(2012) MWH's Water Treatment: Principles and Design, 3rd Edition. Wiley.

Marian Petre (Ed.) (2013) Environmental Biotechnology - New Approaches and Prospective Applications. InTech.

Course Name	PRACTICALS MOLECULAR BIOLOGY		
Type of Course	PRACTICAL COURSE		
Course code	BIT2207		
CO. No	EXPECTED COURSE OUTCOME	LEARNING DOMAINS	PSO NO
CO 1.	Students will develop proficiency in essential molecular biology techniques, such as PCR, gel electrophoresis, DNA cloning, and sequencing.	U/R	1,2
CO 2.	Students will develop proficiency in essential molecular biology techniques, such as PCR, gel electrophoresis, DNA cloning, and sequencing.	U/R	1,2
CO 3.	Students will be able to prepare and handle biological samples, including nucleic acids and proteins, ensuring proper techniques for extraction and purification.	U/AP	1,2,5
CO 4.	Students will gain skills in collecting and analyzing experimental data, including quantitative and qualitative assessments.	U/A/E	1,2,5
CO 5.	Students will learn to accurately document experimental procedures and results, and effectively communicate findings through written reports and oral presentations.	U/A/E	1,2,9
R- Remembering U-Understanding AP-Applying A-Analyzing E-Evaluating C-Creating			

1. Isolation of total DNA from Bacteria
2. Isolation of total RNA using TRIzol
3. Isolation of Plasmid DNA
4. Restriction digestion of Lambda Phage DNA
5. DNA ligation of PCR products
6. Basics of PCR amplification using 16s RNA Primers,
7. Introduction to RT-PCR
8. Analysis of DNA using Agarose gel electrophoresis

Course Name	**PRACTICALS IMMUNOLOGY**		
Type of Course	**PRACTICAL COURSE**		
Course code	**BIT2208**		
CO. No	**EXPECTED COURSE OUTCOME**	**LEARNING DOMAINS**	**PSO NO**
CO 1.	Distinguish the various immune cell types	An	1,2
CO 2.	Evaluate similarities and dissimilarities of different Ags.	An/E	1,2
CO 3.	Determine the protein- protein interaction and identify its molecular level	A/E	1,2
CO 4.	Identification of immunological diseases using various mthods.	E/A	1,2,4
CO 5.	Choose appropriate techniques for the preservation of cells and proteins..	A/E	1,2,4,5
R- Remembering U-Understanding AP-Applying A-Analyzing E-Evaluating C-Creating			

1. Determination of blood group
2. Blood film preparation ND IDENTIFICATION OF CELLS.
3. Lymphocyte separation from peripheral blood
4. Antigen preparation and immunization
5. Immunnodiagnostics (Widal or VDRL using kit.)
6. Single and Double immunodiffusion
7. Immunoelectrophoresis
8. Western blotting
9. ELISA
10 ffinity chromatography
11. Flurochrome-Ab conjugation
12. Preparation of single cell suspension from spleen
13. Cryokpreservation and thawing of cells/cell lines.

Course Name	**PRACTICALS PLANT BIOTECHNOLOGY**		
Type of Course	**PRACTICAL COURSE**		
Course code	**BIT2209**		
CO. No	**EXPECTED COURSE OUTCOME**	**LEARNING DOMAINS**	**PSO NO**
CO 1.	Understanding the basics of media preparation and role of various media components and applying the aspetic techniques in handling the explant.	U/AP	1,2
CO 2.	To understand and make use of surface sterilization technique for the aseptic inoculation of various explants.	U/AP	1,2
CO 3.	Contrast and compare the various types tissue culture like callus propagation, organ culture, and organogenesis and examining the hardening process.	U/AP	1,2
CO 4.	Illustrating the use of agrobacterium to transform the explant and understand the selection of transformants using various assays.	U/AP	1,2,4
CO 5.	Analysing the RFLP and RAPD maps	A	1,2,4,5
R- Remembering U-Understanding AP-Applying A-Analyzing E-Evaluating C-Creating			

1. Preparation of media
2. Surface sterilization,
3. Organ culture
4. Callus propagation, organogenesis, transfer of plants to soil
5. Agrobacterium culture, selection of transformants, Reporter gene (GUS) asssya.
6. Analysis of RFLP and RAPD maps.

Course Name	**MARINE BIOTECHNOLOGY**		
Type of Course	**OPEN ELECTIVE COURSE**		
Course code	**OST 2203**		
CO. No	**EXPECTED COURSE OUTCOME**	**LEARNING DOMAINS**	**PSO NO**
CO 1.	Learn and apply biotechnological techniques, such as molecular cloning, genetic engineering, and bioinformatics, specifically in a marine context.	U/R	1
CO 2.	Develop skills in bioprospecting for novel compounds and bioactive substances from marine organisms for applications in pharmaceuticals, cosmetics, and agriculture.	U/A	1,2,9
CO 3.	Explore the use of marine biotechnology in environmental management, including bioremediation and the development of sustainable aquaculture practices.	U/A/Ap	1,2,12
CO 4.	Understand the ethical considerations and regulatory frameworks governing marine biotechnology, including biodiversity conservation and genetic resources.	U/R	1,6,7
CO 5.	Investigate innovative applications of marine biotechnology in areas like food production, energy, and health care.	U/An/C	8,12
R- Remembering U-Understanding AP-Applying A-Analyzing E-Evaluating C-Creating			
Unit 1 Fundamentals of Marine Biology: physical and chemical parameters of ocean; organisms inhabiting marine environment. Introduction to Marine Microbes and marine bioactive compounds			

