



Two-Year Postgraduate Programme

Master of Science

Microbiology

Faculty of Applied Sciences

Parul University

Vadodara, Gujarat, India

Faculty of Applied Sciences
Master of Science in Microbiology

1. Vision of the Department

Build foundation for excellence and spur development of the Institution as a premier Institution, by igniting and nurturing enthusiasm, interests and passion, in the study of life sciences, in professional courses, as a part of curriculum.

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. Microbiology curriculum enables postgraduates to attain.

PEO 1	To impart advanced knowledge and technical skills in microbiology that should aid to communicate the concepts and results of their laboratory experiments through effective writing and/or oral communication using discipline standards for reporting and citation.
PEO 2	To develop among the students, critical thinking and scientific inquiry in the performance, design, interpretation and documentation of laboratory experiments to the level suitable to succeed at an entry level position in Microbiology and other Life Sciences based industries.
PEO 3	To provide training in pure and applied scientific research. The summer training, industrial visit & project work help the students to know the practical aspects about the subject.
PEO 4	Upon completion of the programme, the graduates of the program will accommodate

	insightful information of Microbiology principles necessary for the applications of this discipline in theory and in practice.
PEO 5	Graduates of the program will acquire knowledge of recent trends in technology and solve problem in industry and everyday terms. Upon completion of the degree, students are able to understand the theoretical concepts of analytics and instruments that are commonly used in and, which will help them to excel in relevant fields.
PEO6	The course aims to develop the students in understanding the areas that are widely used as well as on advanced scientific methods This is achieved via lectures, classes, seminars and a problem-based learning exercise.
PEO7	Student would suggest, evaluate and interpret microbial investigation in a given clinical situation and apply knowledge to solve clinical problems
PEO8	Ability to possess creative professionalism, understand their ethical responsibility and committed towards society.
PEO9	Build on their knowledge to understand highly advanced and specialized courses in future.

4. Program Learning Outcomes

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

PLO 1	Disciplinary Knowledge	Demonstrate comprehensive knowledge of the discipline that form a part of a postgraduate programme. Execute strong theoretical and practical understanding generated from the specific programme in the area of work.
PLO 2	Critical Thinking and Problem Solving	Exhibit the skill of critical thinking and understand scientific texts and place scientific statements and themes in contexts and also evaluate them in terms of generic conventions. Identify the problem by observing the situation closely, take actions and apply lateral thinking and analytical skills to design the solutions.
PLO 3	Social Competence	Exhibit thoughts and ideas effectively in writing and orally; communicate with others using appropriate media, build effective interactive and presenting skills to meet global competencies. Elicit views of others, present complex information in a clear and concise and help reach conclusion in group settings.

PLO 4	Research-related Skills and Scientific Temper	Infer scientific literature, build sense of enquiry and able to formulate, test, analyse, interpret and establish hypothesis and research questions; and to identify and consult relevant sources to find answers. Plan and write a research paper / project while emphasizing on academics and research ethics, scientific conduct and creating awareness about intellectual property rights and issues of plagiarism.
PLO 5	Trans-disciplinary Knowledge	Create new conceptual, theoretical and methodological understanding that integrates and transcends beyond discipline-specific approaches to address a common problem.
PLO 6	Personal and Professional Competence	Perform independently and also collaboratively as a part of team to meet defined objectives and carry out work across interdisciplinary fields. Execute interpersonal relationships, self-motivation and adaptability skills and commit to professional ethics.
PLO 7	Effective Citizenship and Ethics	Demonstrate empathetic social concern and equity centred national development, and ability to act with an informed awareness of moral and ethical issues and commit to professional ethics and responsibility.
PLO 8	Environment and Sustainability	Understand the impact of the scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.
PLO 9	Self-directed and Life-long learning	Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

5. Program Specific Learning Outcomes

PSO 1	Baseline Approach into understanding the diversity	Students shall be enabled to distinguish, differentiate, identify and classify various types of microorganisms.
PSO 2	Demand as per	The course includes emphasizes the applications of

	recent development	microbiology to address environmental problems and provide microbial remedial measures.
PSO 3	Cutting edge Technology	They shall be able to use various bioanalytical instrumentation and techniques to study various aspects of microbiology. .
PSO 4	Human health and Clinical application	Students shall gain insight of the molecular pathogenesis of infectious diseases and advances in immunology.
PSO 5	Industrial application	The study of microbial products and the knowledge of industrial microbiology as well as microbial technology shall enable the students to envision themselves as bio entrepreneurs.

6. Credit Framework

Semester wise Credit distribution of the programme		Category wise Credit distribution of the programme		
			Category	Credit
Semester-1	21		Major Core	68
Semester-2	21		Minor Stream	0
Semester-3	22		Ability Enhancement	4
Semester-4	36		Research Project/Dissertation	28
Total Credits:	100		Total Credits:	100

7. Program Curriculum

Semester 1						
Sr. No.	Subject Code	Subject Name	Credit	Lect	Lab	Tut
1	11201101	Principles of Cell Biology	4	4	0	0
2	11201103	Microbial Diversity and Systematics	4	4	0	0
3	11202101	Genetics	4	4	0	0
4	11203104	Biochemistry of Macromolecules	4	4	0	0
5	11203105	Lab-I (Biochemistry and Analytical Techniques)	2	0	4	0
6	11202102	Lab-II (Molecular Biology and r-DNA Technology)	2	0	4	0
7	11202113	Seminar	1	0	0	1
Total			21	16	08	01
Semester 2						
Sr. No.	Subject Code	Subject Name	Credit	Lect	Lab	Tut
8	11201151	Molecular Virology	4	4	0	0
9	11201152	Biology of the Immune System	4	4	0	0
10	11201153	Medical Microbiology	4	4	0	0
11	11201130 11201131	Fundamentals of biochemical pathway and metabolism (Elective-1) Introduction to Intellectual property rights (Elective-2)	4	4	0	0
12	11201154	Lab-I (Microbiology and Immunology)	2	0	4	0
13	11202152	Lab-II (Molecular Biology)	2	0	4	0
14	11202161	Seminar	1	0	0	1
Total			21	16	08	01

Semester 3						
Sr. No.	Subject Code	Subject Name	Credit	Lect	Lab	Tut
15	111201203	Basic analytical tools and techniques	4	4	0	0
16	11201201	Food and Dairy Microbiology	4	4	0	0
17	11202201	Bioinformatics & Biostatistics	4	4	0	0
18	11201202	Lab-I (Food and Dairy Microbiology)	2	0	4	0
19	11202205	Lab-II(Phyloinformatics and Structural Bioinformatics)	2	0	4	0
20	11200201 11202231	Research Methodology & Scientific Writing (Elective-1) Bioentrepreneurship (Elective-2)	4	4	0	0
21	11203207	Seminar	2	0	0	2
Total			22	16	08	02
Semester 4						
Sr. No.	Subject Code	Subject Name	Credit	Lect	Lab	Tut
22	11201252	Industrial Microbiology & Fermentation Technology	4	4	0	0
23	11201230 11201231	Environmental and agricultural microbiology (Elective-1) Emerging technologies in biological sciences (Elective-2)	4	4	0	0
24	11200251	Dissertation	28	0	28	0
Total			36	08	28	00
Total			100			

8. Detailed syllabus

Semester 1

(1)

a. **Course Name: Microbial Diversity and Systematics (Theory)**

b. **Course Code:** 11201103

c. **Prerequisite:** Knowledge of basic microbiology and taxonomy.

d. **Rationale:** This course will give the fundamental understanding about the evolution of diverse group of microorganisms and various taxonomy ranks.

e. **Course Learning Objective:**

CLOBJ 1	Understanding the history and development of Microbiology as a discipline
CLOBJ 2	Gaining knowledge about the systems of classification of microorganisms.
CLOBJ 3	Exploring the diversity of microbial life, with an emphasis on interactions with microbes that are responsible for infections and those that do not normally cause disease.
CLOBJ 4	Describe the basic microbial structure and functions of various groups of microbes
CLOBJ 5	Compare the various methods for identification of unknown microorganisms
CLOBJ 6	Learning the general characteristics and economic importance, as well as the applications or harmful effects of diverse microorganisms.

f. **Course Learning Outcomes:**

CLO 1	Understanding the basic microbial structure and the similarities and differences among various groups of microorganisms such as bacteria, archaea, cyanobacteria, fungi, and protozoans.
CLO 2	Acquiring knowledge of the facts and figures related to microbiology, including cytology, physiology, ecology, genetics, molecular biology, evolution, taxonomy, and systematics with a focus on microorganisms
CLO 3	Gaining knowledge on various aspects and domains of microbial systematics.
CLO 4	Understanding the concept of microbial evolution.

CLO 5	Identify the group and type of microbes depending on the structures.
CLO 6	Design the experiments based on classification of microbes by modern techniques.

g. Teaching & Examination Scheme:

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

Lect- Lecture, Tut - Tutorial, Lab - Laboratory, Th - Theory, P - Practical, CE - Continuous Evaluation

h. Course Content:

Sr.	Topic	Weightage	Teaching Hrs.
1	Unit-1: Principles of Microbial Diversity: Evolution of life, Principles and concepts of microbial diversity, Ecological diversity, Structural and Functional Diversity. Methods of studying microbial diversity - microscopy, nucleic acid analysis, physiological studies, CLPP, FAME.	25%	10
2	Unit-2: Issues of Microbial Diversity: Problems and limitations in microbial diversity studies, Diversity Indices, Loss of diversity, Sustainability and Resilience, Indicator species, Exploitation of microbial diversity, Conservation and	25%	15

	economics.		
3	Unit-3: Microbial Classification and Taxonomy: Phenetic, phylogenetic and Genotypic classification, Numerical Taxonomy, Taxonomic Ranks, Techniques for determining Microbial Taxonomy and Phylogeny - classical and molecular characteristics, phylogenetic trees; major divisions of life, Bergey's Manual of Systematic Bacteriology, Prokaryotic Phylogeny and major groups of bacteria.	25%	15
4	Unit-4: The Archaea: Ecology, Archaeal cell walls and membranes, genetics and molecular biology, metabolism, archaeal Taxonomy, Phylum <i>Crenarchaeota</i> , Phylum <i>Euryarchaeota</i> .	15%	12
5	Unit-5: Eukaryotic Diversity: Physiological variation, identification, cultivation and classification of important groups of fungi, algae and protozoa.	10%	8
	Total	100%	60

i. Text Book and Reference Book:

1. Bergey's Manual of Systematic Bacteriology by John G. Holt (Editor); Noel R. Krieg (Editor)
2. Microbial systematics, Taxonomy, microbial ecology, diversity by Bhagwan Rekadwad.
3. Modern taxonomy for microbial diversity by Indira P Shetty
4. Bacterial diversity and systematics by F. G Priest, Alberto Ramos- Cormenzana, B.J Tindall.

