



Two-Year Postgraduate Programme

**Master of Science in
Biotechnology**

Faculty of Applied Sciences

Parul University

Vadodara, Gujarat, India

Faculty of Applied Sciences
Master of Science in Biotechnology

1. Vision of the Department

The vision of a Department is to create and nurture a vibrant learning environment built on core values of science, with knowledge of advances in biological sciences is created and disseminated, with satisfaction in teaching and learning.

2. Mission of the Department

M1	To offer best quality Mentoring of Graduate, Post-graduate and doctoral studies students.
M2	To provide research facilities to lead scientific discoveries making global impact.
M3	To create skilled human resource to meet the demand of biological industry.
M4	To establish collaborations with industries, all other stakeholders and closely work with them to develop most sought-of curriculum, improve the skills of students.

3. Program Educational Objectives

The statements below indicate the career and professional achievements that the M.Sc. Biotechnology curriculum enables post graduates to attain.

PEO 1	To develop expertise students in molecular biology including its fundamentals.
PEO 2	To demonstrate the use of molecular biology lab equipment, handling techniques of instruments, and application of various techniques.
PEO 3	To compare and contrast data analysis and statistics knowledge to support professionalism and employability skills in biotechnology.
PEO 4	Make aware the students about cell structure and function, interpret biochemical data, and explain biomolecule concepts. Illustrate cell communication and demonstrate experimentation of it.
PEO 5	Theoretically as well as practically make students memorize the terms in genetic engineering and maintain the research ethics.
PEO 6	Implement awareness in the inheritance and enzyme structure/function in biotechnology.
PEO 7	Develop knowledge about genomics, plant reproduction, and immunology.

4. Program Specific Learning Outcomes

Program Learning outcomes are statements conveying the intent of a program of study.

PLO 1	The program aims to enhance students' expertise in molecular biology, focusing on cell & molecular biology concepts, DNA storage, gene structure, gene expression control, protein technology applications & proficiency in laboratory techniques, including precise instrument handling and experimental methods like electrophoresis.
PLO 2	The program will enhance students' data analysis, professional skills, & employability in biotechnology by teaching them to compare data, calculate confidence intervals, interpret p-values & emphasize ethical research practices. Additionally, students will master biochemical processes, cellular communication & genetic engineering strategies.

5. Program Specific Learning Outcomes

PSO 1	Molecular Biology Expertise:	Graduates will possess specialized knowledge in molecular biology, demonstrating an in-depth understanding of cell and molecular biology concepts. They will be able to relate these concepts to DNA storage, gene structure, control of gene expression, and comprehend the structural organization of genes and applications of protein technology.
PSO 2	Laboratory Proficiency including data analysis	Students will showcase proficiency in molecular biology laboratory techniques, including the effective use of lab equipment, precise handling of instruments, and the application of various experimental techniques. They will specifically demonstrate the separation of mixture components through electrophoresis.

6. Credit Framework

Semester wise Credit distribution of the programme	
Semester-1	24
Semester-2	21
Semester-3	21
Semester-4	29
Total Credits:	95

Category wise Credit distribution of the programme	
Category	Credit
Major Core	47
Research	20
Multidisciplinary	8
Ability Enhancement Course	16
Skill Enhancement Courses	4
Total Credits:	95

7. Program Curriculum

Semester 1						
Sr. No.	Subject Code	Subject Name	Credit	Lect	Lab	Tut
1	11202103	Molecular Biology	3	3	0	0
2	11202104	Analytical Techniques	3	3	0	0
3	11202105	Biostatistics and Computer Applications	3	3	0	0
4	11202106	Lab-1 Biochemistry and Analytical Techniques	4	0	4	0
5	11202107	Lab-2 Molecular biology	4	0	4	0
6	11202113	Seminar	1	0	0	1
7	11203106	Biochemistry	3	3	0	0
8	11203107	Cell and Developmental Biology	3	3	0	0
Total			24	15	8	1
Semester 2						
Sr. No.	Subject Code	Subject Name	Credit	Lect	Lab	Tut
9	11202154	Genetic engineering	4	4	0	0
10	11202155	Immunology	4	4	0	0
11	11202158	Genetics	4	4	0	0
12	11202159	Lab-I Immunology	2	0	4	0
13	11202160	Lab- 2 Microbiology and Genetic Engineering	2	0	4	0
14	11202161	Seminar	1	0	0	1
15	11202180	Elective – 1(Microbiology & Industrial Applications	4	4	0	0
Total			21	16	8	1
Semester 3						
Sr. No.	Subject Code	Subject Name	Credit	Lect	Lab	Tut
16	11202206	Enzymology	4	4	0	0
17	11202207	Plant and Animal biotechnology	4	4	0	0

18	11202208	Molecular virology and Immunotechnology	4	4	0	0
19	11202210	Lab-1 Plant and Animal biotechnology	2	0	4	0
20	11202211	Lab-2 Genomics and proteomics	2	0	4	0
21	11202212	Seminar	1	0	0	1
22	11202223	Genomics and Proteomics	4	4	0	0
Total			21	12	8	1
Semester 4						
Sr. No.	Subject Code	Subject Name	Credit	Lect	Lab	Tut
23	11202253	Bioprocess Engineering and Techniques	4	4	0	0
24	11202255	Dissertation	2	0	20	0
25	11202256	Seminar	1	0	0	1
26	11202282	Elective - Intellectual property rights	4	4	0	0
Total			29	8	20	1

8. Detailed Syllabus

Semester 1

(1)

a. **Course Name:** Biostatistics and Computer Applications

b. **Course Code:** 11202105

c. **Prerequisite:** Biostatistics and Computer Applications course that introduces and emphasizes the basic concepts of Biostatistics and the application of these concepts in the different field.

d. **Rationale:** The course will provide in depth knowledge about the amalgam of computer applications and biostatistics in combination with several scientific fields gave birth to an interdisciplinary field called bioinformatics, which reaches the biological predictions in an in silico way in combination with statistics.

e. **Course Learning Objective:**

CLOBJ 1	Explain fundamental statistical concepts, such as probability distributions, hypothesis testing, and types of variables.
CLOBJ 2	Solve descriptive statistics, graphical representations, and summary measures to comprehend trends and patterns in biological data.
CLOBJ 3	Apply principles of experimental design to formulate research hypotheses and design experiments that yield reliable and interpretable results.
CLOBJ 4	Examine the validity and reliability of experimental results, identifying potential sources of bias or confounding variables.

f. **Course Learning Outcomes:**

CLO 1	Understand the principles of statistical inference and hypothesis testing.
CLO 2	Apply the theoretical foundations of probability theory and distribution theory
CLO 3	Analyze statistical methods to interpret research findings, draw conclusions, and communicate results effectively through written and oral presentations.
CLO 4	Understand fundamental statistical concepts and methods commonly used in biostatistics, including probability distributions, hypothesis testing, and regression analysis.

Teaching & Examination Scheme:

Teaching Scheme (Hrs./Week)			Credit	Examination Scheme					Total
Lect	Tut	Lab		External		Internal			
				T	P	T	CE	P	
3	-	-	3	60	-	40	40	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

g. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	UNIT-I fundamental concepts in applied probability; Exploratory data analysis and statistical inference; Probability and analysis of one and two way samples; discrete and continuous probability models; Expectation and variance; Central limit theorem; Inference; Hypothesis; Critical region and error probabilities; Tests for proportion; Equality of proportions; equality of means of normal populations(variance known, variance unknown); Chi-square test for independence; P-value of the statistic; Confidence limits; Introduction to one way and two-way analysis of variance; Data transformations.	24%	12
2	UNIT-II Elements of programming languages - C and PERL; Data base concept; Database management system; Database browsing and Data retrieval; Sequence database and genome database; Data Structures and Databases; Databases such as GenBank; EMBL; DDBJ; Swissprot; PIR; MIPS; TIGR; Hovergen; TAIR; PlasmoDB; ECDC; Searching for sequence database like FASTA and BLAST algorithm.	20%	12
3	UNIT-III Cluster analysis; Phylogenetic clustering by simple matching coefficients; Sequence Comparison; Sequence pattern; Regular expression-based pattern; Theory of profiles and their use in sequence analysis; Markov models; Concept of HMMS; Baum-Welch algorithm; Use of profile HMM for protein family classification; Pattern recognition methods.	20%	12
4	UNIT-IV Goals of a Microarray experiment; Normalization of Microarray data; Detecting differential gene expression; Principal component analysis; Clustering of microarray data; Structure determination by X-ray crystallography; NMR spectroscopy; PDB (Protein Data Bank) and NDB (Nucleic Acid Data Bank); File formats for storage and dissemination of molecular structure.	21%	12

5	UNIT-V Methods for modeling; Homology modeling; Threading and protein structure prediction; Structure-structure comparison of macromolecules with reference to proteins; Force fields; Molecular energy minimization; Monte Carlo and molecular dynamics simulation.	15%	12
	Total	100	60

h. Text Book and Reference Book:

1. "Principles of Biochemistry, 1993A..L.Lehninger, Nelson and Cox (C.B.S., India).
2. Principles of Biochemistry General Aspects 1983 –Smith et al., general.(Mc Graw Hills)
3. Biochemistry, (2 nd edition) –Voet &Voet.
4. Biochemistry (4 th edition) –A.Stryer (Freeman).
5. Text book of biochemistry with clinical correlations. (4 th edition) –Thomas M.Devlin
6. Text book of Biochemistry, (1908) –West and Todd. (Mac Milan)
7. Biochemistry –Zubay.
8. Nucleic acid Biochemistry and Molecular biology –Main Waring, et al.
9. Understanding enzymes. (1985) –Trevor Palmer (John Wiley)
10. Fundamentals of Enzymology (II ed) by Nicholas C Price and Lewis Stevens, Oxford UnivPress.
11. Principles of Enzymology for Food Science (1972) by J R Whitkar, M Dekker Publishers.
12. Enzymes (3 rd ed 1979) Dixon M and Webb, E C, Longmans, London.
13. The chemical kinetics of enzyme action by K J Laidler and P S Bunting,Oxford University Press, London
14. Enzyme structure and function by S Blackburn, Marcel Dekker, Inc., NY.