Unit 2

Bioactive compounds derived from Marine organisms: aminoacids, macrolides, alkaloids,steroids; introduction to Marine Toxins- paral structure and biological functions and applications of marine bioactive compounds.

Unit 3

Common extraction methods for isolation of bioactive compounds from marine sources: Chromatographic separation of compounds- HPLC, TLC, FPLC; Microplate readers and fluorescence spectroscopy.

Unit 3

Enzyme activity: Common screening methods for isolated enzymes and bioactive molecules-enzyme assays: Caspase assay and LDH assay; Bioassays – General benchtop and primary bioassays; comet assay; MTT assay

Unit 4

Marine derived drug discovery and development: Drug toxicity assays – High-throughput screening assays and types- In vitro and In vivo assays; animal and cell based assays; basic clinical evaluation protocols for marine drugs: source and mode of action; Immunodiagnostics of fish diseases.

Reference

1. D.S. Bhakuni and D.S. Rawat (2005). Bioactive Marine Natural Products

2. Abba Kastin (2013). Handbook of Biologically active peptides 2n edition. Acadmic

press.

3. Hermann Ehrlich (2010). Biological Materials of Marine origin. Invertebrates.

Springer Press.

4. Atta Ur- Rahman, M. Iqbal Choudhary, William J Thomsen (2001). Bioassay

techniques for drug development.

THIRD SEMESTER

Course Name	**ANIMAL BIOTECHNOLOGY**		
Type of Course	**CORE COURSE**		
Course code	**BIT2301**		
CO. No	**EXPECTED COURSE OUTCOME**	**LEARNING DOMAINS**	**PSO NO**
CO 1.	Explain the isolation and development of cell lines.	A/U	1
CO 2.	Choose suitable media for cell culture maintenance	A	1
CO 3.	Select suitable techniques for specific cell separation and evaluation	An/E	1
CO 4.	Evaluate the scale up process for animal cell culture products in various bioreactors.	A/E	5
CO 5.	Examine the growth of stem cells and their application in transplantation.	E/C	5

R- Remembering U-Understanding AP-Applying A-Analyzing E-Evaluating C-Creating

UNIT I

Structure and organization of animal cell. Primary and established cell line culture: isolation of the tissues, mouse, chicken embryo, human biopsy material, primary explant, enzymatic disaggregation- trypsinisation, collagenase method, mechanical disaggregation, separation of viable and nonviable cells, enrichment of viable cells. Cell lines: immortalization of cell lines, selection of cell line, routine maintenance, replacement of medium, subculture, criteria for subculture, use of antibiotics.

UNIT II

Introduction to the balanced salt solutions and simple growth medium. Brief account on the chemical, physical and metabolic functions of different constituents of culture medium. Roe of carbon dioxide, serum and supplements. Serum and protein- free defined media and their applications.

UNIT III

Measurement of viability and cytotoxicity: specific culture methods, cytotoxicity, viability. Comparison of micro titration with cloning, assay by survival and proliferative capacity. Relationship between cell number and cytotoxicity index, anticancer drug screening. Basic techniques of mammalian cell culture in vitro: disaggregation of tissue and primary culture, maintenance of cell culture: cell separation of Density Gradient, immune panning, magnetic sorting, Fluorescence- activated cell sorting.

UNIT IV

Scaling of animal cell culture: General methods and culture parameters- Growth knenetics, medium and nutrients, pH and oxygen. Monolayer culture; cell attachment, scaling up, roller bottle. Suspension culture; small-scale suspension culture, stirred bioreactors, continuous flow culture, mixing and aeration, airlift fermenter, rotating chambers, perfused suspension culture.

UNIT V

Immobilized cultures: entrapment cultures, micro carriers. Perfused monolayer culture: membrane perfusion, hollow-fibre perfusion. Stem cell cultures, embryonic stem cells and their applications, cell culture based vaccine. Organ and histotypic cultures: Types of organ culture techniques: clotted plasma substrate, agar substrate, raft method, Grid method,waqtch glass techniques, single slide techniques, agar gel techniques. Organ culture of tissues e.g. neural cells, rat liver, histotypic culture, gel and sponge techniques.

Reference Books:

1. Culture of animal cells. R.Ian Freshney, Wiley- Liss
2. Animal cell culture- Practical approach. John R.W. Mastrs, Oxford.
3. Cell growth and Division. Apractical Approach. Ed. R. Basega. IRL. Press.
4. Animal Cell Culture Techniques. Eds. MartinClynes, Springer.