(2)

- a. **Course Name:** Principles of Cell Biology (Theory)
- b. **Course Code:** 11201101
- c. **Prerequisite:** Knowledge of components of cell and different functions of the cell components.
- d. **Rationale:** This course will give the fundamental understanding about various chemical processes and functioning of the cell.
- e. **Course Learning Objective:**

CLOBJ 1	Students will understand the structures and purposes of basic components of prokaryotic and eukaryotic cells
CLOBJ 2	Students will learn about the macromolecules, membranes, and organelles associated with a cell
CLOBJ 3	Students will gain knowledge on the function of various cellular components
CLOBJ 4	Students will learn the process of bioenergetics used to generate and utilize energy in cells
CLOBJ 5	Students will also be informed about the evolutionary perspective
CLOBJ 6	Applying knowledge of cell biology to various scenarios, such as environmental or physiological changes, or alterations in cell function due to mutations.

- f. **Course Learning Outcomes:**

CLO 1	Students will learn about the basic principles of cell theory, including the concept that all living things are composed of cells, and that the cell is the basic unit of life.
CLO 2	The course will cover the identification and explanation of various cellular components, such as membrane-bound organelles found in eukaryotic cells, and the understanding of their functions.
CLO 3	Students will gain insights into key cellular processes such as metabolism, energy capture and release, photosynthesis, and cellular respiration.
CLO 4	To gain knowledge on functional aspects of different cellular components
CLO 5	Students will be able to apply their knowledge of cell biology to understand medical, technological, and environmental issues related to cellular processes.

CLO 6	The course will encourage critical thinking and problem-solving skills as students explore cell biology concepts and their implications.
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g. Teaching & Examination Scheme:

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

Lect- Lecture, Tut - Tutorial, Lab - Laboratory, Th - Theory, P - Practical, CE - Continuous Evaluation

h. Course Content:

Sr.	Topic	Weightage	Teaching Hrs.
1	Unit-1: Structure of typical bacterial, plant and animal cells and functions of cell organelles. Mechanism of cell division. Cell cycle - Molecular events including cell cycle check points and Cdk - cyclin complexes and their role in cell cycle regulation. Ultrastructure of plasma membrane - components and membrane asymmetry. Transport processes - active transport, ionophores and ion channels. Exo- and endocytosis. Phago- and pinocytosis.	25%	15
2	Unit-2: General morphology and functions of endoplasmic reticulum. Signal hypothesis. Ribosomes - eukaryotic and	25%	15

	prokaryotic. Ribosomal proteins. Role of Golgi in protein secretion. Lysosomes and peroxisomes. Cytoskeletal elements. Cell - cell interactions.		
3	Unit-3: Mitochondria - structure, biogenesis and enzymatic compartmentation. Organization of mitochondrial respiratory chain, mechanism of oxidative of phosphorylation. Ultrastructure of the chloroplast. Photosynthesis - photophosphorylation. Carbon dioxide fixation in C-3, C-4 and CAM plants. Photorespiration.	25%	15
4	Unit-4: Organic evolution: Origin of life. Species concept, population, clones, races, and subspecies. Mechanisms of speciation. Role of isolating mechanisms. Lamarckism, Darwinism, Neo-Darwinism, synthetic theory of evolution. Micro, macro and mega evolution, sequential and divergent evolution. Natural selection.	25%	15
	Total	100%	60

i. Text Book and Reference Book:

1. Alberts B, Bray D, Johnson A et al. (1997) Essential Cell Biology. London: Garland Publishing.
2. Darwin C (1859) On the Origin of Species. London: Murray.
3. Graur D & Li W-H (1999) Fundamentals of Molecular Evolution, 2nd edn. Sunderland, MA: Sinauer Associates.
4. Madigan MT, Martinko JM & Parker J (2000) Brock's Biology of Microorganisms, 9th edn. Englewood Cliffs, NJ: Prentice Hall.

(3)

a. **Course Name: Genetics (Theory)**

b. **Course Code:** 11202101

c. **Prerequisite:** Knowledge of basic microbial genetics, gene regulation

d. **Rationale:** This course will give the fundamental understanding about the genetic regulation mechanism in prokaryotes and eukaryotes.

e. **Course Learning Objective:**

CLOBJ 1	Understanding how genes and chromosomes function
CLOBJ 2	Understanding the structure of DNA and methods for packaging DNA into the cell
CLOBJ 3	Describing, critically evaluating, and applying current theoretical perspectives in genetics
CLOBJ 4	Identifying genes, their function, and impact of mutations using model systems
CLOBJ 5	Understanding the process of gene cloning and different transfection methods
CLOBJ 6	Demonstrating mastery of cutting edge research approaches in genetics/genomics

f. **Course Learning Outcomes:**

CLO 1	Understand the microbial genetics.
CLO 2	Understand the fundamental concepts of genetics, including inheritance patterns, gene structure, and the molecular basis of genetic variation.
CLO 3	To understand the mechanism of gene expression regulation.
CLO 4	Learn to design and execute research programs related to the structural and functional aspects of genes and proteins.
CLO 5	Gain practical skills in genetic technologies, which can be applied in various industries such as pharmaceuticals, biotechnology, and diagnostic clinics.
CLO 6	Develop the ability to design, conduct, and analyze experimental results in genetics, particularly in model systems like animals and humans.

g. Teaching & Examination Scheme:

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

Lect- Lecture, Tut - Tutorial, Lab - Laboratory, Th - Theory, P - Practical, CE - Continuous Evaluation

h. Course Content:

Sr.	Topic	Weightage	Teaching Hrs.
1	Unit-1: Structure and function of <i>lac</i> operon, Induction of <i>lac</i> operon - a negative control system, Catabolite repression - a positive control system, Function and regulation of <i>trp</i> operon, Attenuation of <i>trp</i> operon, <i>ara</i> operon: dual functions of the repressor, Diversity of sigma factor - Bacterial sporulation and Phage infection in <i>Bacillus subtilis</i> , Heat-shock response in <i>E.coli</i> , Regulation of phage variation in <i>Salmonella</i> . Regulation of lytic phase and lysogenic phase of Bacteriophage h.	25%	15
2	Unit-2: Structural changes in the eukaryotic active chromatin - hypersensitive sites, chromatin remodeling, levels of eukaryote gene control - Control at the level of transcription, processing of RNA, mRNA stabilization in the cytoplasm and translation of mRNA. Eukaryotic promoter and enhancer sequence organization. Interaction of eukaryotic transcriptional factors with	25%	15

	DNA - helix-turn-helix motif, zinc finger motif, leucine zipper, helix-loop-helix motif. Regulation of galactose metabolism in yeast. Steroid hormone induced gene expression. Regulation of gene expression by anti-sense RNA.		
3	Unit-3: Restriction endonucleases, Restriction maps, isolation of gene fragments using restriction endonucleases and mechanical shearing. Cloning vectors - Isolation and properties of plasmids, bacteriophage cosmids, Ti plasmid (binary vector), expression vectors, viral vectors, YAC, BAC, phagemids and vectors used for cloning in mammalian cells, other enzymes related to molecular cloning. Hosts - Prokaryotic: <i>E.coli</i> , <i>B.subtilis</i> , Eukaryotic: Yeast and mammalian cell lines. Ligation of fragments - Cohesive and blunt ends, Homopolymer tailing. Gene transfer techniques. Biological and artificial delivery system, knockout mice.	25%	15
4	Unit-4: Cloning strategies, shot gun experiments, isolation of poly mRNA, synthesis of cDNA, cDNA cloning in bacteria. Genomic and cDNA libraries. Identification of recombinants - structural and functional analysis of recombinants. Design and preparation of DNA and RNA probes for hybridization. Southern blotting, Northern blotting, South Western blotting, PCR, Expression of cloned genes in bacteria, yeast, animal and plant cells. Biological, Medical and Industrial applications of recombinant DNA technology. Transgenics: Making Golden rice and Dolly.	25%	15
	Total	100%	60

i. Text Book and Reference Book:

1. "Methods In Enzymology" by Berger SI and Kimmer AR
2. "Genetic Engineering" by Sandhya Mitra.
3. "Genetics" by P S Verma and V K Agarwal
4. "Principles of Genetics" by Robert Tamarin

(4)

a. Course Name: Biochemistry of Macromolecules (Theory)

b. Course Code: 11203104

c. Prerequisite: : Knowledge of basic functions of various biomolecules present in a cell

d. Rationale: : This course will give the fundamental understanding about the structural and functional features among the cell organelles

e. Course Learning Objective:

CLOBJ 1	understanding of the large molecules that are crucial for life processes
CLOBJ 2	describe the structural sequence of the organism (from organ system to atom),
CLOBJ 3	distinguish between organic and inorganic compounds found in the cell,.
CLOBJ 4	describe the terms polymer, monomer, polymerization, and biological macromolecules,
CLOBJ 5	describe the classification of biological macromolecules into carbohydrates, lipids, proteins, and nucleic acids
CLOBJ 6	Knowledge of the biochemical pathways for the synthesis and breakdown of these macromolecules and their applications in various fields such as agriculture, health, and the environment.

f. Course Learning Outcomes:

CLO 1	Understanding the biochemical composition of cell.
CLO 2	Identify the macromolecule structure of cell.
CLO 3	Understanding the chemical principles that apply to the structures of biological

	building block molecules such as amino acids, monosaccharides, nucleotides, and fatty acids
CLO 4	Understanding the structures of biological macromolecules and their relationships to biological functions. This includes knowledge of proteins, polysaccharides, nucleic acids, and lipids
CLO 5	Understanding the features of and links between the major metabolic pathways, including the appreciation of the role played by gluconeogenesis in overcoming irreversible steps in glycolysis.
CLO 6	Developing biochemical practical skills and techniques, which involve measurement, separation, and purification as related to the above topics.

g. Teaching & Examination Scheme:

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

Lect- Lecture, Tut - Tutorial, Lab - Laboratory, Th - Theory, P - Practical, CE - Continuous Evaluation

h. Course Content:

Sr.	Topic	Weightage	Teaching Hrs.
1	Unit-1: <u>PROTEINS</u> Amino acids - classification, structure and physiochemical properties, chemical synthesis of peptides - solid phase peptide synthesis. Proteins - classification, purification, and criteria of homogeneity. Structural organization, sequence	25%	15

	determination and characterization of proteins. Conformation of proteins - Ramachandran plots. Denaturation of proteins.		
2	Unit-2: <u>CARBOHYDRATES</u> Classification, chemical properties of carbohydrates, Chemistry and biological roles of homo- and heteropolysaccharides, peptidoglycan, glycosaminoglycans, glycoconjugates, glycoproteins, Structural elucidation of polysaccharides; Oligosaccharides - lectin interaction in biochemical processes.	25%	15
3	Unit-3: <u>LIPIDS</u> Classification of Lipids, Fatty acids and their physicochemical properties. Structure and properties of Prostaglandins. Fats and waxes, physicochemical properties and characterization of fats and oil. Structure, properties and biological roles of phospholipids and Sphingolipids. Chemistry and properties of Sterols and Steroids. Salient features of bacterial and plant lipids.	25%	15
4	Unit-4: <u>NUCLEIC ACIDS</u> Nucleic acids - bases, nucleosides, nucleotides, physicochemical properties of nucleic acids, cleavage of nucleic acids by enzymatic methods, non - enzymatic transformation of nucleotides and nucleic acids, methylation, sequencing, chemical synthesis of DNA. Three dimensional structure of DNA. Different forms of DNA - circular DNA and Supercoiling. Types of RNA. Structure of t-RNA. Nucleotids as regulatory molecules, enzyme cofactors and mediators of chemical energy in cells. Porphyrins - Structure and properties of porphyrins - heme, Chlorophyll and Cytochromes.	25%	15

	Total	100%	60
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i. Text Book and Reference Book:

1. Principles of biochemistry by Lehninger
2. Molecular biology of the cell by Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Reff, Keith Roberts and Peter walter
3. Biochemistry- Satyanarayan

(5)

- a. Course Name:** Lab-I Biochemistry and Analytical Techniques
- b. Course Code:** 11203105
- c. Prerequisite:** Basic Knowledge about properties of biomolecules
- d. Rationale:** This module enables learners to develop practical skills and examine the chemical characteristics of amino acids, monosaccharides, nucleotides and fatty acids.
- e. Course Learning Objective:**

CLOBJ 1	Understand the fundamental concepts of biochemistry, including the structure and function of biomolecules, metabolic pathways, and the principles of molecular biology.
CLOBJ 2	Learning to distinguish between organic and inorganic compounds found in the cell.
CLOBJ 3	Develop technical skills in analytical techniques used for the separation, identification, and quantification of biological molecules.
CLOBJ 4	Cultivate critical thinking and problem-solving skills through the analysis and interpretation of biochemical data.
CLOBJ 5	Apply knowledge to real-world scenarios, demonstrating the relevance of biochemistry in health, disease, and medical research.
CLOBJ 6	Enhance scientific literacy, enabling students to critically evaluate scientific

	literature and communicate complex ideas effectively.
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f. Course Learning Outcomes:

CLO 1	Students will gain knowledge of core concepts biochemistry and biochemical techniques.
CLO 2	Students will gain analytical and practical skills in biochemical investigations.
CLO 3	Students will accommodate ability to design experiments based on biochemical principles and achieve translational outcomes.
CLO 4	Students will exhibit originality in identifying, tackling, and solving scientific problems, and to develop leadership qualities in organizations requiring biochemistry expertise.
CLO 5	Students will be able to carry out purification and characterization of biomolecules using analytical and biophysical techniques.
CLO 6	Development of professional roles in fields such as food industries, pharmaceutical industries, biotech industries, medical laboratories, and research institutions, where they can apply their expertise in biochemistry.

g. Teaching & Examination Scheme:

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

Lect- Lecture, Tut - Tutorial, Lab - Laboratory, Th - Theory, P - Practical, CE - Continuous Evaluation

h. Course Content

Exp. No.	List of Practicals
1	Preparations of solutions –molar, normal, ppm, percent.
2	Study of the pH meter and preparation of buffers.
3	Qualitative tests for macromolecules (Proteins, Carbohydrates, Lipids)
4	Iodine value/ Saponification value of oils.
5	Determination of λ_{max} and verification of Beer & Lambert's law
6	Estimation of maltose by DNSA method
7	Estimation of proteins by Biuret method
8	Separation of amino acids & sugars using paper & thin layer chromatography
9	Separation of lipids by TLC
10	Isolation of – starch from potato- casein from milk
11	Separation of plant pigments by column chromatography
12	Titration curve for amino acids and determination of pK value

i. Text Book and Reference Book:

1. J. Jayaraman, Analytical Techniques in Biochemistry. Springer. 2020 (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)

- a. **Course Name:** Lab-II Molecular Biology and r-DNA Technology (Practical)
- b. **Course Code:** 11202102
- c. **Prerequisite:** Basic Knowledge about Molecular Biology and r-DNA Technology

- d. **Rationale:** This practical is designed to develop an understanding of fundamental and applied aspects of genetics and molecular biology with the ability to use that knowledge in a wide range of modern science.
- e. **Course Learning Objective:**

CLOBJ 1	To develop an understanding of fundamental and applied aspects of RDT.
CLOBJ 2	To develop an understanding of fundamental and applied aspects of Molecular biology techniques.
CLOBJ 3	Understanding the steps of gene amplification by PCR.
CLOBJ 4	The course will develop an understanding of use of different DNA modification enzymes
CLOBJ 5	The students will gain a comprehensive insight on various gene transfer methods.
CLOBJ 6	The paper will be helpful for the students in understanding and applying the core concepts in their research project and higher studies.

f. Course Learning Outcomes:

CLO 1	Understanding the basic steps of gene cloning
CLO 2	Learning the role of different modification enzymes in gene cloning
CLO 3	Identifying suitable hosts for cloning.
CLO 4	Understanding role of enzymes and vectors responsible for gene manipulation, transformation and genetic engineering.
CLO 5	Getting detailed knowledge of gene transfer methods
CLO 6	Acquiring knowledge in the techniques, tools, application and safety measures of genetic engineering.

g. Teaching & Examination Scheme:

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

Lect- Lecture, Tut - Tutorial, Lab - Laboratory, Th - Theory, P - Practical, CE - Continuous Evaluation

h. Course content

Exp. No.	List of Practicals
1	Isolation, purification, quantification and separation of DNA from bacterial cell
2	Isolation, purification, quantification and separation of mitochondrial DNA
3	Isolation, purification, quantification and separation of Total genomic DNA (plant / animal)
4	Isolation, purification, quantification and separation of RNA
5	Restriction Endonuclease digestion of DNA, AGE and Southern blotting and Hybridization.
6	Gene transfer methods in bacteria: conjugation
7	Gene transfer methods in bacteria: Transduction
8	Induction and Identification of mutants by UV rays and chemical mutagen in E.coli
9	Identification of amylase enzyme fraction using native PAGE
10	Estimation of BOD and COD of effluent water

11	Report writing
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i. Text Book and Reference Book:

1. Harvey Lodish. 2016. Molecular cell biology. 8th Edition. W. H. Freeman. America.
2. David. P. Clark. 2010. Molecular Biology. Academic Press. USA.
3. Larry Snyder, Wendy Champness. 2013. Molecular Genetics of Bacteria. 4th Edn. American Society for Microbiology. USA.
4. Sandy B. Primrose, Richard M. Twyman, Robert W. Old, 2016. Principles of Gene Manipulation and genomics. 8th Edn. Blackwell Science. United States.
5. Volker A. Erdmann. 2015. RNA and DNA Diagnostics. Springer International Publishing.

Semester -2

(1)

a. Course Name: Medical Microbiology (Theory)

b. Course Code: 11201153

c. Prerequisite: : Knowledge of basic diseases caused by microbes

d. Rationale: This course will give the fundamental understanding about the pathogenicity of microbes and the action of drugs on microbes

e. Course Learning Objective:

CLOBJ 1	To provide students with a comprehensive understanding of microbes, their interactions with hosts, and the diseases they cause.
CLOBJ 2	Understand the fundamental concepts of medical microbiology, including the biological characteristics of microbes and principles of disease transmission and prevention.
CLOBJ 3	Identify and describe various pathogens, such as bacteria, viruses, fungi, and protozoa, and their role in infectious diseases.
CLOBJ 4	Apply clinical microbiology concepts to patient care, including laboratory diagnosis of infectious disease and the human microbiome.
CLOBJ 5	Interpret and apply evidence-based medicine in the context of medical microbiology, staying current with emerging infectious diseases.
CLOBJ 6	To empower students with the knowledge needed for competent clinical practice and integration with other medical disciplines.

f. Course Learning Outcomes:

CLO 1	Students will be able to understand pathogenic microorganisms such as viruses and bacteria, and the basic criteria used in their classification/taxonomy
CLO 2	Students will be able to learn about the modes of transmission of pathogenic microorganisms.
CLO 3	Students will gain knowledge and understanding of the mechanisms of microbial pathogenesis and the outcomes of infections, including chronic microbial infections.

