COURSE STRUCTURE

Master of Science
Microbiology

Under
Choice Based Credit System (CBCS)

DEPARTMENT OF MICROBIOLOGY

Master of Science Program outcomes (PO)

PO No.	Program Outcome Description
PO1	Advanced Subject Knowledge: Graduates will demonstrate advanced knowledge and expertise in their Specialized field, including a comprehensive understanding of advanced concepts and theories.
PO2	Research Proficiency: Students will develop advanced research skills, including the ability to design and Conduct independent research, analyze data, and draw meaningful conclusions.
PO3	Critical Analysis and Synthesis: Graduates will demonstrate advanced critical thinking abilities, the capacity to analyze complex scientific problems, synthesize information from diverse sources, and propose innovative solutions.
PO4	Scholarly Communication: Students will possess advanced skills in scientific writing, oral presentation, and effective communication of research findings to scientific and non-scientific audiences.
PO5	Independent Thinking: Graduates will exhibit independent thinking and creativity in problem-solving, research design, and the development of novel approaches in their field of specialization.
PO6	Leadership and Collaboration: Students will develop leadership skills and the ability to collaborate effectively with diverse teams, providing guidance and fostering a collaborative research environment.
PO7	Advanced Technology and Techniques: Graduates will be proficient in utilizing advanced technology, tools, and techniques specific to their discipline to enhance research and analysis capabilities.
PO8	Ethical Research Practices: Students will adhere to high ethical standards in research, ensuring the responsible conduct of research, integrity, and respect for intellectual property rights.
PO9	Continuous Learning and Adaptability: Graduates will demonstrate a commitment to continuous learning, keeping pace with emerging trends and technologies, and adapting to new challenges in their field.
PO10	Contribution to the Field: Students will make significant contributions to their specialized field, actively participating in conferences, publishing research, and advancing scientific knowledge through their research work.

M.Sc. Microbiology:

PSO No.	Program Specific Outcome Description
PSO1	Advanced Microbiological Knowledge and Expertise: Graduates of the M.Sc. Microbiology program will acquire advanced knowledge and expertise in the study of microorganisms, including their genetics, physiology, pathogenesis, and ecological roles. They will demonstrate proficiency in advanced microbiological techniques and methodologies.
PSO2	Advanced Research and Applied Microbiology: Graduates will engage in advanced research and applied microbiology, addressing complex challenges in various domains such as healthcare, biotechnology, and environmental management. They will contribute to scientific advancements, develop innovative solutions, and apply their knowledge to practical scenarios.

M.Sc Semester I Teaching scheme with credit

Sr No	Course Type	Course Code	Corse Name	Lecture (hrs.)	Practical (hrs.)	Credits	Examination		TOTAL MARKS
							Internal	External	
1	DISCIPLINE SPECIFIC COURSE (DSC)	MMIC101 DSC	Cell Biology	4	0	4	30	70	100
2	DISCIPLINE SPECIFIC COURSE (DSC)	MMIC102 DSC	Molecular biology and Genetics	4	0	4	30	70	100
3	DISCIPLINE SPECIFIC COURSE (DSC)	MMIC103 DSC	Biodiversity and Ecology	4	0	4	30	70	100
4	DISCIPLINE SPECIFIC COURSE (DSC)	MMIC104 DSC	Microbial Taxonomy	4	0	4	30	70	100
5	PRACTICAL COURSE (PRA)	MMIC105 UPRA	Practical Module-I	0	6	3	0	75	75
		MMIC106 UPRA	Practical Module-II	0	6	3	0	75	75
6	Subject Elective	MMIC101 SE	Bioinformatics part 1	2	0	2	15	35	50
		Total credit		18	12	24	135	465	600

M.Sc Semester II Teaching scheme with credit

Sr No.	Course Type	Course Code	Corse Name	Lecture (hrs.)	Practical (hrs.)	Credits	Examination		TOTAL MARKS
							Internal	External	
1	DISCIPLINE SPECIFIC COURSE (DSC)	MMIC201 DSC	Biochemistry	4	0	4	30	70	100
2	DISCIPLINE SPECIFIC COURSE (DSC)	MMIC202 DSC	Instrumentation and Analytical Techniques	4	0	4	30	70	100
3	DISCIPLINE SPECIFIC COURSE (DSC)	MMIC203 DSC	Biostatistics and Research Methodology	4	0	4	30	70	100
4	DISCIPLINE SPECIFIC COURSE (DSC)	MMIC204 DSC	Bioprocess and biochemical engineering	4	0	4	30	70	100
5	PRACTICAL COURSE (PRA)	MMIC205 UPRA	Practical Module-I	0	6	3	0	75	75
		MMIC206 UPRA	Practical Module-II	0	6	3	0	75	75
6	Subject Elective	MMIC201 SE	Bioinformatics part 2	2	0	2	15	35	50
		Total credit		18	12	24	135	465	600