Course Name	**GENETIC ENGINEERING & rDNA TECHNOLOGY**		
Type of Course	**CORE COURSE**		
Course code	**BIT2302**		
CO. No	**Expected Course outcome**	**Learning Domains**	**PSO No**
CO. NO	The basic concepts of vectors. The classification of vectors: animal and plant based vector system. Defining cloning and expression host in prokaryotic and eukaryotic system.	R/U	1
CO 1.	Explaining different gene probes used in various blotting and in situ techniques. Summerizing various enzymes involved in gene cloning.	U	1
CO 2.	Basic concept, types, designing, cloning aspects of polymerase chain reaction. Outlining its application in mutagenesis, molecular diagnostics, mutation detection assays. Extended applications of PCR in genomic libraries and sequencing methodology.	U/AP	1,4,5
CO 3.	Analysing various cloning stratagies and methods of gene transfer in yeast, fungi, plants, mammalian cells. Build knowledge on differential expression profiling and recombinant protein purification.	AP/A	1,4,5
CO 4.	Distinguish various applications of rDNA like gene knockouts in animals, gene therapy, gene silencing, antisense technology and mechanism and application of CRISPRCAS.	AP/A	4,5
R- Remembering U-Understanding AP-Applying A-Analyzing E-Evaluating C-Creating			
Unit-I			

Vectors; cloning vectors: plasmids-pBR322, pUC19 and bluescript vectors; bacteriophages - lambda vectors, insertion and replacement vectors; M13mp vectors; phagemids; cosmids; artificial chromosome vectors, BACs, PACs, YACs, HACs; animal virus derived vectors-SV-40, vaccinia, bacculo and retroviral vectors. Expression vectors; pMal; GST; pET based vectors; intein-based vectors. Baculovirus and Pichia vectors system. Plant based vectors- Ti and Ri as vectors; yeast vectors; shuttle vectors. Prokaryotic and Eukaryotic cloning hosts and expression hosts.

Unit-II

Nucleic acids probes - labelling of DNA and RNA – isotopic and non-isotopic methods (nick translation, random priming, end labeling). Hybridization techniques –southern, northern, western, colony hybridization and fluorescence in-situ hybridization; enzymology of DNA manipulation - restriction enzymes, DNA ligase, klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase.

Unit-III

Polymerase chain reaction, primer design; fidelity of thermo stable enzymes; chemical synthesis of oligonucleotides; PCR and its optimization; types of PCR – multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR; cloning of PCR products- T/A-vectors; proof reading enzymes; PCR in gene recombination; deletion; addition; overlap extension; and SOEing; site directed mutagenesis; PCR based mutagenesis; PCR in molecular diagnostics; viral and bacterial detection; mutation detection- SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), mismatch chemical cleavage (MCC), allele specific amplification (ASA), protein truncation test (PTT). cDNA and genomic libraries- construction and screening. Rapid amplification of cDNA ends (RACE). DNA Sequencing methods- chemical, enzymatic & automated.

Unit-IV

Gene cloning: cohesive and blunt end ligation, linkers, adapters, homopolymer tailing; transformation- bacteria - $CaCl_2$ mediated, electroporation, lipofection; Yeasts and fungi- lithium acetate, PEG mediated, frozen yeast protocol, protoplast transformation, gene gun. Plants - biolistic, electroporation, and viral transformation. Mammalian cells - microinjection, transfection methods. Expression cloning: Walking, Jumping/hopping libraries; southwestern and far-western cloning; recombinant protein technology: design and use of expression vectors. Expression of foreign gene in *E.coli*, baculovirus and pichia expression system. Recombinant protein purification- His-tag; GST-tag; MBP-tag; Principles in maximizing gene expression. Inclusion bodies and regeneration of active proteins. Methodologies to reduce formation of inclusion bodies. Differential gene expression profiling by microarray, Gene knockouts in animals. Gene therapy: somatic and germ line gene therapy in vivo and ex-vivo, Design of SiRNA vectors and gene silencing. Direct gene transfer, molecular chimeras. Antisense technology/ gene transfer in animals and plants

Reference Books:

1. Michael R. Green, Joseph Sambrook (2012) Molecular Cloning: A Laboratory Manual, Vol: I, II & III, 4th Edition. Cold Spring Harbor Laboratory Press.
2. Sandy B. Primrose, Richard Twyman (2006) Principles of Gene Manipulation and Genomics, 7th Edition. Oxford University Press.
3. T. A. Brown (2010) Gene cloning and DNA analysis - an introduction, 6th Edition. Wiley-Blackwell.

4. James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick (2013) Molecular Biology of the Gene, 7th Edition. Cold Spring Harbor Laboratory Press.