CLO 4	Students will be able to describe and review the various types of diseases and explain the fundamentals of disease pathophysiology
CLO 5	Students should be able to distinguish between and critically assess classical and modern approaches to the development of therapeutic agents and vaccines for the prevention of human microbial diseases.
CLO 6	Advanced Skills and Laboratory Techniques: Students should be able to carry out a range of advanced skills and laboratory techniques, such as the purification of isolated microbial pathogens and analyses of their proteins and nucleic acids for downstream applications like gene cloning and sequencing studies

g. Teaching & Examination Scheme:

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

Lect- Lecture, Tut - Tutorial, Lab - Laboratory, Th - Theory, P - Practical, CE - Continuous Evaluation

h. Course Content:

Sr.	Topic	Weightage	Teaching Hrs.
1	UNIT-1: Host-Parasite Relationship: Nonspecific host defences, Virulence factors, Epidemiology, control measures, diagnostic principles, prevention.	20%	10

2	UNIT-2: Principles of virulence and Pathogenicity: Host-Parasite interaction with respect to major human diseases caused by bacteria, protozoa and viruses, Pathogenesis, Diagnosis, Prevention and treatment of diseases caused by bacteria (representative groups).	20%	15
3	UNIT-3: Normal microbial flora of human body: Microbiome of human system, Gnotobiology, Probiotics & prebiotics.	20%	10
4	UNIT-4: General characteristics of Rickettsia/ Mycoplasma/Chlamydia, and Prions: Pathogenesis, diagnosis, prevention and treatment of their disease. Mycoses - Superficial, Subcutaneous and Systemic mycosis.	20%	15
5	UNIT-5: Viral diseases: General characteristics, Pathogenesis, Diagnosis, Prevention and treatment of diseases caused by viruses (representative groups). Protozoans - Malarial parasite etc.	20%	10
	Total	100%	60

i. Text Book and Reference Book:

1. Medical Microbiology by Patrick R. Murray, Ken. S, Rosenthal, Michael A Pfaller.
2. Atlas of medical microbiology by C. Anthony Hart, Paul Shears.
3. A clinical dictionary of pathogenic microorganisms by James H Jorgensen, Michael A Pfaller
4. Textbook of microbiology by Ananthanarayan and Panicker.

(2)

a. Course Name: Biochemical Pathways and Metabolism (Theory)

b. Course Code: 11203153

c. Prerequisite: : Knowledge of basic biochemistry

d. Rationale: This course will give the fundamental understanding about the biochemical cycles occurring in the cell and the role of biochemical in the biological pathways.

e. Course Learning Objective:

CLOBJ 1	Develop learning on Biochemical Pathways and Metabolism typically aim to provide students with a comprehensive understanding of the chemical processes that occur within living organisms.
CLOBJ 2	Understand the structure and function of biological macromolecules and the principles of bioenergetics
CLOBJ 3	Comprehend the major metabolic pathways, including glycolysis, the citric acid cycle, and oxidative phosphorylation, and their regulation.
CLOBJ 4	Appreciate the integration of various metabolic pathways in different tissues and under different physiological conditions.
CLOBJ 5	Apply knowledge of biochemistry to problem-solving in clinical and research settings.
CLOBJ 6	Develop skills in scientific reasoning and data analysis to interpret biochemical research.

f. Course Learning Outcomes:

CLO 1	Understanding the chemical principles that apply to the structures of biological building block molecules such as amino acids, monosaccharides, nucleotides, and fatty acids.
CLO 2	Comprehending the structures of biological macromolecules and their relationships to biological functions, including proteins, polysaccharides, nucleic acids, and lipids.
CLO 3	Grasping the features of and links between major metabolic pathways, such as how the body adjusts to variations in the demand for energy, enzyme specificity and

	regulation, and the role of gluconeogenesis in overcoming irreversible steps in glycolysis.
CLO 4	Developing practical skills in biochemical techniques, including measurement, separation, and purification as related to the above topics.
CLO 5	Applying critical thinking skills to complex problem-based learning activities.
CLO 6	Interpreting, evaluating, and communicating biochemical data from scientific literature and in laboratory-based experimentation.

g. Teaching & Examination Scheme:

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

Lect- Lecture, Tut - Tutorial, Lab - Laboratory, Th - Theory, P - Practical, CE - Continuous Evaluation

h. Content

Sr.	Topic	Weightage	Teaching Hrs.
1	UNIT-1: Approaches for studying intermediary metabolism. Glucose as fuel, glucose transporters, Glycolysis and its regulation. Substrate cycling, TCA cycle – function and regulation, Glyoxylate cycle, Gluconeogenesis and its regulation, HMP shunt and its significance, Uronic acid pathway, Glycogen metabolism and its regulation with special reference to phosphorylase and glycogen	25%	15

	synthase, Metabolism of fructose, galactose and lactose, Biogenesis of amino sugars, peptidoglycans, glycosyl aminoglycans and glycoproteins. In born errors of carbohydrate metabolism.		
2	UNIT-2: Proteins turn over – Role of ubiquitin. General metabolic reactions of amino acids. Metabolic breakdown of individual amino acids. Ketogenic and glycogenic amino acids. Formation of creatinine, ammonia and urea. Regulation of urea cycle. Essential and non-essential amino acids. Biosynthesis and regulation of branched chain amino acids, aromatic amino acids, histidine and methionine. In born errors of amino acid metabolism.	25%	15
3	UNIT-3: Fats as energy stores, Oxidation of fatty acids, Formation and utilization of ketone bodies. Biosynthesis of fatty acids and regulation. Metabolism of arachidonic acid – formation of prostaglandins, thromboxanes, leucotrienes. Biosynthesis of triglycerides. Metabolism of phospholipids, sphingolipids. Biosynthesis of cholesterol and its regulation, Formation of bile acids. Role of liver and adipose tissue in lipid metabolism. In born errors of lipid metabolism.	25%	15
4	UNIT-4: Biosynthesis and degradation of purines and pyrimidines and their regulation. Structure and regulation of ribonucleotide reductase. Biosynthesis of ribonucleotides, deoxyribonucleotides and polynucleotides. Inhibitors of nucleic acid biosynthesis. Biosynthesis and degradation of heme. In born errors	25%	15

	of nucleic acid and porphyrin metabolism.		
	Total	100%	60

i. Text Book and Reference Book:

1. Biochemical pathways: An atlas of biochemistry and molecular biology by Gerhard Michal, Dietmar Schomburg
2. Principles of biochemistry by Lehninger
3. Biochemistry- Satyanarayan

(3)

a. Course Name: Biology of the Immune System (Theory)

b. Course Code: 11201152

c. Prerequisite: : Knowledge of basic immunology and types of immunity

d. Rationale: This course will give the fundamental understanding about the structure of immunoglobulins, antigen antibody interactions and disease associated with immune system.

e. Course Learning Objective:

CLOBJ 1	Understanding the main organs, tissues, cells, and molecules that make up the human immune system.
CLOBJ 2	Learning about the innate and adaptive immune responses, and how they function during the course of an infection.
CLOBJ 3	Exploring the development of immune cells from stem cells in the bone marrow.
CLOBJ 4	Examining how the immune system responds to pathogens with innate and adaptive immune responses.
CLOBJ 5	Recognizing the role of antigens and how the immune system reacts to them.
CLOBJ 6	Understanding the concept of vaccines and how they stimulate an immune response.

f. Course Learning Outcomes:

CLO 1	A comprehensive understanding of the immune system's function and its role in health and disease.
CLO 2	Basic Knowledge: Demonstrate basic knowledge of immunological processes at a cellular and molecular level.
CLO 3	Learning immunological principles and concepts on Innate and Adaptive Immunity and Outline, compare, and contrast the key mechanisms and cellular players of innate and adaptive immunity
CLO 4	Understanding the process of immunological response and learning the mechanism of inflammation.
CLO 5	Understand and explain the basis of immunological tolerance, autoimmunity, and transplantation
CLO 6	To equip students with the ability to analyze and apply immunological concepts to various scenarios, including disease prevention, diagnosis, and treatment.

g. Teaching & Examination Scheme:

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

Lect- Lecture, Tut - Tutorial, Lab - Laboratory, Th - Theory, P - Practical, CE - Continuous Evaluation

h. Content:

Sr.	Topic	Weight age	Teaching Hrs.
1	UNIT-1: Types of immunity – Innate and adaptive. Antigens, Super antigens, Adjuvants. Cells and organs of the immune system - Thymus, bone marrow, spleen, lymph node. T and B lymphocytes – Origin, activation, differentiation, characteristics and functions. Nature of T and B cell surface receptors. Major Histocompatibility Complex- H-2, HLA, Polymorphism of MHC molecules. Congenic and inbred strains of mice. MHC restriction and its role in immune response, Antigen presenting cells, Processing and presentation of antigens.	25%	15
2	UNIT-2: Structure of immunoglobulins, Immunoglobulin classes and biological activities. Isotypes, Allotypes, Idiotypes. Immunoglobulin genes and antibody diversity, Class switching, Humoral and cell-mediated immune responses, Cytokines, Interleukins, Interferons, The Complement components and biological consequences of complement activation.	25%	15
3	UNIT-3: Antigen-antibody interactions: Antibody affinity and avidity, Precipitation reactions – Immunodiffusion, Radial immunodiffusion, double immunodiffusion, immunoelectrophoresis, Rocket immunoelectrophoresis, Agglutination reactions-Hemeagglutination and complement fixation, Immunofluorescence, FACS, RIA, ELISA, Immunoblotting, Hybridoma technology - production of monoclonal antibodies and their applications, humanized antibodies.	25%	15

4	UNIT-4: Immune effector mechanisms – Hypersensitivity: immediate (type I, type II, type III) and delayed hypersensitivity reactions, Immunodeficiencies - SCID and AIDS. Autoimmunity - organ specific (Hashimoto's thyroiditis) and systemic (Rheumatoid arthritis) diseases. Tissue transplantation - auto, allo, iso and xenograft, tissue matching, transplantation rejection, mechanism and control, immunosuppressive agents. Cancer immunology – Tumor associated antigens, Immunological surveillance of cancer.	25%	15
	Total	100%	60

i. Text Book and Reference Book:

1. Janeway's Immunobiology by Charles Janeway
2. Kuby Immunology by Punt, Jenni, Stanford, Sharon, Jones, Patricia
3. Fundamental Immunology by William Paul
4. Cellular and molecular Immunology by Abul Abbas Andrew Lichtman and Shiv Pillai