ANNEXURE-III
Semester 1

(2)

a. Course Name: Biochemistry

b. Course Code: 11203106

c. Prerequisite: Basic knowledge about biomolecules and their role.

d. Rationale: The objective is to study about the structure and biological functions of macromolecules such as proteins, polysaccharides, lipids, and nucleic acids, as well as small molecules such as primary metabolites, secondary metabolites, and natural products.

e. Course Learning Objective:

CLOBJ 1	Explain the basic principles of biochemistry, including the structure and function of biomolecules.
CLOBJ 2	Explain the biochemical mechanisms underlying cellular processes.
CLOBJ 3	Describe biochemical techniques and laboratory protocols to isolate, characterize, and manipulate biomolecules for various biotechnological applications.
CLOBJ 4	Evaluate the impact of genetic mutations or environmental factors on biochemical processes, predicting their effects on cellular function and organismal physiology.

f. Course Learning Outcomes:

CLO 1	Understand the basic structure of different Biomolecules.
CLO 2	Remember the Conformation, isomerism of the bimolecular structures and their importance.
CLO 3	Understand the role of Building blocks of carbohydrates and proteins and their appearance in biological matters.
CLO 4	Analyse the nucleic acids structure, properties and their functions and enzymatic hydrolysis techniques provide.

g. Teaching & Examination Scheme:

Teaching Scheme (Hrs./Week)			Credit	Examination Scheme					Total
Lect	Tut	Lab		External		Internal			
				T	P	T	CE	P	
3	-	-	3	60	-	40	40	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	UNIT-I Chemical basis of life; Composition of living matter; Water – properties, pH, ionization and hydrophobicity; Emergent properties of biomolecules in water; Biomolecular hierarchy; Macromolecules; Molecular assemblies; Structure-function relationships Amino acids – structure and functional group properties; Peptides and covalent structure of proteins; Elucidation of primary and higher order structures; Evolution of protein structure; Structure-function relationships in model proteins like ribonuclease A, myoglobin, hemoglobin, chymotrypsin etc.; Tools to characterize expressed proteins.	22%	12
2	UNIT-II Enzyme catalysis – general principles of catalysis; Quantitation of enzyme activity and efficiency; Enzyme characterization and Michaelis-Menten kinetics; Relevance of enzymes in metabolic regulation, activation, inhibition and covalent modification; Single substrate enzymes.	20%	12
3	UNIT-III Sugars - mono, di, and polysaccharides; Suitability in the context of their different functions- cellular structure, energy storage, signalling; Glycosylation of other biomolecules - glycoproteins and glycolipids; Lipids - structure and properties of important members of storage and membrane lipids; lipoproteins.	20%	12
4	Biomembrane organization - sidedness and function; Membrane bound proteins - structure, properties and function; Transport phenomena Nucleosides, nucleotides, nucleic acids - structure, diversity and function; sequencing; Brief overview of central dogma.	18%	12
5	UNIT-V Bioenergetics-basic principles; Equilibria and concept of free energy; Coupled processes; Glycolytic pathway; Kreb's cycle; Oxidative phosphorylation; Photosynthesis; Elucidation of metabolic pathways; Logic and integration of central metabolism; entry/ exit of various biomolecules from central pathways; Principles of metabolic regulation; Regulatory steps; Signals and second messengers.	20%	12
	Total	100	60

i. Text Book and Reference Book:

1. Lehninger's Principles of Biochemistry (2000) by Nelson, David L and Cox, M M, Macmillan/worth, NY.
2. Fundamentals of Biochemistry (1999) by Donald Voet, Judith G Voet and Charlotte W Pratt, John Wiley & Sons, NY.
3. Biochemistry III ed (1994) by Lubert Stryer, WH Freeman and Co., San Francisco.
4. Outlines of Biochemistry (1987) by Eric E Conn, P K Stumpf, G Bruening and Ray H Doi, John Wiley & Sons, NY.
5. Principles of Biochemistry General aspects 1983 Smith et al. (McGraw Hills)
6. Biochemistry (4 th edition) – Thomas M.Devlin.
7. Text book of Biochemistry (1908) west and Todd. (Mac Milan)
8. Text book of Biochemistry – Zubay.
9. Biochemistry – Garret and Girsham

Semester 1

(3)

a. Course Name: Analytical Techniques

b. Course Code: 11202104

c. Prerequisite: Prior knowledge on modern methods and technologies used in biochemical analysis.

d. Rationale: The main objective of the course is qualitative and quantitative analysis of different molecules taking place in a biochemical reaction. It includes the development of different tools and methods for identification, analysis and examination of physical properties of different biochemical compositions to provide better chemical information. It helps the biochemistry students in understanding the basic science in a variety of applications.

e. Course Learning Objective:

CLOBJ 1	Describe the basic components and functions of instrumentation systems.
CLOBJ 2	Explain the underlying physical and chemical principles behind the operation of analytical instruments, including spectroscopic techniques, chromatographic separations, and electrophoretic methods.
CLOBJ 3	Use instrumentation software and data analysis tools to process, visualize, and interpret experimental data obtained from analytical instruments.
CLOBJ 4	Describe the performance and reliability of analytical instruments, assessing factors such as sensitivity, precision, accuracy, and detection limits.
CLOBJ 5	Explain the suitability of different instrumentation techniques for specific analytical tasks in biotechnology,

f. Course Learning Outcomes:

CLO 1	understand the handling techniques of various instruments.
CLO 2	Apply the Application of different techniques.
CLO 3	Analyze the mixture of component using electrophoresis.
CLO 4	Understand the theory and application of different chromatography technique, including centrifugation.
CLO 5	Understand the applications of bioinstruments.

g. Teaching & Examination Scheme:

Teaching Scheme (Hrs./Week)			Credit	Examination Scheme					Total
Lect	Tut	Lab		External		Internal			
				T	P	T	CE	P	
3	-	-	3	60	-	40	40	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	UNIT-I Basic Techniques Buffers; Methods of cell disintegration; Enzyme assays and controls; Detergents and membrane proteins; Dialysis, Ultrafiltration and other membrane techniques Spectroscopy Techniques UV, Visible and Raman Spectroscopy; Theory and application of Circular Dichroism; Fluorescence; MS, NMR, PMR, ESR and Plasma Emission spectroscopy.	25%	15
2	UNIT-II Chromatography Techniques TLC and Paper chromatography; Chromatographic methods for macromolecule separation – Gel permeation, Ion exchange, Hydrophobic, Reverse-phase and Affinity chromatography; HPLC and FPLC; Criteria of protein purity Electrophoretic techniques Theory and application of Polyacrylamide and Agarose gel electrophoresis; Capillary electrophoresis; 2D Electrophoresis; Disc gel electrophoresis; Gradient electrophoresis; Pulsed field gel electrophoresis.	25%	15
3	Basic principles; Mathematics & theory (RCF, Sedimentation coefficient etc); Types of centrifuge – Microcentrifuge, High speed & Ultracentrifuges; Preparative centrifugation; Differential & density gradient centrifugation; Applications (Isolation of cell components); Analytical centrifugation; Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods.	25%	15
4	UNIT-IV Radioactivity Radioactive & stable isotopes; Pattern and rate of radioactive decay; Units of radioactivity; Measurement of radioactivity; Geiger-Muller counter; Solid & Liquid scintillation counters (Basic principle, instrumentation & technique); Brief idea of radiation dosimetry; Cerenkov radiation; Autoradiography; Measurement of stable isotopes; Falling drop method; Applications of isotopes in biochemistry; Radiotracer techniques; Distribution studies; Isotope dilution technique; Metabolic studies; Clinical application; Radioimmunoassay.	25%	15
	Total	100	60

i. Text Book and Reference Book:

1. The tools of Biochemistry – Terrace.E.Cooper (John Willey).
2. A Biologists guide to Principles and Techniques of practical Biochemistry Ed.Bryan, L.Williams & Keith Wilson (Edward Arnold).
3. Biochemical research techniques – A practical introduction. Ed. John M.Wriggelsworth.
4. Principles & Techniques of Practical Biochemistry – Wilson and Walker.
5. Analytical Biochemistry. David. J.Home & Hazelpack. (Longman).
6. Practical Clinical Biochemistry, (5 th edition) – H.Varley, A.H.Cowenlock & M.Bell
7. A manual of Radiology. J.C.Steward & D.M. Hawcroft. (Sidgwick)
8. Instrumental methods of chemical analysis – B.K. Sharma publications)
9. Physical principles and Techniques of Protein chemistry – Leach. (Parts A, B, C)
10. Text book of biochemistry – west and Todd
11. Physical Biochemistry (II ed 1983) by D Friefelder, WH Freeman & Co., USA
12. Biophysical chemistry – Upodhya and Nath (Himalaya publications)
13. Physical Biochemistry (II ed 1985) by van Holde KE, Prentice Hall Inc., New Jersey.
14. Chromotography: A laboratory handbook of chromatographic and electrophoretic methods. (IIIrd 1975) by Erich Heftman, van Nostrand Reinhold, NY.