Course Name	BIOPROCESS TECHNOLOGY		
Type of Course	CORE COURSE		
Course code	BIT2303		
CO. NO	EXPECTED COURSE OUTCOME	LEARNING DOMAINS	PSO NO
CO 1.	Explain the historical development in fermentation technology	R/U	1
CO 2.	Improvement in the product yield in fermentation	C/A	1,4
CO 3.	Assess the specific growth rate, and relate the biomass and product yield in fermentation	u/E	1,5
CO 4.	Design the bioreactor /Fermentor for antibiotic production	A/E	1,2,12
CO 5.	Develop appropriate techniques for the recovery of fermentation products..	C/E	1,12

R- Remembering U-Understanding AP-Applying A-Analyzing E-Evaluating C-Creating

Unit-I

Introduction to bioprocess technology, Chemical *vs* Biological processes. History of fermentation; Types of fermentation; Media for fermentation process; Understanding fermentation process, Process flow diagram. Industrial production of antibiotic, enzymes and vaccines.

Unit-II

Isolation, screening and strain improvement of industrially important microbes. Microbial Metabolism: microbial reactions and their types; stoichiometry calculations; yield coefficient; degree of reduction; transport of nutrients; Diffusion; facilitated diffusion; active transport; metabolic pathways- glycolysis, EMP and pentose pathway, TCA cycle, electron transport chain; anabolism; aerobic and anaerobic fermentation.

Unit-III

Microbial growth kinetics in batch and continuous fermentation; physico-chemical conditions affecting growth, pH, temperature, aeration and agitation; media for microbial growth; media optimization. Stoichiometry of growth; elemental balances and degree of reduction; specific growth rate, μ_{max}, biomass and productivity in a fermenter, dilution factor in a continuous system. Basic concepts of mass transfer, mass transfer resistance and heat transfer.

Unit-IV

Bioreactor technology: introduction to bioreactors; types of ideal reactors; design equation for ideal reactors; mode of operation of bioreactors- fed-batch and continuous reactors, fluidized bed reactors, immobilized reactors - immobilized enzyme reactors, methods of immobilization, solid state fermentation; bioreactors for plant and animal cell culture; bioreactor instrumentation and process control. Statistical modeling and large scale production systems.

Downstream process: introduction to downstream processing; strategies to recover and purify fermentation products; separation of insoluble products by filtration; centrifugation; coagulation and flocculation; cell disruption; precipitation; osmosis; dialysis; extraction; leaching; ATPS; adsorption; chromatography; drying; crystallization.

Reference Books:

1. Pauline M. Doran (2012) Bioprocess Engineering Principles, 2nd Edition. Academic Press.
2. James E. Bailey and David F. Ollis (2010) Biochemical Engineering Fundamentals, 2nd Edition. Tata McGraw - Hill Education.
3. Peter F. Stanbury, Allan Whitaker, Stephen J. Hall, (1999) Principles of Fermentation Technology, 2nd Edition. Butterworth-Heinemann.

WulfCrueger, AnnelieseCrueger, T.D. Brock (1991) Biotechnology: A Textbook of Industrial Microbiology, 2nd Edition.Sinauer Associates Inc

Course Name	AQUACULTURE BIOTECHNOLOGY		
Type of Course	CORE COURSE		
Course code	BIT2304		
CO. NO	Expected Course outcome	Learning Domains	PSO No
CO 1.	To understand the basics of fish breeding and various techniques employed. Illustrating the various conservation strategies and transformation techniques to improve the yield and quality in the field of aquaculture.	U	1
CO 2.	Introducing the various feed technology applied in aquaculture and the effects of mycotoxins on feeds.	U/AP	1
CO 3.	To identify various molecular diagnostic techniques and vaccines that help in the early detection of fish diseases. Introducing the modern techniques like ribotyping and RNAi. To understand the techniques employed in detection of toxic substances and pathogenic organisms	U/AP	1,4
CO 4.	Outline the role of genetically modified microorganisms as probiotics and immunostimulants and to understand the bioremediation of soil and water.	U	1
CO 5.	To understand and illustrate post-harvest biotechnology, the role of biosensors in detecting toxins, application of nanotechnology in various aspects of aquaculture. Introducing the marine food processing techniques.	U/AP	1,4
R- Remembering U-Understanding AP-Applying A-Analyzing E-Evaluating C-Creating			

Unit-I

Fish Breeding: synthetic hormones for induced breeding. Gene bank and conservation: cryopreservation of gametes and embryos.Transgenics, methods of gene transfer in fishes, screening for transgenic, applications, regulation of GMOs, IPR.

Unit-II

Feed technology: micro encapsulated feeds, micro coated feeds, micro-particulate feeds and bio-encapsulated feeds, mycotoxins and their effects on feeds.

Unit-III

Health management: DNA and RNA vaccines, molecular diagnosis of viral diseases, PCR,dot-blot, ribotyping of pathogenic microbes, RNAi, genetically modified micro-organisms as probiotics, immunostimulants,bioremediation of soil and water.

Unit-IV

Post-harvest biotechnology: delaying of spoilage, detection of toxic substances and pathogenic microbes, biosensors for toxins. Application of nanotechnology in aquaculture. Ecotoxicology and pollution, Marine food processing.