(4)

a. Course Name: Molecular Virology (Theory)

b. Course Code: 11201151

c. Prerequisite: Knowledge of basic virology

d. Rationale: This course will give the fundamental understanding about classification of viruses, cultivation of viruses, structure and replication of viruses

e. Course Learning Objective:

CLOBJ 1	Understanding the structure, replication, and classification of viruses.
CLOBJ 2	Understanding the basics of virology, including virus dissemination and vector-virus relationships.
CLOBJ 3	Learning how viral genome and host immune defenses constrain infection and replication of viruses.
CLOBJ 4	Studying transmission strategies, immune evasion, and host responses that

	contribute to viral pathogenesis.
CLOBJ 5	Gaining knowledge about diagnostics, clinical aspects, and the implications of human viral diseases.
CLOBJ 6	Learning about viral vaccines, their types, and the antiviral actions of interferons.

f. Course Learning Outcomes:

CLO 1	Students will learn about the diversity of virus structures and the molecular strategies viruses use to infect and replicate within host cells.
CLO 2	To gain knowledge with an advanced level of understanding and appreciation of viruses and virus-host interactions at the molecular and cellular level.
CLO 3	The course will cover the molecular details of virus replication cycles and the diverse strategies used by RNA and DNA viruses for replication.
CLO 4	Students will learn the ways viruses interact with their hosts, including topics like tumor virology, host antiviral responses such as interferon and apoptosis, and viral anti-host-defense responses.
CLO 5	The course will cover beneficial uses of viruses, such as vectors in protein expression, recombinant vaccines, functional genomics, gene therapy, and oncolytics, are also discussed.
CLO 6	Students will be inculcated with recent advances in molecular virology, evolution, and current themes

g. Teaching & Examination Scheme:

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

Lect- Lecture, Tut - Tutorial, Lab - Laboratory, Th - Theory, P - Practical, CE - Continuous Evaluation

h. Course Content:

Sr.	Topic	Weightage	Teaching Hrs.
1	UNIT-1: Classification of viruses, Methods of cultivation, detection, quantitation. Propagation and maintenance of viruses (bacterial, plant and animal viruses). Structure and replication of plant viruses (a) TMV (b) Cauliflower mosaic virus.	25%	15
2	UNIT-2: Structure and replication of bacteriophages: Lytic ds linear DNA viruses (T2, T7); Lysogenic ds linear DNA virus (Lambda); ss Circular DNA virus (ϕ X 174); Male specific filamentous ss RNA virus (F17 and M13)	25%	15
3	UNIT-3: Recombination in phage, multiplicity reactivation and phenotypic mixing. Structure and replication of animal viruses (Adenovirus (eg. Type 2)	25%	15
4	UNIT-4: Structure and replication of Myxoviruses (eg. Influenza); Pox virus (eg. Vaccinia); Hepatitis virus. Effect of animal virus infection on host cell; Viral interference and interferon; Tumor viruses (DNA and RNA).	25%	15
	Total	100%	60

i. Text Book and Reference Book:

1. Bacterial Viruses: Exploitation for Biocontrol and Therapeutics by: Aidan Coffey and Colin Buttimer
2. Viruses of Microorganisms by: Paul Hyman and Stephen T. Abedon
3. Virus Evolution: Current Research and Future Directions by: Scott C. Weaver, Mark Denison, Marilyn Roossinck and Marco Vignuzzi.
4. Viruses and Interferon: Current Research by: Karen Mossma

(5)

a. Course Name: Lab-I Microbiology and Immunology (Practical)

b. Course Code: (11201154)

c. Prerequisite: Basic Knowledge about Microbiology and Immunology

d. Rationale: This practical is designed to develop knowledge about the structure of bacteria; types of microscopes and microscopy; sterilization methods and quality control; disinfection, antibiotics – testing and quality control; alga structure and life-cycle patterns and also about the immunity, organs of immunity and cells involved; Types of antigens and properties; immunoglobulin – types; MHC and its significance; hypersensitivity reactions.

e. Course Learning Objective:

CLOBJ 1	Develop core competencies in microbiology: structure and function, information flow, energy transfer and evolution.
CLOBJ 2	To learn different culturing techniques for microbial growth and understanding the technique to measure microbial growth.
CLOBJ 3	To impart knowledge on differential morphological and biochemical techniques to identify microbes.
CLOBJ 4	Identifying differential immune cells from human blood.
CLOBJ 5	Learning the principles of serological procedures and how they are applied in the laboratory setting by understanding Ag Ab reactions

CLOBJ 6	Performing different immunotechniques such as enzyme-linked immunosorbent assay (ELISA), immunoprecipitation, SDS-PAGE and western blot.
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f. Course Learning Outcomes:

CLO 1	Students will learn to maintain aseptic conditions in the lab to prevent contamination and will also gain proficiency in using microscopes to examine microorganisms.
CLO 2	Students will gain hands-on experience in microbiological techniques, such as culturing, isolating, and identifying microorganisms.
CLO 3	Students will learn about the diversity of microorganisms and their roles in various environments.
CLO 4	Students will be able to define central immunologic principles and concepts.
CLO 5	Students will develop skill to outline, compare, and contrast the key mechanisms and cellular players of innate and adaptive immunity and how they relate.
CLO 6	The students will be able to apply advanced skills of Immunotechnology to different immune related cases.

g. Teaching & Examination Scheme:

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

Lect- Lecture, Tut - Tutorial, Lab - Laboratory, Th - Theory, P - Practical, CE - Continuous Evaluation

h. Course Content

Exp. No.	List of Practicals
1	Different methods of cultivation and preservation of microorganisms
2	Staining of bacteria: Simple staining, differential staining, staining of spores and capsules
3	Isolation, purification, quantification and separation of Total genomic DNA (plant / animal)
4	Biochemical tests and motility for the identification of bacteria
5	Isolation of phage from soil
6	Cultivation and preservation of phages
7	Quantitation of phages
8	Phage induction
9	Precipitin reaction by double immunodiffusion and radial immunodiffusion (Ouchterlony and Mancini's methods)
10	Detection of antibodies or antigen by ELISA (Indirect and sandwich ELISA)
11	Detection of antigens by immunoblotting technique

i. Text Book and Reference Book:

1. Roger Y. Stanier, John L. Ingraham, Mark L. Wheelis, Page R. Painter, General Microbiology, MacMillan Press. Ed. 5; 2004.
- 2.. Topley & Wilson's: Principles of Bacteriology, Virology & Immunology, Edward Arnold. Ed. 9; 2002.
3. Lansing M. Prescott, John P Harley, Donald A. Klein; Microbiology, McGraw Hill. Ed. 6; 2005.

(6)

- a. **Course Name:** Lab-II Molecular Biology (Practical)
- b. **Course Code:** (11201152)
- c. **Prerequisite:** Basic Knowledge about Molecular Biology
- d. **Rationale:** This practical is designed to develop hands-on knowledge and acquire adequate skill required to isolate, demonstrate and quantitate nucleic acids, transfer DNA to bacteria and separate biomolecules by electrophoresis.
- e. **Course Learning Objective:**

CLOBJ 1	To impart hands-on experience using modern instruments and methods of molecular biology in order to equip students with the knowledge and practical skills necessary for careers in biological research and related fields.
CLOBJ 2	To gain hands on experience in gene isolation, cloning by PCR approach, DNA on and PCR amplification for DNA fingerprinting analysis via RAPD and restriction digestion.
CLOBJ 3	To isolate RNA for cDNA synthesis and perform gene expression analysis by qPCR.
CLOBJ 4	To get expertise in isolation of plasmids, cloning of gene and transformation into suitable bacteria for selection of recombinant clones.
CLOBJ 5	To inculcate best practices and knowledge on biohazards in molecular biology laboratories.
CLOBJ 6	Explain the differences in working areas for molecular biology procedures.

f. Course Learning Outcomes:

CLO 1	To acquire technical skills on isolation of DNA & Plasmid & their quantification
CLO 2	The course will impart an understanding of the cell based gene cloning strategies.
CLO 3	Students will gain knowledge on different modification enzymes used in molecular biology
CLO 4	Students will gain knowledge on protein quantification & TLC

CLO 5	Students will have an understanding of invitro gene amplification technique, PCR to apply it in strain identification and understand evolutionary pattern by RAPD
CLO 6	Students will be able to apply students with the ability to conduct independent work in a laboratory setting.

g. Teaching & Examination Scheme:

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

Lect- Lecture, Tut - Tutorial, Lab - Laboratory, Th - Theory, P - Practical, CE - Continuous Evaluation

h. Course Content

Exp. No.	List of Practicals
1	Isolation, purification, quantification and separation of plasmid DNA by miniprep method (Boiling lysis) Isolation, purification, quantification and separation of plasmid DNA by maxiprep method(Alkaline lysis)
2	Restriction analysis / mapping of vector DNA
3	Modification of DNA by Klenow and alkaline phosphatase enzyme (Kit)
4	Ligation of vector and insect DNA, and checking of Ligation Product.
5	Preparation of competent cells, transformation of E.coli and screening of transformants (Blue / white screening)
6	Determination of insert size by R.E analysis and PCR amplification of cloned DNA

7	Optimizing PCR assays (template DNA concentration, Mg ²⁺ concentration, and temperature)
8	RAPD analysis from microbe genome.

i. Text Book and Reference Book:

- 1) David. P. Clark. 2010. Molecular Biology. Academic Press. USA.
- 2) Larry Snyder, Wendy Champness. 2013. Molecular Genetics of Bacteria. 4th Edn. American Society for Microbiology. USA.
- 3) Sandy B. Primrose, Richard M. Twyman, Robert W. Old, 2016. Principles of Gene Manipulation and genomics. 8th Edn. Blackwell Science. United States

Semester 3

(1)

a. Course Name: Research Methodology & Scientific Writing (Theory)

b. Course Code: 11200201

c. Prerequisite: Basic knowledge of research methods and its applications.

d. Rationale: This course will give the fundamental understanding about various methods related to research. The Students will learn the process of research, review article, research project writing.

e. Course Learning Objective:

CLOBJ 1	This involves learning about the various stages of research, from identifying a problem to reporting the findings.
CLOBJ 2	Formulating clear and testable research questions and hypotheses is a key skill in scientific inquiry.
CLOBJ 3	To attain ability to select appropriate research methods, whether qualitative or quantitative, and understanding how to implement them effectively.
CLOBJ 4	Gaining proficiency in gathering data through various methods such as experiments, surveys, or observations, and then analyzing this data using statistical techniques.
CLOBJ 5	Learning how to write scientific papers, reports, and proposals clearly and effectively, and how to present findings in academic and professional settings.
CLOBJ 6	To equip students with the necessary skills to conduct scientific research and communicate their findings effectively. The course may also cover the use of statistical software, the peer review process, and the publication of research. It's designed to prepare students for careers in research, academia, or any field that requires rigorous scientific analysis and communication.

f. Course Learning Outcomes:

CLO 1	Understanding basic concepts of research and its methodologies, which involves recognizing and applying different research approaches to solve practical problems.
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CLO 2	Defining and formulating research problems, where you learn to identify, articulate, and apply appropriate parameters to research questions.
CLO 3	Developing scientific communication skills, both oral and written, to effectively draft research papers and present findings.
CLO 4	Analyzing and adhering to ethical practices in conducting research and disseminating results, ensuring integrity in the scientific process.
CLO 5	Students will gain knowledge and clarity on different sections of scientific papers, reports, and proposals.
CLO 6	To equip students with the necessary skills to conduct rigorous research and communicate their findings clearly and ethically.

g. Teaching & Examination Scheme:

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

Lect- Lecture, Tut - Tutorial, Lab - Laboratory, Th - Theory, P - Practical, CE - Continuous Evaluation

h. Content:

Sr.	Topic	Weightage	Teaching Hrs.
1	UNIT-I Research process- Characteristics and requirements: • Types of research	8%	5

2	UNIT-II Reviewing the literature: The place of the literature review in research, Clarity and focus to research problem Improving research methodology, Broadening your knowledge base in your research area, enabling you to contextualize your findings How to review the literature, Searching, reviewing of the literature, Developing a theoretical and conceptual framework	25%	10
3	UNIT-III Formulating a research problem: Source, consideration and step in formulating a research problem. Formulation of research objectives in qualitative research	12%	5
4	UNIT-IV Conceptualizing a research design: Research design- Function and theory of research design	8%	5
5	UNIT-V Constructing an Instrument for Data Collection: Selection a method of data collection Collection data using attitudinal scales. Validity and reliability of a research instrument	12%	5
6	UNIT-VI Writing a research proposal: How to write a research proposal . Objectives, Hypotheses, Study design, Setting, Measurement procedures, Ethical issues. Sampling, Analysis of data, Structure of the report and Problems and limitations	25%	10
7	UNIT-VII Writing a research report: Writing a research report, developing an outline, writing about a variable. Referencing, writing a bibliography and	10%	20

	summary		
	Total	100%	60

i. Text Book and Reference Book:

1. Research Methodology: Methods and Techniques by R.C. Kothari.
2. Research Methodology and Scientific Writing by C. George Thomas.
3. Writing Scientific Research Articles Strategy and Steps 3rd Edition 2021 by Margaret Cargill, John Wiley.
4. Scientific Writing and Research Quality by Kumar Prasann.

(2)

a. Course Name: Bioinformatics & Biostatistics (Theory)

b. Course Code: 11202201

c. Prerequisite: Knowledge of basic bioinformatics and statistics.

d. Rationale: This course will give the fundamental understanding about various components of bioinformatics. They will learn the applications of biostatistics in the field of biology.

e. Course Learning Objective:

CLOBJ 1	To develop Understanding the principles and concepts of biology and computer science.
CLOBJ 2	To understand bioinformatics data, information resources, and software effectively from large databases.
CLOBJ 3	To gain knowledge on how bioinformatics methods can be used to relate sequence to structure and function.
CLOBJ 4	To develop problem-solving skills to address a range of biological questions with new algorithms and analysis methods.
CLOBJ 5	To learn Various methods of statistical analysis and their application in biological data
CLOBJ 6	Applying mathematical and statistical logic in programming languages aiding life science research.

f. Course Learning Outcomes:

CLO 1	Students will learn the importance of statistical analysis in biology and become familiar with various methods of statistical analysis.
CLO 2	Students will learn to classify data, understand frequency distribution, and use graphical methods for data representation.
CLO 3	The course will cover mean deviation, variance, standard deviation, coefficient of variation, hypothesis testing, and probability distributions.
CLO 4	Students will learn how to locate and extract data from key bioinformatics databases and understand the types of databases, such as primary and secondary databases.
CLO 5	The course will acquaint students with the computational aspect of biotechnology, including how bioinformatics data is stored and organized in databases like NCBI.
CLO 6	The course will teach similarity searching methods like BLAST & FASTA and their applications in bioinformatics.

g. Teaching & Examination Scheme:

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

Lect- Lecture, Tut - Tutorial, Lab - Laboratory, Th - Theory, P - Practical, CE - Continuous Evaluation

h. Content

Sr.	Topic	Weightage	Teaching Hrs.
1	UNIT-I: Scope of computers in current biological research. Basic operations, architecture of computer. Introduction of digital computers. Organization, low level and high level languages, binary number system. The soft side of the computer – Different operating systems – Windows, Linux. Introduction of programming in C. Introduction to Internet and its applications.	25%	15
2	UNIT-II: Introduction to Bioinformatics – Genomics and Proteomics. Bioinformatics – Online tools and offline tools. Biological databases. Types of data bases – Gen bank, Swiss port, EMBL, NCBL, and PDB. Database searching using BLAST and FASTA.	25%	15
3	UNIT-III: Multiple sequence alignment and Dynamic programming. Gene and Genome annotation – Tools used. Physical map of genomes. Molecular phylogeny - Concept methods of tree construction. Protein secondary structure prediction. Protein 3D structure prediction. Protein docking. Introduction to homology modeling, Computer Aided Drug Design (CADD) in Drug discovery.	25%	15
4	UNIT-IV: Brief description and tabulation of data and its graphical representation. Measures of central tendency and dispersion - mean, median, mode, range, standard deviation, variance. Simple linear regression and correlation. Types of errors and	25%	15

	level of significance. Tests of significance – F & t tests, chi-square tests, ANOVA.		
	Total	100%	60

i. Text Book and Reference Book:

1. Bioinformatics and Functional Genomics by Jonathan Pevsner.
2. Introduction to bioinformatics Book by Arthur M. Lesk.
3. Essential bioinformatics Book by Jin Xiong.
4. Biostatistics for the Biological and Health Sciences Book by Jason Roy, Mario F. Triola, and Mario Triola.
5. Biostatistics: A Foundation for Analysis in the Health Sciences Book by Wayne W. Daniel.

(3)

a. Course Name: Food and Dairy Microbiology (Theory)

b. Course Code: 11201201

c. Prerequisite: Basic knowledge of microorganism and their role present in food and milk.

d. Rationale: This course will give the fundamental understanding about various microbes present in food and milk. They will be able to learn the applications of microbes in various food and dairy products.

e. Course Learning Objective:

CLOBJ 1	Gaining knowledge about important genera of microorganisms associated with food and their characteristics.
CLOBJ 2	Acquiring essential knowledge and applications of various techniques (traditional to advanced) for preserving food.
CLOBJ 3	Learning various techniques for the enumeration and control of microorganisms in food.
CLOBJ 4	Comprehending the role of different microorganisms in food spoilage, food fermentation, and food-borne diseases.
CLOBJ 5	Understanding microbiological quality control and investigation procedures for

	food-borne illnesses to ensure food safety and hygiene.
CLOBJ 6	Knowing the requirements and components of a Food Safety Management System (FSMS) and the use of Microbiological Risk Assessment (MRA) tools for assessing microbiological risks in the food sector.

f. Course Learning Outcomes:

CLO 1	Will equip students with essential knowledge about food microbiology, preservation techniques, and the impact of microorganisms on food quality and safety.
CLO 2	Analysis the Methods of food preservation
CLO 3	Understand the Role of microorganisms in food spoilage
CLO 4	Will impart the information on the types of spoilage microorganisms, their growth conditions, and the factors that influence their activity.
CLO 5	Students will explore the role of microorganisms in the production of fermented foods (e.g., yogurt, cheese, sauerkraut) and probiotics.
CLO 6	Apply the methods to preserve the food from microbial contamination.

g. Teaching & Examination Scheme:

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

Lect- Lecture, Tut - Tutorial, Lab - Laboratory, Th - Theory, P - Practical, CE - Continuous Evaluation

h. Content:

Sr.	Topic	Weightage	Teaching Hrs.
1	UNIT-I: Industrial Food fermentations Starter cultures their biochemical activities, production and preservation of the following fermented foods. a. Soy sauce fermentation by Moulds b. Fermented vegetables – Saurkraut c. Fermented Meat – Sausages d. Production and application of Bakers Yeast e. Application of microbial enzymes in food industry	25%	15
2	UNIT-II: Quality assurances in foods Foodborne infections and intoxications; bacterial with examples of infective and toxic types –, Clostridium, Salmonella, Shigella, Staphylococcus, Campylobacter, Listeria. Mycotoxins in food with reference to Aspergillus species. Quality assurance: Microbiological quality standards of food. Government regulatory practices and policies. FDA, EPA, HACCP, ISI.	25%	15
3	UNIT-III: Food preservation methods Radiations - UV, Gamma and microwave Temperature Chemical and naturally occurring antimicrobials Biosensors in food industry.	25%	15
4	UNIT-IV: Microbiology of cheese and beverage fermentation. Microbiology of fermented milk products (acidophilus milk, yoghurt). Role of microorganisms in beverages – tea and coffee fermentations. Vinegar1 Fermentation	25%	15

	Total	100%	60
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i. Text Book and Reference Book:

1. Modern Food Microbiology by James M. Jay, Martin J. Loessner, David A. Golden.
2. Food Microbiology 4th Edition by Martin R Adams, Maurice O Moss, Peter McClure.
3. Food Safety and Quality-Based Shelf Life of Perishable Foods by Peter J. Taormina, Margaret D. Hardin.
4. Dairy Microbiology by Mahanta K.C.