ANNEXURE-III

Semester 1

(4)

a. Course Name: Cell and Developmental Biology

b. Course Code: 11203107

c. Prerequisite: Awareness on structure and function of cell organelles and cell division

d. Rationale:. To study the structure and function of cells and to know about extracellular Matrix and cell communication. Understanding the function of intracellular organelles and cell cycle mechanism.

e. Course Learning Objective:

CLOBJ 1	Describe the structure and function of cells, including organelles, membranes, cytoskeleton, and cellular processes such as metabolism, signalling, and transport.
CLOBJ 2	Analyze and interpret key cellular processes, molecular signaling pathways, and developmental events.
CLOBJ 3	Comprehensive understanding of the integration of cellular and developmental biology concepts.
CLOBJ 4	Analyze cellular structures, organelle dynamics, and subcellular localization patterns using advanced microscopy and imaging techniques, such as confocal microscopy, electron microscopy, or live-cell imaging.
CLOBJ 5	Synthesize knowledge of cellular and developmental biology principles to design and implement experiments addressing specific research questions in biotechnology, demonstrating creativity, innovation, and scientific rigor.

f. Course Learning Outcomes:

CLO 1	Understanding of Cell Structure and Function.
CLO 2	Demonstrate the communications of cells with other cells and to the environments.
CLO 3	Synthesize knowledge from Integration of Cellular and Developmental Biology Concepts.
CLO 4	Knowledge of Cellular Diversity and Specialization.
CLO 5	Understanding of Developmental Processes

g. Teaching & Examination Scheme:

Teaching Scheme (Hrs./Week)			Credit	Examination Scheme					Total
Lect	Tut	Lab		External		Internal			
				T	P	T	CE	P	
3	-	-	3	60	-	40	40	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	UNIT-I Cell Theory & Methods of Study Microscope and its modifications – Light, phase contrast and interference, Fluorescence, Confocal, Electron (TEM and SEM), Electron tunneling and Atomic Force Microscopy, etc. Membrane Structure and Function Structural models; Composition and dynamics; Transport of ions and macromolecules; Pumps, carriers and channels; Endo- and Exocytosis; Membrane carbohydrates and their significance in cellular recognition; Cellular junctions and adhesions; Structure and functional significance of plasmodesmata.	22%	12
2	UNIT-II Organelles Nucleus – Structure and function of nuclear envelope, lamina and nucleolus; Macromolecular trafficking; Chromatin organization and packaging; Cell cycle and control mechanisms; Mitochondria – structure, organization of respiratory chain complexes, ATP synthase, Structure-function relationship; Mitochondrial DNA and male sterility; Origin and evolution; Chloroplast– Structure-function relationship; Chloroplast DNA and its significance; Chloroplast biogenesis; Origin and evolution.	20%	12
3	UNIT-III Endo-membrane System and Cellular Motility Structure and function of microbodies, Golgi apparatus, Lysosomes and Endoplasmic Reticulum; Organization and role of microtubules and microfilaments; Cell shape and motility; Actin-binding proteins and their significance; Muscle organization and function; Molecular motors; Intermediate filaments; Extracellular matrix in plants and animals.	18%	12

4	UNIT-IV Cellular Movements and Pattern Formation Laying of body axis planes; Differentiation of germ layers; Cellular polarity; Model plants like Fucus and Volvox; Maternal gene effects; Zygotic gene effects; Homeotic gene effects in Drosophila; Embryogenesis and early pattern formation in plants; Cell lineages and developmental control genes in Caenorhabditis.	18%	11
5	UNIT-V Differentiation of Specialized Cells Stem cell differentiation; Blood cell formation; Fibroblasts and their differentiation; Cellular basis of immunity; Differentiation of cancerous cells and role of proto-oncogenes; Phase changes in Salmonella; Mating cell types in yeast; Surface antigen changes in Trypanosomes; Heterocyst differentiation in Anabaena; Sex determination in Drosophila. Plant Meristem Organization and Differentiation Organization of Shoot Apical Meristem(SAM); Organization of Root Apical Meristem(RAM); Pollen germination and pollen tube guidance; Phloem differentiation; Self-incompatibility and its genetic control; Embryo and endosperm development; Heterosis and apomixis.	22%	13
	Total	100	60

i. Text Book and Reference Book:

1. Cell biology – De Roberties and DeRoberties.
2. Cell and Molecular biology – Shieler and Bianchi.
3. Cell biology (1991) – David E.Sadva (Johnes & Barrette, C. H Best & B.T.Taylor.
4. Biochemistry –West et al.
5. Principles of Biochemistry. – A.L.Lehninger.
6. Text book of Biochemistry with clinical correlations Thomas M.Devlin, (John Wiley).
7. Harper's review of Biochemistry – Martin et al (Longman)
8. Biochemistry L.Stryer. (Freeman)
9. Dynamics of Biological Membranes – M.D.Houselay and K.K.Stainless (John wiley).
10. Introduction to Biological membranes (2nd edn 1988) M K Jain, John Wiley & Sons, NY.
11. Comprehensive introduction to membrane biochemistry (1987) by D B Datta.
12. Biological membranes: Their structure and function (2 nd edn 1980) Harrison R.
13. Text Book of Medical Physiology (10th edn 2001) by A G Guyton and Hall J E. Harcourt,Asia.
- 14.15. Cell biology Karp et al.

ANNEXURE-III

Semester 2

(1)

- a. **Course Name:** Genetic engineering
- b. **Course Code:** 11202154
- c. **Prerequisite:** Basic knowledge in genetic engineering
- d. **Rationale:** To enhance students' understanding and application of advanced genetic manipulation techniques, molecular biology principles, and biotechnological innovations, while developing critical thinking skills through the evaluation of genetic engineering strategies, safety considerations, and ethical implications.
- e. **Course Learning Objective:**

CLOBJ 1	Describe the genetic principles underlying genetic engineering, including gene structure, regulation, inheritance patterns, and molecular biology techniques.
CLOBJ 2	Interpret experimental data from genetic engineering experiments, such as gel electrophoresis results, DNA sequencing data, and gene expression analyses.
CLOBJ 3	Discuss genetic engineering techniques to manipulate DNA sequences, construct recombinant vectors, and engineer gene expression systems for biotechnological applications.
CLOBJ 4	Describe genetic constructs, plasmid maps, and gene expression profiles using bioinformatics tools and software to assess the integrity and functionality of engineered DNA constructs.

f. **Course Learning Outcomes:**

CLO 1	Understanding of Genetic Principles.
CLO 2	Explain the need of genetic engineering in society and its rules.
CLO 3	Apply different Molecular Techniques in different applications.
CLO 4	Analyze the different application of Gene Editing Technologies.

g. **Teaching & Examination Scheme:**

Teaching Scheme(Hrs./ Week)			Credit	Examination Scheme					Total
Lect	Tut	Lab		External		Internal			
				T	P	T	CE	P	
4	-	-	4	60	-	40	40	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	UNIT-I Basics Concepts DNA Structure and properties; Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern, Southern, western and Colony hybridization, Fluorescence in situ hybridization.	25%	14
2	UNIT-II Cloning Vectors Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/baculo & retroviral vectors; Methodologies to reduce formation of inclusion bodies; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors.	25%	15
3	UNIT-III Cloning Methodologies Insertion of Foreign DNA into Host Cells; Transformation; Construction of libraries; Isolation of mRNA and total RNA; cDNA and genomic libraries; cDNA and genomic cloning; Expression cloning; DNA sequencing and sequence assembly: Maxam-Gilbert's and Sanger's methods, Shot gun sequencing, Next generation sequencing strategies for large genomes. DNA mapping and DNA fingerprinting: Physical and molecular mapping, Hybridization and PCR based methods of fingerprinting. Site directed mutagenesis: Methods and applications. Polymerase Chain Reaction: Principle and basic types of PCR; Reverse Transcription and Real Time PCRs.	25%	18
4	UNIT-IV Applications of Genetic engineering in improvement of plants, animals and microbes; Gene editing and its applications; Metagenomics and Metabolic engineering; Gene therapy; Biosafety and levels of Physical and Biological containment; The Indian Guidelines for release and use of GM organisms.	25%	13
	Total	100	60

i. Text Book and Reference Book:

1. Principles of Biochemistry. –A.L.Lehninger (CBS Publishers).
2. Genetics By Benjamin Pierce
3. Principles of Genetics by Gardner
4. Fundamental of Genetics by B D Singh
5. Concepts of genetics by W Klug

ANNEXURE-III
Semester 2

(1)

- a. **Course Name: Immunology**
- b. **Course Code: 11202155**
- c. **Prerequisite:** Basic knowledge in Immunology
- d. **Rationale:** The paper intends to provide a to better understand how the immune system functions. With better understanding, more effective medications, therapies, and scientific techniques can be developed to diagnose and treat immune-mediated diseases.
- e. **Course Learning Objective:**

CLOBJ 1	Describe cellular and molecular components of the immune system, including innate and adaptive immunity, immune cells, cytokines, and signaling pathways.
CLOBJ 2	Describe the processes involved in immune responses, including antigen recognition, immune cell activation, antigen presentation,
CLOBJ 3	To identify nature of immune response that develops against bacterial, viral or parasitic infection.
CLOBJ 4	Describe immunization principles, vaccination, vaccine development, types, and their mechanisms in preventing infectious diseases.
CLOBJ 5	To create and design the new experiments to understand the development of immune response against foreign particles.

f. Course Learning Outcomes:

CLO 1	Understanding of Immune System Components.
CLO 2	Knowledge of Immunological Processes and Immunological disorder.
CLO 3	Compare and contrast primary and secondary immune response.
CLO 4	Understanding of Immunization and Vaccination.
CLO 5	Evaluate scientific literature in immunology, assessing experimental methodologies, data interpretation.

g. Teaching & Examination Scheme:

Teaching Scheme (Hrs./Week)			Credit	Examination Scheme					Total
Lect	Tut	Lab		External		Internal			
				T	P	T	CE	P	
4	-	-	4	60	-	40	40	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	UNIT-I Immunology- fundamental concepts and anatomy of the immune system Components of innate and acquired immunity; Phagocytosis; Complement and Inflammatory responses; Haematopoiesis; Organs and cells of the immune system- primary and secondary lymphoid organs; Lymphatic system; Lymphocyte circulation; Lymphocyte homing; Mucosal and Cutaneous associated Lymphoid tissue. (MALT&CALT); Antigens - immunogens, Hapten-carrier system, Adjuvants; Major Histocompatibility Complex - MHC genes, MHC and immune responsiveness and disease susceptibility, HLA typing.	20%	15
2	UNIT-II Immune responses generated by B and T lymphocytes Immunoglobulins-basic structure, classes & subclasses of immunoglobulins, antigenic determinants; Multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily; B cell maturation, activation and differentiation; Generation of antibody diversity; class switching, T-cell maturation, activation and differentiation and T-cell receptors; Functional T Cell Subsets; Humoral and Cell-mediated immune responses, ADCC; Cytokines-properties, receptors and therapeutic uses; Antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens.	30%	15
3	Antigen-antibody interactions Antibody affinity and avidity, cross reactivity, Precipitation reactions Immunodiffusion, Radial immunodiffusion, double immunodiffusion, immunoelectrophoresis, Rocket immunoelectrophoresis, Agglutination reaction and complement fixation, Immunofluorescence, FACS, RIA, ELISA, Immunoblotting, Hybridoma technology - production of monoclonal antibodies and their applications, humanized antibodies. The Complement components and biological consequences of complement activation.	20%	15
4	UNIT-IV Clinical Immunology Hypersensitivity – Type I-IV; Autoimmunity; Types of autoimmune diseases; Mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; Treatment of autoimmune diseases; Transplantation – Immunological basis of graft rejection; Clinical transplantation and immunosuppressive therapy; Tumor immunology – Tumor antigens; Immune response to tumors and tumor evasion of the immune system, Immunodeficiency-	30%	15

	Primary immune deficiencies, Acquired or secondary immunodeficiencies. Vaccines - Active and passive immunization; Live, killed, attenuated, sub unit vaccines; recombinant vector vaccines and DNA Vaccines.		
	Total	100	60

i. Text Book and Reference Book:

1. Kuby Immunology by Judy Owen
2. Principles of Immunology by Howard Karsner
3. Immunology By Male

ANNEXURE-III
Semester 2

(2)

- a. **Course Name:** Genetics
- b. **Course Code:** 11202158
- c. **Prerequisite:** Knowledge about Gene and Genome.
- d. **Rationale:** This paper provides insights into Genetics research studies how individual genes or groups of genes are involved in health and disease.

e. Course Learning Objective:

CLOBJ 1	Describe the fundamental principles of genetics, including the structure and function of DNA, gene expression, genetic variation, and inheritance patterns.
CLOBJ 2	Explain Mendelian principles to predict inheritance patterns and analyze genetic crosses in organisms, including understanding concepts such as dominance, segregation, and independent assortment.
CLOBJ 3	Examine how genetic variation arises and its implications in phenotype diversity, population genetics, and evolutionary processes.
CLOBJ 4	Understand the applications of genetics in biotechnology, including gene cloning, genetic engineering, genome editing, and the production of recombinant proteins.

f. Course Learning Outcomes:

CLO 1	Understanding of Genetic Principles and Mendelian Genetics.
CLO 2	Understanding of Molecular Genetics and molecular mechanism.
CLO 3	Analysis of Genetic Variation and Genetic Analysis Techniques.
CLO 4	Application of Genetics in Biotechnology and Clinical Genetics.

g. Teaching & Examination Scheme:

Teaching Scheme (Hrs./Week)			Credit	Examination Scheme					Total
Lect	Tut	Lab		External		Internal			
				T	P	T	CE	P	
4	-	-	4	60	-	40	40	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	UNIT-I Bacterial mutants and mutations Isolation; Useful phenotypes (auxotrophic, conditional, lethal, resistant); Mutation rate; Types of mutations(base pair changes; frameshift; insertions; deletions; tandem duplication); Reversion vs. suppression; Mutagenic agents; Mechanisms of mutagenesis; Assay of mutagenic agents (Ames test).	20%	15
2	UNIT-II Gene transfer in bacteria History; Transduction – generalized and specialized; Conjugation – F, F', Hfr; F transfer; Hfr-mediated chromosome transfer; Transformation – natural and artificial transformation; Gene mapping; Transposable genetic elements; Insertion sequences; Composite and Complex transposons; Replicative and non-replicative transposition; Genetic analysis using transposons.	30%	15
3	UNIT-III Bacteriophage–structure; Assay; Lambda phage – genetic map, lysogenic and lytic cycles; Gene regulation; Filamentous phages such as M13; Plasmids – natural plasmids; their properties and phenotypes; Plasmid biology - copy number and its control; Incompatibility; Plasmid survival strategies; Antibiotic resistance markers on plasmids (mechanism of action and resistance); Genetic analysis using phage and plasmid.	20%	16
4	UNIT-IV Restriction-modification systems History; Types of systems and their characteristics; Methylation-dependent restriction systems; applications. Transposable elements: Types of bacterial transposable elements; Structure, genetic organization and mechanism of transposition of Tn5, Tn3, phage Mu, Tn7, IS911, Integrons, Retrotransposons, conjugative and mobilizable transposons, Assays of transposition.	30%	14
	Total	100	60

i. Text Book and Reference Book:

1. Fundamentals of Genetics by B D Singh
2. Principles of genetics by Eldon John Gardner
3. Genetics by V Rastogi

ANNEXURE-III
Semester 2

(4)

- a. **Course Name: Microbiology and industrial application**
- b. **Course Code:** 11202180
- c. **Prerequisite:** knowledge about fermentation and application.
- d. **Course Learning Objective** to learn about Microbiology and its different applications.
- e. **Rationale:** The main objective of this course is microorganisms are used for the production of important substances, such as antibiotics, food products, enzymes, amino acids, vaccines, and fine chemicals.

CLOBJ 1	Describe the diversity of microorganisms, including bacteria, viruses, fungi, and protists, and their roles in various environments and industrial processes.
CLOBJ 2	Memorize key microbial processes such as growth kinetics, metabolism, and microbial interactions.
CLOBJ 3	Demonstrate microbiological techniques, such as microbial culturing, isolation, and identification, to analyze microbial communities and isolate industrially relevant strains.
CLOBJ 4	Evaluate the efficiency and productivity of microbial bioprocesses and troubleshoot fermentation problems to optimize yields.
CLOBJ5	Develop strategies for strain improvement and metabolic engineering to enhance the performance of industrial microorganisms.
CLOBJ6	Assess the role of microbial biotechnology in addressing grand challenges such as climate change, resource scarcity, and public health crises.

f. Course Learning Outcomes:

CLO 1	Understanding of Microbial Diversity and Apply the knowledge to understand the microbial physiology and to identify the microorganisms.
CLO 2	Understand how to regulate biochemical pathways and modify processes to enhance control over microorganisms in microbial product synthesis.
CLO 3	To understand the role of microorganisms in environmental processes.
CLO 4	Understanding the role of microorganisms in the biogeochemical cycles of nutrients.
CLO 5	Understand Bioprocess Engineering and Biotechnological Applications
CLO 6	To provide the knowledge of features of industrially important microorganisms, their screening and selection from natural resources.

g. Teaching & Examination Scheme:

Teaching Scheme (Hrs./Week)			Credit	Examination Scheme					Total
Lect	Tut	Lab		External		Internal			
				T	P	T	CE	P	
4	-	-	4	60	-	40	40	-	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	UNIT-I Microbial Diversity & Systematics Classical and modern methods and concepts; Domain and Kingdom concepts in classification of microorganisms; Criteria for classification; Classification of Bacteria according to Bergey's manual; Molecular methods such as Denaturing Gradient Gel Electrophoresis (DGGE), Temperature Gradient Gel Electrophoresis (TGGE), Amplified rDNA Restriction Analysis and Terminal Restriction Fragment Length Polymorphism (T-RFLP) in assessing microbial diversity; 16S rDNA sequencing and Ribosomal Database Project.	20%	13
2	Microbial Growth & Physiology Ultrastructure of Archaea (Methanococcus); Eubacteria (E.coli); Unicellular Eukaryotes (Yeast) and viruses (Bacterial, Plant, Animal and Tumor viruses); Microbial growth: Batch, fed-batch, continuous kinetics, synchronous growth, yield constants, methods of growth estimation, stringent response, death of a bacterial cell. Microbial physiology: Physiological adaptation and life style of Prokaryotes; Unicellular Eukaryotes and the Extremophiles (with classical example from each group).	20%	13
3	UNIT-III Microbial Interactions and Infection Host-Pathogen interactions; Microbes infecting humans, veterinary animals and plants; Pathogenicity islands and their role in bacterial virulence.	20%	10
4	UNIT-IV	20%	10

	Microbes and Environment Role of microorganisms in natural system and artificial system; Influence of Microbes on the Earth's Environment and Inhabitants; Ecological impacts of microbes; Symbiosis (Nitrogen fixation and ruminant symbiosis); Microbes and Nutrient cycles; Microbial communication system; Quorum sensing; Microbial fuel cells; Prebiotics and Probiotics; Vaccines.		
5	UNIT-V Industrial Applications Basic principles in bioprocess technology; Media Formulation; Sterilization; Thermal death kinetics; Batch and continuous sterilization systems; Primary and secondary metabolites; Extracellular enzymes; Biotechnologically important intracellular products; exopolymers; Bioprocess control and monitoring variables such as temperature, agitation, pressure, pH Microbial processes-production, optimization, screening, strain improvement, factors affecting down stream processing and recovery; Representative examples of ethanol, organic acids, antibiotics etc.	20%	14
	Total	100	60

i. Text Book and Reference Book:

1. Bailey & Scott's Diagnostic Microbiology By Patricia M. Tille
2. Medical Microbiology by by Stefan Riedel
3. Textbook of Medical Mycology by Jagdish Chander
4. Textbook of applied Microbiology by Anju dhir