Reference Books:

1. Garth L. Fletcher, Matthew L. Rise (2012) Aquaculture Biotechnology.Wiley-Blackwell.
2. T. J.Pandian, C.A. Strüssmann, M.P. Marian (Eds.) (2005) Fish Genetics and Aquaculture Biotechnology.Science Publishers.
3. Dunham, R.A. Stylus (2010) A Review of “Aquaculture and Fisheries Biotechnology, Genetic Approaches”,
4. 2nd Edition. Cabi Publishing.
5. Boris Gomelsky(2011) Fish Genetics: Theory and Practice.VDMVerlagDr. Müller.

Course Name	PRACTICAL ANIMAL BIOTECHNOLOGY		
Type of Course	**PRACTICAL COURSE**		
Course code	**BIT2305**		
CO. NO	**EXPECTED COURSE OUTCOME**	**LEARNING DOMAINS**	**PSO NO**
CO 1.	Choose the methods in the preparation of animal cell culture media	R/U	1
CO 2.	How the cell viability and maintenance of cells are assessed.	U/E	1,2,3, 9
CO 3.	Analyse the importance of various components in the growth of animal cells.	A/C	1,9
CO 4.	Evaluate the toxicity effect of compounds in animal cells.	A/E	1,9
CO 5.	Design for the development of hybrid cells for the production molecules in diagnosis and treatment.	C/A	1,2,3, 9

R- Remembering U-Understanding AP-Applying A-Analyzing E-Evaluating C-Creating

1. Preparation of culture medium and membrane filtration.
2. Preparation of single cell suspension from spleen.
3. Cell counting and cell viability test
4. Cell culture maintenance and sub culturing.
5. Role of serum in cell culture.
6. Cryopreservation and thawing
7. Preparation of metaphase chromosome from cultured cells.
8. MTT assays for cell viability and growth
9. Demonstration of apoptosis of DNA laddering.
10. Cell fusion with PEG.

Course Name	PRACTICAL IN GENETIC ENGINEERING & RDNA TECHNOLOGY		
Type of Course	PRACTICAL COURSE		
Course code	BIT2306		
CO. NO	EXPECTED COURSE OUTCOME	LEARNING DOMAINS	PSO NO
CO 1.	Constructing various restriction digestion patterns of plasmid/phage DNA.	AP/C	1,5
CO 2.	Developing the competent *E.coli* cells for bacterial transformation and its selection.	C	8
CO 3.	Examine the synthesis of cDNA and its amplification of selected genes using qRT PCR	A	1,5
CO 4.	Understand and analyse the purification of selected gene, its cloning and identification of recombinants/ transformants by colony PCR	A	1,5
CO 5.	Compare various molecular techniques i.e., RFLP, RAPD, Southern hybridization and Blotting techniques	U/A	1,5
CO 6	Determining the genetic lineage using DNA barcodes	E	1,5

R- Remembering U-Understanding AP-Applying A-Analyzing E-Evaluating C-Creating

1. Restriction digestion and analysis of Plasmid/Phage DNA.
2. Preparation of competent E. coli cells
3. Transformation and Selection of recombinant E. coli
4. First Strand cDNA synthesis
5. PCR amplification of selected genes from cDNA using qRT PCR
6. PCR Purification and cloning into Plasmid
7. Selection of recombinants/ Transformants by colony PCR
8. Restriction Fragment Length Polymorphism
9. Random Amplified Polymorphic DNA
10. DNA Barcoding using mitochondrial genes.
11. Southern Hybridization and Blotting

Course Name	PRACTICALS BIOPROCESS TECHNOLOGY		
Type of Course	PRACTICAL COURSE		
Course code	BIT2307		
CO. NO	EXPECTED COURSE OUTCOME	LEARNING DOMAINS	PSO NO
CO 1.	Illustrate the various parts and operation of fermentor	R/U	1
CO 2.	Evaluate the efficiency of immobilised cells in the production of clinically important compounds.	U/E	1,3
CO 3.	Application of Biotechnological tools to improve the antibiotic production by microbial cells.	A/E	1,4
CO 4.	Formulate the media for the higher production of wine.	C/A	5
CO 5.	Improvement of Biotechnological methods for the recovery of fermentation Products.	C/E	8
R- Remembering U-Understanding AP-Applying A-Analyzing E-Evaluating C-Creating			

1. Fermenter Parts, Function and Operation
2. Fermentation - estimation of biomass
3. Immobilization of Yeast cells
4. Ethanol Production by immobilized Yeast
5. Antibiotic production by microorganisms
6. Immobilization of enzyme
7. Separation of microbial cells through centrifugation process
8. Wine production by yeast

Course Name	PRACTICAL IN AQUACULTURE BIOTECHNOLOGY		
Type of Course	PRACTICAL COURSE		
Course code	BIT2308		
CO. No	EXPECTED COURSE OUTCOME	LEARNING DOMAINS	PSO No
CO 1.	Understanding the isolation methodology for total DNA from fish muscle and infer with the help of Electrophoresis	U/A	1
CO 2.	Make use of Trizol reagent to isolate the total RNA from fish liver and infer with the help of Electrophoresis	AP/A	1,
CO 3.	To understand the basics of cryopreservation, preparation of extenders, cryoprotectants for Tilapia sperm cryopreservation.	U/AP	1
CO 4.	Introducing and understanding the method to generate transgenic fishes.	U/A	1
CO 5.	PCR and dot blot analysis of fish genes.	U/AP	1,8
R- Remembering U-Understanding AP-Applying A-Analyzing E-Evaluating C-Creating			