(4)

a. Course Name: Analytical Tools & Technique (Theory)

b. Course Code: 11203103

c. Prerequisite: Basic knowledge of techniques used in biology.

d. Rationale: This course will give the fundamental understanding about various sophisticated techniques used in biology. They will be able to learn the applications, principle and methodologies of technologies.

e. Course Learning Objective:

CLOBJ 1	Learn the basic concepts of advances techniques used in the field of microbiology and molecular biology
CLOBJ 2	Understanding the historical evolution and advantages of molecular techniques
CLOBJ 3	Mastering cutting-edge methodologies such as PCR (Polymerase Chain Reaction), NGS (Next Generation Sequencing), and CRISPR-Cas9.
CLOBJ 4	Exploring the clinical applications of these techniques in diagnosing and treating infectious diseases, cancer, genetics, and more.
CLOBJ 5	Enhancing analytical, statistical, and validation skills through hands-on training.
CLOBJ 6	To equip students with the necessary skills to apply molecular biology techniques in various scientific and clinical settings that can significantly enhance your knowledge and increase your employability in the field of medical sciences, biotechnology, and related areas.

f. Course Learning Outcomes:

CLO 1	Students will be able to explain the theoretical aspects of key analytical techniques and instruments used in geochemistry, including but not limited to electron microscopy, X-ray diffraction, mass spectrometry and spectroscopy.
CLO 2	The students will have knowledge to strategically plan analytical campaigns to apply to different types of samples and research objectives, including selection of the most appropriate technique/instrumentation for the students' research project.
CLO 3	Students will have knowledge and skills to undertake the correct sample preparation and characterization prior to analysis by the chosen techniques or instruments.
CLO 4	Students will be able to design an analytical work-flow to acquire data and achieve the research objectives of their project.
CLO 5	Students will gain knowledge to process data from the chosen instruments and demonstrate understanding of the limitations and quality of the data. Justify the approach taken to data processing
CLO 6	Students will gain knowledge to write a clear and concise justification and description of the analytical techniques employed, suitable for publication in a scientific journal.

g. Teaching & Examination Scheme:

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

Lect- Lecture, Tut - Tutorial, Lab - Laboratory, Th - Theory, P - Practical, CE - Continuous Evaluation

h. Content:

Sr.	Topic	Weightage	Teaching Hrs.
1	Unit-1: Principles and applications of light, phase contrast, fluorescence, scanning and transmission electron microscopy. Properties of electromagnetic radiations. Principles, instrumentation and applications of UV, visible, infrared, ORD, CD, NMR spectroscopy. Spectrofluorimetry and mass spectrometry, X-ray diffraction. Flow cytometry.	25%	15
2	Unit-2: Principles and applications of gel-filtration, ion-exchange and affinity chromatography. TLC, GLC and HPLC. Basic principles of sedimentation. Applications of preparative and analytical ultra centrifuges. Principles and applications of lyophilization.	25%	15
3	Unit-3: General principles of electrophoretic techniques. Polyacrylamide Gel Electrophoresis. Iso-electric focusing. Isotachopheresis. 2-D Electrophoresis. Capillary electrophoresis. Agarose gel electrophoresis of DNA and RNA. Blotting techniques. DNA fingerprinting.	25%	15

4	Unit-4: Stable and radioactive isotopes. Detection and measurement of radioactivity. Applications of radioisotopes in biological sciences. Autoradiography. Non-isotopic tracer techniques. Principles and range of electrochemical techniques. Operation of pH electrodes. Principles and applications of Ion-selective and gas sensing electrodes. Oxygen electrodes.	25%	15
	Total	100%	60

i. Text Book and Reference Book:

1. Wilson And Walkers Principles And Techniques Of Biochemistry And Molecular Biology, by Hofmann A.
2. Basic Techniques In Biochemistry Microbiology And Molecular Biology Principles And Techniques by Aakanchha Jain Richa Jain Sourabh Jain, Humana Press Inc.
3. Biological Instrumentation & Methodology, by Bajpai P.K.
4. Tools, Techniques And Assessment In Biology by John Adds.

(5)

a. Course Name: Lab-I - Food and Dairy Microbiology (Practical)

b. Course Code: 11201202

c. Prerequisite: Basic Knowledge about basic microbiology principles, parhogens and sterilization theory

d. Rationale: The aim of this course is to understand the basic and applied aspects of foods, i.e. the types and nutritive value of foods, microbial sources for food contamination, Principle and methods of food preservation, control of food borne microbes, fermented foods, enzymes used in the food industry

e. Course Learning Objective:

CLOBJ 1	To equip students with the necessary skills and knowledge to ensure food safety and quality in the food and dairy industry by studying the principles and methods of food preservation, the analysis of fermented foods, and the study of food borne
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	diseases.
CLOBJ 2	Understanding the basic microbiology of foods and dairy products, including the significance and activities of microorganisms in food.
CLOBJ 3	Gaining knowledge about microbial food spoilage, the role of intrinsic and extrinsic factors on the growth and survival of microorganisms, and sources of contamination.
CLOBJ 4	Learning about traditional food preservation techniques such as low temperature, high temperature, radiation, and chemical preservation.
CLOBJ 5	Analyzing types of dairy starter cultures, fermented food, milk products, and probiotics.
CLOBJ 6	Relating to the microbes causing food intoxications and food infections, and understanding their causative agents, foods involved, symptoms, and preventive measures.

f. Course Learning Outcomes:

CLO 1	Students will gain both theoretical knowledge and practical skills that are essential for careers in food safety, quality control, and related fields
CLO 2	Understanding of Microbial Physiology: Students will learn to apply their knowledge to understand the physiology of microorganisms and identify different types of microorganisms.
CLO 3	Microbiological Techniques: Mastery of various bacteriological techniques, including microscopy, staining, and cultivation of microorganisms from food samples.
CLO 4	Food Safety: Knowledge of the role of microorganisms in food safety, including the significance and activities of microorganisms in food and dairy products.
CLO 5	Fermentation Processes: Insight into different types of fermentation processes, the equipment used, and the microbiological processes involved.
CLO 6	Quality Control: Ability to compare various physical and chemical methods used in the control of microorganisms to ensure the quality and safety of food products

g. Teaching & Examination Scheme:

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

Lect- Lecture, Tut - Tutorial, Lab - Laboratory, Th - Theory, P - Practical, CE - Continuous Evaluation

h. Content

Exp. No.	List of Practicals
1	Production and estimation of lactic acid by Lactobacillus Sp. Or Streptococcus Sp.
2	Extraction and estimation of diacetyl.
3	Sauerkraut fermentation
4	Isolation of food poisoning bacteria from contaminated foods, Dairy products
5	Extraction and detection of afla toxin for infected food
6	Preservation of potato/onion by UV radiation
7	Production of fermented milk by Lactobacillus acidophilus.
8	Rapid analytical techniques in food quality control using microbial Biosensors.

i. Text Book and Reference Book and web links:

1. Alina Maria Holban. Alexandru Mihai Grumezescu. 2018. Advances in Biotechnology for Food Industry: Handbook of Food Bioengineering. Volume 14. Academic Press. Cambridge, Massachusetts. USA.
2. Dr. Peng Zhou. 2015. Modern food processing Biotechnology. Delve Publishing LLC. Canada.
3. Firdos Alam Khan. 2014. Biotechnology in Medical Sciences. CRC press. USA.

(6)

a. Course Name: Lab-II - Phyloinformatics and Structural Bioinformatics (Practical)

b. Course Code: 11202205

c. Prerequisite: Basic Knowledge about basic computer operation, internet and bioinformatics theory

d. Rationale: The aim of this course is to emphasize the integration of computer science, statistics and cellular and molecular instrumentations for developing and applying biological research. This course will make the students to understand basic and advanced principles and concepts.

e. Course Learning Objective:

CLOBJ 1	To provide students with a comprehensive understanding of the computational methods used in the analysis of biological data and structures.
CLOBJ 2	To understand phylogenetic systematics and its applications.
CLOBJ 3	To apply computational intelligence, phylogenetics, and bioinformatics to multi-omics data.
CLOBJ 4	To learn about bioinformatics data resources and tools for the analysis and interpretation of biomacromolecular structures.
CLOBJ 5	To understand how to analyze and interpret available structural data to gain useful information given specific research contexts.
CLOBJ 6	To predict protein structure and function, and explore interactions with other macromolecules as well as with low-MW compounds.

f. Course Learning Outcomes:

CLO 1	Students will gain knowledge and awareness of the basic principles and concepts of biology, computer science and mathematics
CLO 2	Students will be able to explain which type of data is available from the most common public databases like (NCBI, EMBI, UniProt, GenBank, Protein Data Bank, CATH).
CLO 3	Students will gain insights on accessing and browsing a range of structural data repositories.
CLO 4	Students will develop the potential in determining the existence and quality of structural information about small molecules, macromolecules, or complexes.
CLO 5	Students will gain knowledge in building and evaluating structural models for proteins with characterized relatives.
CLO 6	Predicting protein function based on sequence and structure data, and navigating AI-predicted protein structures.

g. Teaching & Examination Scheme:

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

Lect- Lecture, Tut - Tutorial, Lab - Laboratory, Th - Theory, P - Practical, CE - Continuous Evaluation

h. Content

Exp. No.	List of Practicals
1	1. Demonstrate a case study based complete Phylogenetic analysis using a. PHYLIP b. MEGA
2	Protein Profile Analysis and Pattern recognition using SIB
3	Motif searching using PROSITE.
4	Overview of Protein conformation analysis; Structure optimization and validation
5	Nucleic acid structure prediction using HADDOCK webserver
6	RNA structure prediction
7	Protein tertiary structure prediction using Modeller
8	Active site identification
9	Docking using Argus lab, Hex
10	Protein-protein interactions

i. Text Book and Reference Book and web links:

1. Welham, S. J, Gezan, S. A, Clark, S. J, Mead, A. 2014. Statistical Methods in Biology [electronic 43 resource].
2. Design and Analysis of Experiments and Regression Hoboken : CRC Pres. Pavan Kumar Agrawal and Rahul Shrivastava. 2017.
3. Bioinformatics Database Resources chapter – 4. DOI: 10.4018/978-1-5225-1871-6.ch004
4. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5037948/>
5. https://www.amboss.com/us/knowledge/Statistical_analysis_of_data
6. <https://www.nottingham.ac.uk/sczsteve/Ohlendieck%20and%20Harding%202018.pdf>

Semester 4

(1)

a. Course Name: Agricultural and Environmental Microbiology (Theory)

b. Course Code: 11201251

c. Prerequisite: Basic knowledge of microorganisms present in soil.

d. Rationale: The students will be able to learn about the various microorganisms and their role in catalysing biogeochemical processes and thereby increasing plant growth.

e. Course Learning Objective:

CLOBJ 1	Understanding the basic principles of microbiology in the context of agriculture and the environment.
CLOBJ 2	Gaining knowledge about microbial diversity, including prokaryotic and eukaryotic microbes.
CLOBJ 3	Learning about bacterial cell structure, nutrition, growth, and genetics, including genetic recombination and the role of plasmids and transposons.
CLOBJ 4	Exploring the role of microbes in soil fertility, crop production, and biogeochemical cycling of nutrients.
CLOBJ 5	Studying biofertilizers and biopesticides, and their application in sustainable agriculture.
CLOBJ 6	Understanding the microbial processes and their applications in agriculture for the development of a sustainable environment.

f. Course Learning Outcomes:

CLO 1	Understanding Microbial Diversity: Students will learn about the diversity of microorganisms and their roles in different ecosystems, particularly in soil and plant environments.
CLO 2	Microbial Processes: Knowledge of microbial processes that influence soil fertility, plant growth, and environmental sustainability.
CLO 3	Biotechnology Applications: Insight into the applications of biotechnology in agriculture, such as the development of biofertilizers and biopesticides.
CLO 4	Environmental Impact: Ability to assess the impact of microorganisms on

	environmental quality and the potential for bioremediation.
CLO 5	Research Skills: Development of research skills to independently conduct experiments and analyze data in the fields of agricultural and environmental microbiology.
CLO 6	Ethical and Professional Conduct: Understanding of ethical issues and professional conduct in the application of microbiology in agriculture and the environment.

g. Teaching & Examination Scheme:

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

Lect- Lecture, Tut - Tutorial, Lab - Laboratory, Th - Theory, P - Practical, CE - Continuous Evaluation

h. Content:

Sr.	Topic	Weightage	Teaching Hrs.
1	UNIT-I: Biological Nitrogen fixation: Physiology and Biochemistry of Nitrogen fixing organisms, Genetics and regulation of <i>nif</i> gene expression, Signalling factors and molecular interaction in establishing Rhizobia legume symbiosis.	10%	10

2	UNIT-II: Phosphate Biofertilizers: PSMs, Inorganic phosphate solubilization and its mechanisms, Phosphate mineralizers – phytate and organic phosphate hydrolyzing bacteria, and Ecto- and Endo- Mycorrhizae.	15%	10
3	UNIT-III: Plant Growth Promoting Rhizobacteria: PGPR in improving plant growth, Mechanism in plant growth promotion, Factors affecting rhizosphere colonization	20%	10
4	UNIT-IV: Environmental Problems and Monitoring: Pollution and its classification, Effluent standards: examination of waste water characteristics, municipal and industrial waste water, Global environmental problems: global warming, acid rain, ozone depletion, Sampling and analysis, Environmental monitoring and audit, Environmental laws and policies in India.	20%	10
5	UNIT-V: Bio-Treatment Kinetics and Reactor Design: Principals of biological treatments, Biological treatments: Composting, Suspended growth systems, Attached growth systems, Bioreactor design: Activated Sludge Process, Tickling Filters, Fluidised bed and Packed bed reactor, Rotating Biological Contractors, Oxidation Ponds and Ditches, Lagoons, Anaerobic Reactors.	20%	10

6	UNIT-VI: Bioremediation and Biodegradation: Bioremediation principles and Processes: Biosorption, Bioaccumulation, Bioconversion, Biotransformation, Bioleaching, Biodegradation, Detoxification, Activation, Acclimatisation and Co-metabolism, strategies and techniques of bioremediation: in situ and ex situ, of Hydrocarbons, Pesticides and Dyes, GMO's in bioremediation and biodegradation.	15%	10
	Total	100%	60

i. Text Book and Reference Book:

1. Microbial Ecology: Fundamentals and Applications by Ronald M. Atlas and Richard Bartha.
2. Environmental Microbiology by Ian L. Pepper, Charles P. Gerba, Terry J. Gentry.
3. Handbook of Microbial Biofertilizers by Mahendra Rai.
4. Development of Bioinsecticide by Faiza Saleem, Abdul Rauf Shakoor

(2)

a. Course Name: Industrial Microbiology & Fermentation Technology (Theory)

b. Course Code: 11201252

c. Prerequisite: Basic knowledge of microbes involved in fermentation technology.

d. Rationale: The students will be able to learn about the various microorganisms and their role in fermentation techniques. They will be able to learn the downstream processes and involvement of microbes in it.

e. Course Learning Objective:

CLOBJ 1	Understanding the fundamental processes of industrial microbiology and fermentation, including the exploitation of enzymes and microbes for the manufacturing of industrially significant products.
CLOBJ 2	Gaining knowledge of the design and construction of fermentors, as well as the parameters that need to be monitored and controlled during the fermentation process.
CLOBJ 3	Learning about the principles of sterilization necessary for effective fermentation.

CLOBJ 4	Studying the kinetics of microbial growth and product formation, and understanding the mechanisms of microbial growth.
CLOBJ 5	Familiarizing with the types of fermentors and the downstream processing involved in the production of microbial products.
CLOBJ 6	Understanding the role of microbes in food preparation, preservation, and spoilage, and the strategies for strain selection and improvement.

f. Course Learning Outcomes:

CLO 1	Equip students with the skills and knowledge necessary to apply biological and engineering principles in the fermentation industry, assess critical parameters in fermentation processes, and understand the principles of fermentor design, sterile engineering, process development, and production economics.
CLO 2	Students will gain an overview of different types of bioreactors and their design, which is crucial for industrial production.
CLO 3	The course will cover the kinetics of microbial growth, which is essential for optimizing fermentation processes.
CLO 4	Students will learn techniques for the isolation, screening, and improvement of industrially important microorganisms.
CLO 5	The rationale behind medium formulation for the industrial production of various products will be a key part of the curriculum.
CLO 6	Knowledge of downstream processing, including the detection and assay of fermentation products, is also a significant outcome.

g. Teaching & Examination Scheme:

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

Lect- Lecture, Tut - Tutorial, Lab - Laboratory, Th - Theory, P - Practical, CE - Continuous Evaluation

h. Content:

Sr.	Topic	Weightage	Teaching Hrs.
1	UNIT-I: Introduction to Fermentation Processes: Range of fermentation processes, Strain improvement of industrially important microorganisms, screening methods.	20%	12
2	UNIT-II: Microbial Growth: Batch culture, Continuous culture, Fed-batch culture, Applications and examples, Scale up of fermentation processes, Sterilization of media, fermentor and feeds.	20%	12
3	UNIT-III: Design of a Fermentor: Functions, construction, and maintenance of aseptic conditions. Types of fermentors, Aeration and agitation (Non Newtonian fermentations).	20%	10

4	UNIT-IV: Industrial products produced by microorganisms: e.g. Enzymes, organic acids, amino acids. Production of antibiotics, vitamins, alcohol fermentation, Glycerol-based fermentations.	20%	10
5	UNIT-V: Process Control: Enzyme probes - Bio sensors, Control of various parameters, Computer applications in fermentation technology.	10%	8
6	UNIT-VI: Downstream processing: Unit operations, Recovery and purification of fermentation products.	10%	8
	Total	100%	60

i. Text Book and Reference Book:

1. Modern Industrial Microbiology and Biotechnology by Nduka Okafor.
2. Industrial Microbiology by L.E. Casida.
3. Fermentation Technologies: Industrial applications by P L Yu.
4. Principles of Fermentation Technology Stanbury Peter F.

(3)

a. Course Name: Dissertation

b. Course Code: 11200251

c. Prerequisite: Basic knowledge of research and review article writing and preparation of thesis.

d. Rationale: The students will the methodologies and scientific project pursual.

e. Course Learning Objective:

CLOBJ 1	Demonstrate the ability to design, plan, and execute a comprehensive research project independently
CLOBJ 2	Critically evaluate existing literature, theories, and practices to identify research gaps
CLOBJ 3	Formulate and defend a research question or hypothesis based on systematic analysis
CLOBJ 4	Analyze qualitative and/or quantitative data using appropriate methods and tools
CLOBJ 5	Make an original contribution to the knowledge base of the chosen discipline.
CLOBJ 6	Conduct research in compliance with institutional and disciplinary ethical guidelines

f. Course Learning Outcomes:

CLO 1	Demonstrate a deep and systematic understanding of the chosen research area, including relevant theories, methodologies, and current advancements.
CLO 2	Design and execute a research project using appropriate research methodologies and tools.
CLO 3	Develop creative and innovative solutions to complex research problems.
CLO 4	Demonstrate the ability to address research challenges with intellectual rigor and originality.
CLO 5	Present research findings effectively, both in written and oral forms, to academic and non-academic audiences.
CLO 6	Produce a well-organized, clear, and concise dissertation that adheres to academic standards in structure, style, and referencing

g. Teaching & Examination Scheme:

Teaching Scheme (Hrs./Week)			Credit	Examination Scheme					Total
Lect	Tut	Lab		Internal			External		
				Th	CE	P	Th	P	
-	-	28	28	-	-	100	-	200	300

Lect- Lecture, Tut - Tutorial, Lab - Laboratory, Th - Theory, P - Practical, CE - Continuous Evaluation

h. Content

Sr.	Topic	Weightage	Teaching Hrs.
1	Dissertation - literature survey, research problem design, hypothesis construction, pilot study, data generation from field/laboratory exercise, data analysis. Work compilation in thesis report. Assessment based on report evaluation and viva voce.	100%	28
	Total	100%	28