ANNEXURE-III

Semester 3

(1)

a. Course Name: Enzymology

b. Course Code: 11202206

c. Prerequisite: Students should have basic knowledge of Enzymes, Structure of enzymes, nomenclature, and classification.

d. Rationale: The course will provide comprehensive understanding of Enzymology Principles, application of enzymes in biotechnological processes, molecular biology techniques in Enzymology, integration of Enzymology with Bioprocess Engineering, critical evaluation of current Enzymology Research.

e. Course Learning Objective:

CLOBJ 1	To acquire fundamental knowledge on enzymes and their importance in biological reactions.
CLOBJ 2	To understand ability to difference between a chemical catalyst and biocatalyst Exposure to the nature of non-protein enzymes such as ribozymes.
CLOBJ 3	Understanding the role of enzymes in clinical diagnosis and industries. Students will understand the difference between a chemical catalyst and biocatalyst and understand activation energy.
CLOBJ 4	They will study non-protein enzymes such as ribozymes and will be exposed to the Industrial and biomedical applications of enzymes.

f. Course Learning Outcomes:

CLO 1	Describe structure of action of enzymes.
CLO 2	Elaborate the structure, Function and kinetics of enzymes.
CLO 3	Discuss the on current applications and future potential of enzymes.
CLO 4	Explain in detail law of thermodynamics.

g. Teaching & Examination Scheme:

Teaching Scheme (Hrs./Week)			Credit	Examination Scheme					Total
Lect	Tut	Lab		External		Internal			
				T	P	T	CE	P	
4	-	-	4	60	-	40	40	-	100

SEE - Semester End Examination, CIA - Continuous Internal Assessment (It consists of Assignments/Seminars/Presentations/MCQ Tests, etc.)

h. Course Content:

Sr. No.	Topic	Weightage	Teaching Hours
1	Unit-1: Introduction to enzymology and historical developments in enzymology Protein Structure: Primary, secondary, tertiary and quaternary structure, techniques used in enzyme characterization Enzyme classification: IUB enzyme classification. Enzyme Activity: Principle and techniques of enzymatic analysis, factors affecting enzyme Activity, Extraction and Purification of enzyme: Objectives and strategy, separation techniques, test of purity.	22%	13
2	Unit-2 Enzyme mechanisms: Lysozyme, Chymotrypsin, Carboxypeptidase, Restriction endonuclease, Aspartate transcarbomylase. Allosteric enzymes and sigmoidal kinetics: Protein ligand binding, Co-operativity, MWC & KNF models, Regulation of enzyme activity. Control of metabolic pathways. Enzymatic catalysis- acid-base catalysis- covalent catalysis- metal ion catalysis electrostatic catalysis- catalysis through proximity and orientation effects catalysis by transition state binding.	26%	16
3	Unit-3: Enzyme kinetics- Factors affecting enzyme activity- Michaelis-Menten equation analyses of kinetic data- Lineweaver-burk plot- catalytic efficiency- Haldane relationship- Hill's plot- Bisubstrate reactions- sequential - ping-pong reactions rate equations and examples. Enzyme inhibition- Irreversible- reversible- competitive- non-competitive uncompetitive inhibition- Graphical analysis.	24%	14
4	Unit-4: Isoenzymes and its physiological significance, Ribozymes and Abzymes Enzyme engineering: Chemical modification of enzymes: methods of modification of primary structure, catalytic and allosteric properties, use of group specific reagents. Enzyme Immobilization Enzymes in non conventional media, Enzymes sensors, Enzymes as analytical reagents.	28%	17
	Total	100	60

i. Text Book and Reference Book:

- 1.) Lehninger Principles of Biochemistry" by David L. Nelson and Michael M. Cox:
- 2.) Enzyme Structure and Mechanism" by Alan Fersht,
- 3.) Introduction to Enzyme and Coenzyme Chemistry" by T.P. Singer and C. J. O. Reilly,
- 4.) Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis" by Robert A. Copeland:
- 5.) Enzyme Kinetics: Behavior and Analysis of Rapid Equilibrium and Steady-State Enzyme Systems" by Irwin H. Segel.
- 6.) Enzyme Technology" by Martin F. Chaplin and Christopher Bucke.

ANNEXURE-III
Semester 3

(2)

- a. **Course Name: Plant and Animal biotechnology**
- b. **Course Code: 11202207**
- c. **Prerequisite:** Basic knowledge of plant and animal physiology and its various techniques.
- d. **Rationale:** Provide students with a solid foundation in the fundamental principles of plant and animal biotechnology, covering topics such as genetic engineering, molecular biology, and cellular processes specific to plants and animals.

e. Course Learning Objective:

CLOBJ 1	To introduce the students to the principles and applications of plant tissue culture and animal cell culture.
CLOBJ 2	Familiarization with knock-out and transgenic animals to model disease and study gene function.
CLOBJ 3	Development of plant transformation vectors specifically designed to facilitate transfer of improved/unique genetic traits to plants.
CLOBJ 4	To provide knowledge on diverse genetic transformation technologies available for the production of transgenic plants in crop improvement programs.
CLOBJ 5	Students are able to rationalize and develop strategies for incorporating novel traits in plants and animals through genetic engineering.

f. Course Learning Outcomes:

CLO 1	Discuss the Mechanisms of plant pollination and its sexual reproduction.
CLO 2	Compare the data distributions via visual displays natural and artificial ways to propagate plants.
CLO 3	Calculate the expected plant phenotypes for specific genetic methods.
CLO 4	Analyse the structure of animal genes and genomes.
CLO 5	Explain the contribution of 'functional genomics' in biotechnology.

g. Teaching & Examination Scheme:

Teaching Scheme			Credit	Examination Scheme					Total
Lect Hrs/ Wee k	Tut Hrs/	Lab Hrs/		External		Internal			
				T	P	T	CE	P	
4	-	-	4	60	-	20	20	-	100

SEE - Semester End Examination, CIA - Continuous Internal Assessment (It consists of Assignments/Seminars/Presentations/MCQ Tests, etc.)

h. Course Content:

Sr. No.	Topic	Weightage	Teaching Hours
1	Unit-1: Unit I: Plant Tissue Culture Historical perspective; totipotency; Callus, In vitro Morphogenesis embryogenesis; organogenesis; somatic embryogenesis; establishment of cultures callus culture, cell suspension culture, media preparation nutrients and plant hormones; sterilization techniques; application of tissue culture micropropagation somaclonal variation; zygotic embryogenesis and its applications in genetics and plant breeding; germplasm conservation and cryopreservation; synthetic seed production; protoplast culture and somatic hybridization protoplast isolation; culture and usage; somatic hybridization methods and applications; cybrids and somatic cell genetics, plant cell culture for secondary metabolite production.	25%	15
2	Unit-2: Unit II: Plant Genetic Manipulation: Genetic engineering Agrobacterium plant interaction; virulence; Ti and Ri plasmids; opines and their significance; T-DNA transfer; disarmed Ti plasmid Genetic transformation – <i>Agrobacterium</i> mediated gene delivery; cointegrate and binary vectors and their utility; direct gene transfer PEG mediated, electroporation, particle bombardment and alternative methods; characterization of transgenics; chloroplast transformation; molecular pharming concept of plants as biofactories, production of industrial enzymes and pharmaceutically important compounds.	25%	15
3	Unit-3: Unit III : Animal Cell Culture Brief history of animal cell culture; cell culture media and reagents; culture of mammalian cells, tissues and organs; primary culture, secondary culture, continuous cell lines, suspension cultures; application of animal cell culture for virus isolation and in vitro testing of drugs, testing of toxicity of environmental pollutants in cell culture, application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins.	25%	15

4	Unit-4: Unit IV Animal Reproductive Biotechnology and vaccinology Animal reproductive biotechnology: structure of sperms and ovum; cryopreservation of sperms and ova of livestock; artificial insemination; super ovulation, embryo recovery and in vitro fertilization. culture of embryos; cryopreservation of embryo application of transgenic animal biotechnology animal cloning- basic concept, cloning for conservation of endangered species. Vaccinology: history of development of vaccines, introduction to the concept of vaccines, conventional methods of animal vaccine production, recombinant approaches to vaccine production, modern vaccines.	25%	15
	Total	100	60

i. Text Book and Reference Book:

- 1.) Plant Biotechnology and Genetics: Principles, Techniques, and Applications" by C. Neal Stewart Jr,
- 2.) Plant Biotechnology: The Genetic Manipulation of Plants" by Adrian Slater, Nigel W. Scott, and Mark R. Fowler,;
- 3.) Plant Biotechnology and Agriculture: Prospects for the 21st Century" by Arie Altman and Paul M. Hasegawa:
- 4.) Animal Biotechnology: Models in Discovery and Translation" by Ashish Verma and Anchal Singh,
- 5.) Transgenic Animal Technology: A Laboratory Handbook" edited by Carl A. Pinkert:

ANNEXURE-III
Semester 3

(3)

- a. **Course Name: Molecular virology and Immunotechnology**
- b. **Course Code: 11202208**
- c. **Prerequisite:** Student should be having the knowledge of structure of Virus and its different properties, basics of immunology and antigen antibody reaction etc.
- d. **Rationale:.** Provide students with a deep understanding of the molecular mechanisms involved in viral infections, including viral entry, replication, and assembly, to comprehend the basis of host-virus interactions. Explore fundamental principles of immunology, including the structure and function of the immune system, antigen-antibody interactions, and the mechanisms of innate and adaptive immunity.
- e. **Course Learning Objective:**

CLOBJ 1	Describe how the structures of immune system molecules facilitate their functions.
CLOBJ 2	Students are able to explain at a molecular level how pathogens evade immune responses and cause infections.
CLOBJ 3	Define antigen and describe how antigens affect the adaptive defenses. understand the principles governing vaccination and the mechanisms of protection against infectious diseases.
CLOBJ 4	Basic understanding of the molecular aspects of Immunology. Understand the importance of haptens and adjuvants. Explain the structure, properties and functions of antibodies.