1. Isolation of total DNA from fish muscle tissue
2. Isolation of total RNA from fish liver using TRIzol
3. Preparation of extenders for cryopreservation for Tilpaia
4. Preparation of Cryoprotectants -DMSO, Ethlyene Glycol and Tilapia Sperm cryopreservation
5. Introduction to methods for generating transgenic fish –Microinjection and Electroporation
6. PCR analysis of Fish genes using semi qRT PCR
7. PCR dot blot,

Course Name	RESEARCH METHODOLOGY AND SCIENTIFIC WRITING

Type of Course	**ELECTIVE PAPER**		
Course code	**BIT 2309**		
CO. NO		**Learning Domains**	**PSO No**
CO 1.	Gain a solid foundation in various research designs (e.g., qualitative, quantitative, mixed methods) and their appropriate applications.	U/A/E	1,2
CO 2.	Develop skills in identifying and formulating clear, relevant, and feasible research questions and hypotheses.	U/A	1,9
CO 3.	Learn various data collection methods (e.g., surveys, experiments, interviews, observational studies) and how to choose the right method for your research.	U/A	1,2,5
CO 4.	Develop the ability to conduct thorough literature reviews, critically evaluating existing research and identifying gaps in knowledge.	U/A	1,2,5
CO 5.	Gain practical skills in writing scientific papers, including structuring articles, writing clear abstracts, and adhering to specific formatting guidelines.	U/AP	1,2,5
R- Remembering U-Understanding AP-Applying A-Analyzing E-Evaluating C-Creating			
UNIT I Introduction to research methodology, objectives of research, types of research, research approaches, significance of research, research and scientific method, criteria of good research, general problems encountered by researchers,. **UNIT II** Defining research problems, selecting research problems, steps/techniques involved in defining research problems, research design, important concepts in research design, dependent and independent variables, extraneous variables, research hypothesis, experimental and non-experimental hypothesis, important experimental design, completely randomized design, randomized block design ,			

Latin square design.

UNIT III

Concept of effective communication- setting clear goals for communication; determining outcomes and results; initiating communication; avoiding breakdowns while communicating; creating value in conversation; barriers to effective communication; non-verbal communication-interpreting non-verbal cues; importance of body language, power of effective listening; recognizing cultural differences;

UNIT IV

Presentation skills – formal presentation skills; preparing and presenting using over-head projector, PowerPoint; defending interrogation; scientific poster preparation & presentation; participating in group discussions; Computing skills for scientific research - web browsing for information search; search engines and their mechanism of searching; hidden Web and its importance in scientific research; internet as a medium of interaction between scientists; effective email strategy using the right tone and conciseness.

UNIT V

Technical writing skills - types of reports; layout of a formal report; scientific writing skills - importance of communicating science; problems while writing a scientific document; plagiarism, software for plagiarism; scientific publication writing: elements of a scientific paper including abstract, introduction, materials & methods, results, discussion, references; drafting titles and framing abstracts; publishing scientific papers-peer review process and problems, recent developments such as open access and nonblind review; plagiarism; characteristics of effective technical communication; scientific presentations; ethical issues; scientific misconduct.

Reference Books

1. Valiela, I. (2001). Doing Science: Design, Analysis, and Communication of Scientific Research. Oxford: Oxford University Press.
2. On Being a Scientist: a Guide to Responsible Conduct in Research. (2009). Washington, D.C.: National Academies Press.
3. Gopen, G. D., & Smith, J. A. The Science of Scientific Writing. American Scientist, 78 (Nov-Dec 1990), 550-558.
4. Mohan, K., & Singh, N. P. (2010). Speaking English Effectively. Delhi: Macmillan India.
5. Movie: Naturally Obsessed, The Making of a Scientist.

Course Name	**BIOPHARMACEUTICALS**

Type of Course	ELECTIVE COURSE		
Course code	**BIT 2310**		
CO. NO	**EXPECTED COURSE OUTCOME**	**LEARNING DOMAINS**	**PSO NO**
CO 1.	Define pharmaceuticals, summarizing its history and different source of drugs.	R/U	1
CO 2.	To identify the basic concepts of pharmacodynamics, its physio-chemical principles and mechanism of drugs. analyse various pharmacokinetics factors that effects the biological systems.	AP/A	1
CO 3.	To determine the production and analysis of different therapeutic products and its manufacturing practise.	E	1,3,4
CO 4.	Discovery and development of new drugs from natural resources. To determine controlled and sustained drug delivery system	A/E	5.8
CO 5.	To distinguish the phases in clinical trial, toxicological testing and to compare different regulatory bodies.	U/A	8

R- Remembering U-Understanding AP-Applying A-Analyzing E-Evaluating C-Creating

Unit I

Introduction to Pharmaceuticals. History & Definition of Drugs. Sources of Drugs - Plant, Animals, Microbes and Minerals. Different dosage forms. Routes of drug administration

Unit-II

Pharmacodynamics and Pharmacokinetics. Physico-Chemical Principles and mechanism of drug action, drug receptors and Physiological receptors: structural and functional families. Drug absorption, factors that affect the absorption of drugs, Distribution of drugs, Biotransformation of drugs, Bioavailability of drugs, Lipinski's rule; ADMET.