Course Learning Outcomes:

CLO 1	Relate the immune system and immune responses in context of human body.
CLO 2	Describe the specific interactions of Antigens and antibodies and the diversity of antibodies.
CLO 3	Explain the principle and applications of various immuno techniques.
CLO 4	Elaborate the interactions between viruses and the host immune systems.

f. Teaching & Examination Scheme:

Teaching Scheme			Credit	Examination Scheme					Total
Lect Hrs/ Wee k	Tut Hrs/	Lab Hrs/		External		Internal			
				T	P	T	CE	P	
4	-	-	4	60	-	20	20	-	100

SEE - Semester End Examination, **CIA** - Continuous Internal Assessment (It consists of Assignments/Seminars/Presentations/MCQ Tests, etc.)

g. Course Content:

Sr. No	Topic	Weightage	Teaching Hours
1	Unit-1: Unit-1 Introduction to virology Structure of animal viruses and plant viruses; Classification of viruses; Method of cultivation, detection, quantification propagation and maintenance of viruses. Satellite viruses; Viroids; Virusoids.; Economic loss due to important viruses.	25%	15
2	Unit-2: Genome organization in virus: Genome organization of animal viruses; Replication of RNA viruses; Replication of DNA viruses, Diseases causes by animal viruses. (rabies, hepatitis, rubella, ebola). Genome organization of DNA and RNA plant viruses; Replication of DNA and RNA plant viruses Diseases causes by plant viruses (TMV, CMV).	25%	15
3	Unit-3: Basic of Antigen – Antibody interaction techniques: Salient Features, Strength and properties Of Ag-Ab Reactions (affinity, cross reactivity, specificity), Lattice hypothesis, Antigen – Antibody interaction techniques: Precipitation Reaction(Precipitation in gel and liquid), Agglutination Reaction (Slide agglutination, tube agglutination, plate agglutination, Passive agglutination, Microscopic agglutination, Haemagglutination Test), Complement Fixation, Immunoassays: ELISA, RIA, Immunofluorescence, fluorescence activated cell sorting (FACS), Epitope mapping, Western blotting, Dot blotting	25%	15
4	Unit-4: Multigene organization of immunoglobulin genes, Generation of Ab diversity, Somatic cell fusion to obtain hybrid cell, Hybridoma technology, Monoclonal and polyclonal antibody, Production of monoclonal Antibodies, Application of monoclonal antibodies: Diagnostic application, Therapeutic application, Immunopurification.	25%	15
	Total	100	60

h. Text Book and Reference Book:

- 1.) Principles of Virology" by S. Jane Flint, Vincent R. Racaniello, Glenn F. Rall, and Anna Marie Skalka,
- 2.) Fields Virology" by David M. Knipe and Peter M. Howley,
- 3.) Molecular Virology" by Cann, Knipe, and Lea.
- 4.) Kuby Immunology" by Judy Owen, Jenni Punt, and Sharon Stranford,
- 5.) Janeway's Immunobiology" by Kenneth Murphy, Casey Weaver, and Allan Mowat,
- 6.) Molecular Immunology" by Peter J. Delves, Seamus J. Martin, Dennis R. Burton, and Ivan M. Roitt.
- 7.) Molecular Biology of the Cell" by Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter.

ANNEXURE-III
Semester 3

(4)

a. **Course Name:** - Genomics and Proteomics

b. **Course Code:** 11202230

c. **Prerequisite:** Knowledge of the computer and all the *In vitro* methods of gene expression.

d. **Rationale:**. Introduce students to foundational genomics techniques like DNA sequencing, genome mapping, and bioinformatics for genomic data analysis. Explore genomics applications in understanding gene functions through transcriptomics, epigenomics, and CRISPR-based technologies for functional genomics studies.

e. **Course Learning Objective:**

CLOBJ 1	Explain basic concepts of next generation sequencing and proteomics and the main differences between the currently used instruments.
CLOBJ 2	Develop technical skills for analysis and interpretation of 'omics' data, including commonly used online and R based analysis tools, making these skills an integral part of their professional practice.
CLOBJ 3	Know about available online data repositories and other 'omics' resources.

f. **Course Learning Outcomes:**

CLO 1	Explain the various strategies and methods of genome sequencing.
CLO 2	Demonstrate the genome databases analysis and gene expression profiling.
CLO 3	Analyse the data available in database.

g. **Teaching & Examination Scheme:**

Teaching Scheme			Credit	Examination Scheme					Total
Lect Hrs Wee k	Tut Hrs/	Lab Hrs/		External		Internal			
				T	P	T	CE	P	
4	-	-	4	60	-	20	20	-	100

h. Course Content:

Sr. No	Topic	Weightage	Teaching Hours
1	Unit-1: Structural organization of genome in Prokaryotes and Eukaryotes; Organelle DNA-mitochondrial, chloroplast; DNA sequencing-principles and translation to large scale projects; Recognition of coding and non- coding sequences and gene annotation; Tools for genome analysis- RFLP, DNA fingerprinting, RAPD, PCR, Linkage and Pedigree analysis-physical and genetic mapping.	25%	15
2	Unit-2: Genome sequencing projects Microbes, plants and animals; Accessing and retrieving genome project information from web; Comparative genomics, Identification and classification using molecular markers-16S rRNA typing/sequencing, ESTs and SNPs.	25%	15
3	Unit-3: Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Microscale solution isoelectric focusing; Peptide fingerprinting; LC/MS- MS for identification of proteins and modified proteins; MALDI-TOF; Protein-protein interactions, Yeast two hybrid system.	25%	15
4	Unit-4: Functional genomics and proteomics Analysis of microarray data; Protein and peptide microarray-based technology; PCR-directed protein in situ arrays; Structural proteomics.	25%	15
	Total	100	60

i. Text Book and Reference Book:

- 1.) Genomes by T.A. Brown
- 2.) Introduction to Genomics by Arthur M. Lesk
- 3.) Genomics and Proteomics: Principles, Technologies, and Applications by Sandrine Hughes and Nicola Stanley-Wall
- 4.) Genomics and Proteomics in Nutrition edited by Carolyn D. Berdanier, Judy L. Bolton, and Sivakanesan Dakshanamurthy
- 5.) Proteomics: Methods and Protocols" edited by Richard J. Simpson
- 6.) Principles of Proteomics" by Richard Twyman

ANNEXURE-III
Semester 4

(1)

- a. **Course Name: Bioprocess Engineering and Techniques**
- b. **Course Code: 11202253**
- c. **Prerequisite:** Basic knowledge about fermentation process, industrially important microbes and process related to it, application of microbes in food industry.
- d. **Rationale:** The course addresses the challenges associated with scaling up bioprocesses from laboratory to industrial scale. Understanding factors such as mass transfer, heat transfer, and mixing at larger scales is crucial for successful industrial implementation.

e. Course Learning Objective:

CLOBJ 1	To study the historical development of bio process technology.
CLOBJ 2	To evaluate the kinetics and thermodynamics of enzymatic process.
CLOBJ 3	To study the stoichiometry and energetics of cell growth and product formation.
CLOBJ 4	To evaluate the kinetics and mechanism of microbial growth.
CLOBJ 5	Able to formulate and operate conversion processes of biological resources into bio-based value added materials related to food, feed, fuels, pharmaceutical, nutraceutical, biomaterials or biochemicals.

f. Course Learning Outcomes:

CLO 1	Provide a comprehensive understanding of the principles and fundamental concepts of bioprocess engineering, emphasizing the application of engineering principles to biological systems.
CLO 2	Diversity of biological systems used in bio processing.
CLO 3	Explore the kinetics of microbial growth and product formation,
CLO4	Design of and operation of bioreactors.
CLO 5	Quality Control in Bioprocessing and Process Optimization.

g. Teaching & Examination Scheme:

Teaching Scheme			Credit	Examination Scheme					Total
Lect Hrs/ Week	Tut Hrs/	Lab Hrs/		External		Internal			
				T	P	T	CE	P	
4	-	-	4	60	-	20	20	-	100

h. Course Content:

Sr. No.	Topic	Weightage	Teaching Hours
1	Unit-1: Basic principle of Biochemical engineering Isolation, screening (primary and secondary) and maintenance of industrially important microbes; media formulation and optimization; Strain improvement for increased yield and other desirable characteristics.	25%	15
2	Unit-2: Concepts of basic mode of fermentation processes Bioreactor designs; Types of fermentation and fermenters; Concepts of basic modes of fermentation - Batch, fed batch and continuous; Conventional fermentation v/s biotransformation; Solid substrate, surface and submerged fermentation; Fermentation economics; Fermentation media; Fermenter design-mechanically agitated; Upstream processing: Media formulation; Sterilization; Aeration and agitation in bioprocess; Measurement and control of bioprocess parameters; Scale up and scale down process.	25%	15
3	Unit-3: Downstream processing Bioseparation - filtration, centrifugation, sedimentation, flocculation; Cell disruption; Liquid-liquid extraction; Purification by chromatographic techniques; Reverse osmosis and ultra filtration; Drying; Crystallization; Storage and packaging; Treatment of effluent and its disposal	25%	15
4	Unit-4: Applications of Microbes in food process operations and production, Fermented beverages; 1. Beer 2. Wine. Solvents: ethanol, acetone-butanol Organic acids: citric acid and acetic acid. Microbial production of therapeutic agents: streptomycin and cephalosporin. Microbial production of enzymes and vitamins: amylase and lipase, B2 and B12.	25%	15
	Total	100	60

i. Text Book and Reference Book:

- 1.) Bioprocess Engineering: Basic Concepts (3rd Edition) by Shijie Liu
- 2.) Introduction to Chemical Engineering Kinetics and Reactor Design by Charles G. Hill and Thatcher W. Root:
- 3.) Biochemical Engineering and Biotechnology by Ghasem Najafpour
- 4.) Bioprocess Engineering: Systems, Equipment and Facilities by Jean-Paul Charpentier, Shigeo Katoh, and Peter R. Luyben:

ANNEXURE-III

Semester 4

(2)

- a. **Course Name:** Intellectual property rights
- b. **Course Code:** 11202282
- c. **Prerequisite:** Educational background, , Basic Knowledge of Technology and Science Research and Analytical Skills , understanding of business and innovations, Language Proficiency, requirement of Practical Experience Understanding of legal knowledge.
- d. **Rationale:.** Protecting Biotechnological Innovations, Navigating Regulatory Landscape, Encouraging Entrepreneurship, Enhancing Collaborations and Partnerships, Mitigating Legal Risks, Commercialization and Technology Transfer, Professional Development, Ethical Considerations. All these points should be taken into consideration while learning this course.

Course Learning Objective:

CLOBJ 1	Learners will be able to define intellectual property (IP) and identify various forms of IP.
CLOBJ 2	To identify the significance of practice and procedure of Patents.
CLOBJ 3	To recognize the importance of IP and to educate the pupils on basic concepts of Intellectual Property Rights.

Course Learning Outcomes:

CLO 1	Describe the awareness about Intellectual Property Rights (IPRs).
CLO 2	Estimate the business strategies by taking account of IPRs.
CLO 3	formulation of ethical issues associated with scientific research.

e. Teaching & Examination Scheme:

Teaching Scheme			Credit	Examination Scheme					Total
Lect Hrs/	Tut Hrs/	Lab Hrs/ Week		External		Internal			
				T	P	T	CE	P	
-	-	20	20	-	200	-	-	100	300

f. Course Content:

Sr. No.	Topic	Weightage	Teaching Hours
1	Unit-1: Introduction to Intellectual Property Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of New GMOs; International framework for the protection of IP. IP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies; Introduction to History of GATT, WTO, WIPO and TRIPS.	25%	15
2	Unit-2: Concept of 'prior art' Invention in context of "prior art"; Patent databases; Searching International Databases; Country-wise patent searches (USPTO, EPO, India etc.); Analysis and report formation.	25%	14
3	Unit-3: Basics of Patents Types of patents; Indian Patent Act 1970; Recent Amendments; Filing of a patent application; Precautions before patenting- disclosure/non- disclosure; WIPO Treaties; Budapest Treaty; PCT and Implications; Role of a Country Patent Office; Procedure for filing a PCT application.	25%	15
4	Unit-4: Patent filing and Infringement Patent application- forms and guidelines, fee structure, time frames; Types of patent applications: provisional and complete specifications; PCT and convention patent applications; International patenting- requirement, procedures and costs; Financial assistance for patenting- introduction to existing schemes; Publication of patents-gazette of India, status in Europe and US. Patenting by research students, lecturers and scientists- University/organizational rules in India and abroad, credit sharing by workers, financial incentives. Patent infringement- meaning, scope, litigation, case studies and examples.	25%	16
	Total	100	60

g. Text Book and Reference Book:

- 1.) Intellectual Property: A Very Short Introduction by Siva Vaidhyanathan.
- 2.) Intellectual Property Law: A Practical Guide to Copyrights, Patents, Trademarks, and Trade Secrets by Stephen Elias and Richard Stim.
- 3.) Intellectual Property in Biotechnology: Importance for Scientists, Ethicists, and Industry by Kuan-Teh Jeang:
- 4.) Biotechnology and Intellectual Property Rights: Legal and Social Implications" by R. Saha and S. Saha

ANNEXURE-IV

- a. **Course Name:** Lab 1- Biochemistry and Analytical Techniques
- b. **Course Code:** 11203112
- c. **Prerequisite:** Basic Knowledge about properties of biomolecules.
- d. **Rationale:** The "Biochemical analysis lab " is vital as it offers hands-on experience, reinforcing theoretical knowledge by applying basic biochemical concepts, fostering practical skills essential for life sciences disciplines.
- e. **Course Learning Objective:**

CLOBJ 1	Recall the fundamental concepts of biochemistry, including enzyme kinetics, metabolism, and biomolecular structure.
CLOBJ 2	Explain the principles underlying biochemical reactions and their role in cellular processes.
CLOBJ 3	Utilize enzymatic assays and kinetic analyses to study enzyme activity and biochemical pathways.
CLOBJ 4	Evaluate the accuracy and precision of biochemical measurements and troubleshoot experimental procedures to optimize results.
CLOBJ 5	Critically evaluate the efficacy and safety of biotechnological products and processes in industry, agriculture, and medicine.

f. Course Learning Outcomes:

CLO 1	Understanding of Biochemistry as a discipline and milestone discoveries in life sciences that led to establishment of Biochemistry as separate discipline.
CLO 2	Understanding of concepts of acids, bases, indicators, pKa values, etc. Acquiring skill to determine pKa value of amino acids.
CLO 3	Fundamental laws relating to photochemistry and applications of UV-visible.
CLO 4	Students will use current biochemical and molecular techniques to plan and carry out experiments.
CLO 5	Capable to choose and apply suitable separation techniques to identify different biomolecules.

g. Teaching & Examination Scheme:

Teaching Scheme (Hrs./Week)			Credit	Examination Scheme					Total
Lect	Tut	Lab		External		Internal			
				T	P	T	CE	P	
	-	4	2		60		40	0	100

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Text Book and Reference Book:

1. J. Jayaraman, Laboratory Manual in Biochemistry. New Age International Pvt Ltd Publishers. 2011 (Paperback).
2. S. Sadasivam, A. Manickam, Biochemical Methods. New age publishers. 2009 (paperback).
3. S. K. Sawhney, Randhir Singh, Introductory Practical Biochemistry.
4. Alpha Science International, Ltd. 2 edition, 2005.
5. Harold Varley, Practical Clinical Biochemistry, CBS.
6. edition, 2006. 2. Hans Bisswanger, Practical Enzymology. Wiley VCH. 2nd Edition, 2011.
7. Robert Eienthal, Enzyme Assays: A Practical Approach (Practical Approach Series). Oxford University Press, U.S.A. 2 edition, 2002

i. Experiment List:

Exp. No.	Name of the Experiment
1	To prepare an Acetic-Na Acetate Buffer system and validate the Henderson-Hasselbach equation.
2	To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis.
3	Spectrophotometer and validating the Beer- Lambert's Law.
4	Titration of Amino Acids and separation of aliphatic, aromatic and polar amino acids by TLC.
5	AN ENZYME PURIFICATION THEME (such as E.coli Alkaline phosphatase or any enzyme of the institutions choice).
6	Preparation of cell-free lysates.
7	Generating a Purification Table Assessing purity by SDS-PAGE Gel Electrophoresis.
8	Enzyme Kinetic Parameters: Km, Vmax and Kcat.

ANNEXURE-IV

- a. **Course Name:** Lab 2-Molecular Biology
- b. **Course Code:** 11202107
- c. **Prerequisite:** Basic Knowledge about properties of biomolecules .
- d. **Rationale:** The offers hands-on experience, reinforcing theoretical knowledge by applying basic biochemical concepts, fostering practical skills essential for life sciences disciplines.
- e. **Course Learning Objective:**

CLOBJ 1	Recall the fundamental principles of molecular biology, including the structure and function of DNA, RNA, and proteins.
CLOBJ 2	Understand the mechanisms of DNA replication, transcription, and translation, and analyze how these processes influence gene expression and regulation.
CLOBJ 3	Apply molecular biology techniques to isolate, amplify, and analyze specific DNA sequences for research and diagnostic purposes.
CLOBJ 4	Analyze experimental data generated from molecular biology experiments, including sequence alignments, expression profiles, and protein interactions.

f. **Course Learning Outcomes:**

CLO 1	The objective of this laboratory course is to provide the students practical skills in basic molecular biology and microbial bioresources.
CLO 2	Students will learn different techniques of molecular biology.
CLO 3	Demonstrate practical skills in different laboratory equipment's and their handling.
CLO 4	To get expertise in isolation of genomic DNA.

g. **Teaching & Examination Scheme:**

Teaching Scheme (Hrs./Week)			Credit	Examination Scheme					Total
Lect	Tut	Lab		External		Internal			
				T	P	T	CE	P	
	-	4	2		60		40	00	100

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Text Book and Reference Book:

1. J. Jayaraman, Laboratory Manual in Biochemistry. New Age International Pvt Ltd Publishers. 2011 (Paperback).
2. S. Sadasivam, A. Manickam, Biochemical Methods. New age publishers. 2009 (paperback).
3. S. K. Sawhney, Randhir Singh, Introductory Practical Biochemistry.
4. Alpha Science International, Ltd. 2 edition, 2005.
5. Harold Varley, Practical Clinical Biochemistry, CBS.
6. edition, 2006. 2. Hans Bisswanger, Practical Enzymology. Wiley VCH. 2nd Edition, 2011.
7. Robert Eienthal, Enzyme Assays: A Practical Approach (Practical Approach Series). Oxford University Press, U.S.A. 2 edition, 2002

i. Experiment List:

Exp. No.	Name of the Experiment
1	Plasmid DNA isolation and DNA quantitation: Plasmidminipreps
2	Restriction digestion
3	Preparation of competent cells.
4	Agarose gelelectrophoresis
5	Purification of DNA from an agarose gel
6	DNA Ligation
7	Transformation of E.coli with standard plasmids, Calculation of transformation efficiency

ANNEXURE-IV

- a. **Course Name:** Lab 1-Immunology
- b. **Course Code:** 11202159
- c. **Prerequisite:** Basic knowledge of enzymes
- d. **Rationale:** The purpose of immunology and immunology research is to better understand how the immune system functions. With better understanding, more effective medications, therapies, and scientific techniques can be developed to diagnose and treat immune-mediated diseases.
- e. **Course Learning Objective:**