Unit-III

Sources, Production& analysis of Biopharmaceuticals. Good manufacturing practices, manufacturing facilities. Production of Therapeutic Proteins, Hormones, Cytokines - Interferon's, Interleukins I & II, Tumor Necrosis Factor (TNF); Nucleic

acids. Vaccine production

Unit-IV

Controlled and sustained drug Delivery Systems. Biomaterial for the sustained drug delivery-Nanoparticles (chitin/chitosan). Drug delivery methods for therapeutic proteins-Liposome mediated drug delivery. Discovery and development of new drugs from natural resources. Nanomedicines. Toxicological testing. Phases in Clinical trial. Regulatory bodies- FDA, CDSCO, DGCI -OECD Guidelines.

Reference:

1. Raymond G Hill and Humphery P Rang (2012) Drug Discovery and Development: Technology in Transition, 2nd Edition. Churchill Livingstone.
2. ChandrakantKokate (2011) Textbook of Pharmaceutical Biotechnology. Elsevier.
3. Rick NG (2008) Drugs: From Discovery to Approval, 2nd Edition. Wiley-Blackwell.
4. Daan J. A. Crommelin, Robert D. Sindelar, Bernd Meibohm (Eds.) (2007) Pharmaceutical Biotechnology: Fundamentals and Applications, 3rd Edition.CRC Press.
5. Gary Walsh (2003) Biopharmaceuticals: Biochemistry & Biotechnology, 2nd Edition. Wiley-Blackwell

Course Name	**FUNDAMENTALS OF MOLECULAR BIOLOGY**

Type of Course	**OPEN ELECTIVE COURSE**		
Course code	**OST2303**		
CO. No	**EXPECTED COURSE OUTCOME**	**LEARNING DOMAINS**	**PSO NO**
CO 1.	To understand the basics of cellular organization, cell organelles, their morphology, structure and functions. To get an insight of genome organization, genome structure and various molecular mechanisms like replication, repair and various enzymes involved.	U/A/E	1
CO 2.	Compare and contrast the various molecular mechanisms like translation and transcription and various enzymes involved in the process in prokaryotes and Eukaryotes.	U/A	1
CO 3.	To build and awareness on basics of cloning, types of vectors and methods of gene transfer like electroporation, transformation, lipofection etc. To get an awareness on various prokaryotic and eukaryotic cloning for gene expression studies	U/A	1
CO 4.	Compare and contrast various molecular techniques and tools like PCR. Blotting techniques, primer designing and optimization protocols.	U/A	1,5
CO 5.	PCR, its types and various application of PCR mutagenic and diagnostic studies	U/AP	1,4
R- Remembering U-Understanding AP-Applying A-Analyzing E-Evaluating C-Creating			
Unit 1: Introduction to Cell organelles andGenome organization-Mendels experiments and chromosomes; Prokaryotes and Eukaryotes- Genetic materials: DNA RNA – Structure and Types, DNA as Genetic material; Molecular mechanism of DNA replication and DNA repair-Prokaryotes and Eukaryotes; DNA Replication;			

Replication enzymes and functions.

Unit 2:

Protein Synthesis: Prokaryotic Transcription and Translation- Genetic Code and mRNA synthesis: Molecular Mechanism of transcription- initiation, elongation and termination; Enzymes and Molecular factors involved. Translation

Unit 3:

Cloning: Plasmids, Virus and Bacteriophages as vectors; Types and mechanism of Vector construction- M13 vector, Lambda Phage vector, Phagemids and cosmids; Gene cloning methods: cohesive and blunt end ligation; Electroporation, Transformation, Transfection, Lipofection, viral transformation; Prokaryotic and Eukaryotic Cloning hosts for gene expression.

Unit 4:

Techniques and tools in Molecular Biology:DNA and RNA isolation, Agarose Gel Electrophoresis, Restriction Enzymes- Types andDNA digestion, Western Blotting, Southern Blotting, Polymerase Chain Reaction- primer designing methods and optimization of protocols; Common types of PCR methodologies- multiplex PCR, hot-start PCR, colony PCR and real time PCR. Site Directed Mutagenesis: Applications of PCR in molecular diagnostics.

References:

1. Michael R Green and Joseph Sambrook (2012): Molecular Cloning: A laboratory manual

Vol: I- III. 7 th edition. Cold spring harbour laboratory press

2. T A Brown. Gene Cloning and DNA analaysis- an introduction Wiley Blackwell

3. James D Watson et al. Molecular Biology of the Gene. Cold Spring Harbour Laboratory

Press.