CLOBJ 1	Apply immunological techniques, such as ELISA, flow cytometry, and immunoblotting, to analyze immune responses and characterize immune cells and molecules.
CLOBJ 2	Evaluate the role of the immune system in health and disease, including autoimmune disorders, infectious diseases, and cancer immunotherapy.
CLOBJ 3	Assess the impact of immunological research on public health, including vaccination strategies, disease prevention, and outbreak management.
CLOBJ 4	Analyze the efficacy and safety of immunological interventions, including vaccines, monoclonal antibodies, and immune checkpoint inhibitors, to assess their impact critically.

f. Course Learning Outcomes:

CLO 1	Trace the history and development of immunology.
CLO 2	Explain the importance of phagocytosis and natural killer cells in innate body defence.
CLO 3	Compare and contrast the origin, maturation process, and general function of B and T lymphocytes.
CLO 4	The student will get exposure of wide applications of enzymes and their future potential.

g. Teaching & Examination Scheme:

Teaching Scheme (Hrs./Week)			Credit	Examination Scheme					Total
Lect	Tut	Lab		External		Internal			
				T	P	T	CE	P	
	-	4	2		60		40	0	100

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Text Book and Reference Book:

1. A textbook of Immunology by Latha Madhavee
2. Practical Immunology by Frank C Hay
3. Essential of Immunology by S K Gupta
4. Immunology and Immunotechnology by Ashim Chakravarty

i. Experiment List:

Exp. No.	Name of the Experiment
1	Antibody titre by ELISA method.
2	Double diffusion, Immuno-electrophoresis
3	Radial Immuno diffusion.
4	SDS-PAGE
5	SDH from liver
6	Blood smear identification of leucocytes by Giemsa stain
7	Lymphnode Immuno histochemistry (direct and indirect peroxidase assay)
8	Immunodiagnostics using commercial kits

ANNEXURE-IV

- a. **Course Name:** Lab 2-Microbiology and genetic engineering
- b. **Course Code:** 11202160
- c. **Prerequisite:** Basic Knowledge about Microbiology and genetic engineering.
- d. **Rationale:.** The aim of this lab is to give students hands-on experience, bridging theoretical knowledge with real-world applications. These sessions enhance understanding of genetic manipulation, microbial systems, and synthetic biology through practical experiments, fostering essential skills for navigating genetic engineering and microbiology in scientific and industrial contexts.
- e. **Course Learning Objective:**

CLOBJ 1	Understanding the basic steps of genetic engineering.
CLOBJ 2	Getting detailed knowledge of gene transfer methods and identifying suitable hosts for cloning.
CLOBJ 3	Acquiring theoretical knowledge in the techniques, tools, application and safety measures of genetic engineering.
CLOBJ 4	To provide basic understanding of the principles of modern applied microbiology.
CLOBJ 5	To provide teaching and research activities in applied microbiology.

- f. **Course Learning Outcomes:**

CLO 1	Understand the role of microorganisms in industrial processes for the benefit humankind
CLO 2	Apply the knowledge to understand the microbial physiology and to identify the microorganisms.
CLO 3	Application of bacterial and eukaryotic plasmids in research.
CLO 4	Ability the principles of physiological understanding in improvement of industrial processes.
CLO 5	Ability the principle of management and controls on the microbial processes in industrial settings.

g. Teaching & Examination Scheme:

Teaching Scheme (Hrs./Week)			Credit	Examination Scheme					Total
Lect	Tut	Lab		External		Internal			
				T	P	T	CE	P	
	-	4	2		60		40	0	100

L- Lectures; T- Tutorial; P- Practical; C- Credit; MSE- Mid-Semester Evaluation, CE- Continuous Evaluation, ESE- End Semester Examination

h. Text Book and Reference Book:

1. Demain, A. L., Davies, J. E. and Atlas, R. M. Manual of Industrial Microbiology and Biotechnology, ASM Press.
2. Vogel, H. C. and Tadaro, C. M., Fermentation and Biochemical Engineering Handbook: Principles, Process Design and Equipment, William Andrew Publisher.
3. Atkinson, B. and Mavituna, F., Biochemical Engineering and Biotechnology Handbook, Stockton Press.
4. Davis, L. G., Dibner, M. D. and Battey, J. F., Basic Methods in Molecular Biology, Elsevier

i. Experiment List:

Exp. No.	Name of the Experiment
1	Sterilization, disinfection, safety in microbiological laboratory
2	Preparation of media for growth of various microorganisms.
3	Identification and culturing of various microorganisms
4	Growth curve, measure of bacterial population by turbidometry and studying the effect of temperature, pH, carbon and nitrogen
5	Assay of antibiotics production and demonstration of antibiotic resistance Isolation and screening of industrially important microorganism.
6	Isolation of genomic DNA from Bacillus subtilis* genome.(*Any other bacterial strain can be used.)
7	Estimation of thymine by colorimetry, Fluorimetry
8	Preparation of plasmid

Exp. No.	Name of the Experiment
9	Quntification and Purification of DNA by Agarose gel electrophoresis.
10	Plasmid isolation and confirming recombinant by PCR and RE digestion.

ANNEXURE-IV

- a. **Course Name:** Lab-1 Plant and Animal biotechnology
- b. **Course Code:** 11202210
- c. **Prerequisite:** Knowledge of plant and animal physiology and enzymes applied in biotechnology.
- d. **Rationale:** Rationale: Practical sessions allow students to apply theoretical knowledge gained in lectures. Working with actual samples and organisms enhances understanding and retention of concepts related to animal and plant biotechnology.
- e. **Course Learning Objective:**

CLOBJ 1	To introduce the students to the principles and applications of plant tissue culture and animal cell culture
CLOBJ 2	Learn scientific and engineering principles related to the processing/production of the recombinant proteins.
CLOBJ 3	To equip the students with the skills advanced tools and techniques used in biotechnology to acquire skills to pursue a career in biotechnology.

f. Course Learning Outcomes:

CLO 1	Apply Basic Laboratory Techniques
CLO 2	Develop Proficiency in Tissue Culture
CLO 3	Perform Genetic Engineering Experiments:

g. Teaching & Examination Scheme:

Teaching Scheme (Contact Hours)				Examination Scheme				
Lecture	Tutorial	Lab	Credit	Theory Marks		Practical Marks		Total Marks
				External Marks	Internal Marks	External Marks	Internal Marks	
-	-	4	2	-	-	60	40	100

h. Text Book and Reference Book:

1. Plant Biotechnology: The Genetic Manipulation of Plants by Adrian Slater, Nigel W. Scott, and Mark R. Fowler
2. Animal Biotechnology: Models in Discovery and Translation by Verma A., Singh A., and Mandal P
3. Practical Skills in Biomolecular Science by Rob Reed, David Holmes, and Jonathan Weyers
4. Animal Cell Biotechnology: Methods and Protocols" edited by Ralf Pörtner

1. Experiment List:

Exp. No.	Name of the Experiment
1	MS media preparation.
2	Callus Induction
3	Establishment of shoot tip culture using MS medium
4	Isolation of protoplasts using enzymatic method.
5	Hardening and Planting infield
6	Establishment and maintenance of suspension culture
7	Establishment and maintenance of somatic embryogenesis (Demo)
8	Synthetic seeds (Entrapment method)

ANNEXURE-IV

- a. **Course Name:** Lab-2 Genomics and proteomics
- b. **Course Code:** 11202211
- c. **Prerequisite:** Knowledge of Central dogma and advances in study of gene and proteins.
- d. **Rationale:** Integration of bioinformatics tools into practical sessions allows students to analyze and interpret genomic and proteomic data, providing exposure to computational aspects of the field.
- e. **Course Learning Objective:**

CLOBJ 1	Identify the different approaches used to study the genome and proteome.
CLOBJ 2	Outline the structural organization of prokaryotic and eukaryotic nuclear genome.
CLOBJ 3	Describe sequencing techniques and whole genome sequencing.

f. **Course Learning Outcomes:**

CLO 1	Perform plenty of strategies and methods of genome sequencing.
CLO 2	Demonstrate the whole genome databases analysis and gene expression profiling.
CLO 3	Perform comparative gene function through various methods.

g. **Teaching & Examination Scheme:**

Teaching Scheme (Contact Hours)				Examination Scheme				
Lecture	Tutorial	Lab	Credit	Theory Marks		Practical Marks		Total Marks
				External Marks	Internal Marks	External Marks	Internal Marks	
-	-	4	2	-	-	60	40	100

h. **Text Book and Reference Book:**

1. Genome Analysis: A Laboratory Manual by Michael Green and Greg S. Barsh
2. Bioinformatics: Sequence and Genome Analysis by David W. Mount
3. Proteomics: Methods and Protocols edited by R. J. Simpson
4. Bioinformatics and Functional Genomics by Jonathan Pevsner
5. Next-Generation DNA Sequencing Informatics" edited by Stuart M. Brown
6. Mass Spectrometry in Proteomics" edited by Michael L. Gross and Gary Siuzdak

1. **Experiment List:**

Exp. No.	Name of the Experiment
1	Explore comparative genomics resources and NCBI and EBI.
2	Comparison of full / partial genomic sequences using following methods to identify conserved genes and map/compare the annotations of the two sequences ◦ BLAST2 ◦ MegaBLAST and Discontiguous MegaBLAST ◦ MUMmer ◦ PipMaker ◦ VISTA ◦ Artemis
3	Compare gene order of given genomic sequences using the GeneOrder tool.
4	Explore and query the comparative genomics databases: COG, VirGen, CORG, HOBACGEN, Homophila, XREFdb, Gramene etc.
5	Explore and query SNP and SNP-related databases.
6	Explore and query the protein-protein interaction databases: DIP, PPI Server, BIND, PIM, PathCalling, MINT, GRID, InterPreTS.
7	Comparative genomics case studies of – ◦ model organisms ◦ plants ◦ microbes ◦ viruses ◦ host-vector-parasites