4. T A Brown. Genomes .Taylor and Francis, London.

Course	**BIODIVERSITY**

Name			
Type of Course	**ELECTIVE PAPER**		
Course code	**BIT 2311**		
CO. NO	**EXPECTED COURSE OUTCOME**	**LEARNING DOMAINS**	**PSO NO**
CO 1.	Gain a comprehensive understanding of the concept of biodiversity, including its components (genetic, species, and ecosystem diversity) and significance.	U/A/E	1,4,5
CO 2.	Learn how biodiversity contributes to ecosystem functions and services, such as nutrient cycling, pollination, and climate regulation.	U/A	1
CO 3.	Develop skills in identifying and classifying various species using taxonomic keys and field guides.	U/A	1,4,7
CO 4.	Acquire techniques for assessing biodiversity in different ecosystems, including sampling methods and biodiversity indices.	U/A	1,4,5
CO 5.	Understand the principles of conservation biology, including the threats to biodiversity and strategies for conservation and sustainable management.	U/AP	1
R- Remembering U-Understanding AP-Applying A-Analyzing E-Evaluating C-Creating			

Unit-I

Introduction-definition-geological history of biodiversity-(global level scenario) Mega biodiversity countries, biodiversity hot spots - global and Indian. Marine biodiversity. Threats to biodiversity.

Unit-II

Extinct and endangered species, causes of biodiversity losses, conservation methods – *insitu* and ---------*exsitu* conservation, wild life management, national parks, sanctuaries, sacred groves, gene pool. Types of biodiversity-genetic, species (α, β, γ). Impact of Alien species; GMOs on biodiversity. Impact of exotic species on endemic biota. Eco-restoration.

Unit-III

Sustainable utilization and conservation of biodiversity: biodiversity status, monitoring and documentation biodiversity management approaches, biopiracy, principles of conservation, cryopreservation, germplasm conservation and gene bank conservation strategies. GIS –remote sensing; Biodiversity indices and software packages used for accessing diversity indices.

Unit-IV

International treaties and global efforts for management of genetic resources relating to biodiversity. Convention on Biological Diversity (CBD) and Cartagena protocol. Biodiversity Legislation in India; Indian Biodiversity Act 2002, National Biodiversity Authority of India. Climate change and conservation of genetic resources.

Reference Books:

1. Edward O. Wilson (2010)The Diversity of Life, 15th Edition. Belknap Press.
2. Simon Levin (2013) Encyclopedia of Biodiversity, 2nd Edition.Academic Press.
3. Jane B. Reece, Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Robert B. Jackson (2013) Campbell Biology, 10th Edition. Benjamin Cummings.
4. Biodiversity and Conservation, Journal. ISSN: 0960-3115

FOURTH SEMESTER

Course Name	**DISSERTATION**		
Type of Course	**RESEARCH PROJECT**		
Course code	**BIT 2401**		
CO. NO	**EXPECTED COURSE OUTCOME**	**LEARNING DOMAINS**	**PSO NO**
CO 1.	Students will gain advanced understanding in a specific area of biotechnology, such as genetic engineering, bioinformatics, pharmaceutical biotechnology, environmental biotechnology, or industrial biotechnology.	U/A/E	1
CO 2.	Mastery of theoretical concepts, recent developments, and technological applications in the chosen area.	U/A	1
CO 3.	Applying this knowledge to design and conduct independent research to answer a specific scientific or industrial question.	U/A	1,10,12
CO 4.	Students will demonstrate the ability to design a well-structured research project, formulating hypotheses, selecting appropriate research methods, and justifying methodological choices.	U/A	2,3, 8
CO 5.	Ability to identify research gaps, formulate testable hypotheses, select appropriate quantitative or qualitative methods, and critically assess the best tools for data collection and analysis	U/AP	1,5,8
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Course Name	**RECENT ADVANCES IN BIOTECHNOLOGY- JOURNAL SEMINAR**		
Type of Course	**SEMINAR**		
Course code	**BIT 2402**		
CO. NO	**EXPECTED COURSE OUTCOME**	**LEARNING DOMAINS**	**PSO NO**
CO 1.	Students will develop the ability to critically read and evaluate primary scientific literature, understanding experimental design, data interpretation, and the implications of findings.	U/A/E	1
CO 2.	Students will acquire a thorough understanding of the latest developments, trends, and emerging technologies in the field of biotechnology, such as CRISPR gene editing, synthetic biology, personalized medicine, biopharmaceuticals, and bioinformatics.	U/A	1,8
CO 3.	Evaluating study methodologies, understanding experimental controls, assessing the validity and reliability of results, and recognizing limitations in the studies.	U/A	1,8,9
CO 4.	Critically assessing journal articles and presenting a balanced view of their findings, while being able to identify potential weaknesses or areas for improvement	U/A	1,8,10,11
CO 5.	Students will improve their ability to present complex scientific information in a clear, concise, and engaging manner, both orally and in writing, tailored to a scientific audience.	U/AP	11
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