M.Sc Semester III Teaching scheme with credit

Sr No.	Course Type	Course Code	Corse Name	Lecture (hrs.)	Practical (hrs.)	Credits	Examination		TOTAL MARKS
							Internal	External	
1	DISCIPLINE SPECIFIC COURSE (DSC)	MMIC301DSC	Bacteriology and virology	4	0	4	30	70	100
2	DISCIPLINE SPECIFIC COURSE (DSC)	MMIC302DSC	Genetics of bacteria and virus	4	0	4	30	70	100
3	DISCIPLINE SPECIFIC COURSE (DSC)	MMIC303DSC	Microbial physiology and development	4	0	4	30	70	100
4	DISCIPLINE SPECIFIC COURSE (DSC)	MMIC304DSC	Immunology	4	0	4	30	70	100
5	PRACTICAL COURSE (PRA)	MMIC305UPRA	Practical Module-I	0	6	3	0	75	75
		MMIC306UPRA	Practical Module-II	0	6	3	0	75	75
6	Subject Elective	MMIC301SE	Microbial diversity and extremophiles	2	0	2	15	35	50
		Total credit		18	12	24	135	465	600

M.Sc Semester IV Teaching scheme with credit

Sr No.	Course Type	Course Code	Corse Name	Lecture (hrs.)	Practical (hrs.)	Credits	Examination		TOTAL MARKS
							Internal	External	
1	DISCIPLINE SPECIFIC COURSE (DSC)	MMIC401 DSC	Recombinant DNA Technology	4	0	4	30	70	100
2	DISCIPLINE SPECIFIC COURSE (DSC)	MMIC402 DSC	Medical microbiology	4	0	4	30	70	100
3	DISCIPLINE SPECIFIC COURSE (DSC)	MMIC403 DSC	Food technology	4	0	4	30	70	100
4	DISCIPLINE SPECIFIC COURSE (DSC)	MMIC404 DSC	Air and water microbiology	4	0	4	30	70	100
5	PRACTICAL COURSE (PRA)	MMIC405 UPRA	Practical Module-I	0	6	3	0	75	75
		MMIC406 UPRA	Practical Module-II	0	6	3	0	75	75
6	Subject Elective	MMIC401 SE	Drug discovery and clinical research	2	0	2	15	35	50
		Total credit		18	12	24	135	465	600

Subject Code: MMIC101DSC **Semester: I**
Subject Name: Cell Biology

Teaching Examination Scheme:

Teaching (Hours/week)			Examination Scheme			
Lecture	Tutorial	Practical	Internal		External	Total
			Mid	CE		
04	0	01	20	10	70	100

Course Objective:

- Students will understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles
- Students will understand how these cellular components are used to generate and utilize energy in cells

Course Outcomes: At the end of the course, students shall be able to

CO1	Describe the evolution, diversity and replication of cells;
CO2	Explain the role of compartmentalization and signalling in cellular biology; Interpret and explain key experiments in the history of cell biology;
CO3	Evaluate and apply knowledge of modern techniques in cellular biology.

Content

Credit: 04

Unit	Topic	Content	Hrs.	Weightage
1		**Cell Organells Part-1**	15	25%
	1.1	Cell wall: Structure and functions, Plasmodesmata Structure, role in movement of molecules and macromolecules; comparison with gap junctions.		
	1.2	Plasma membrane: Structure, models, and functions, sites for ATPases, ion carriers, channels and pumps, receptors.		
	1.3	Structural organization and function of intracellular organelles: Plastids, Mitochondria, Chloroplast, Golgibodies, Lysosomes, Peroxisomes, Endoplasmic reticulum, Ribosomes.		
	1.4	Cytoskeleton- microtubules, microfilamenets and intermediate filaments.		
2		**Cell Organells Part-2**	15	25%
	2.1	Nucleus: Structure and functions, nuclear pores nucleosome organization, Nucleolus.		
	2.2	Chromatin organization: Chromosome structure and packaging of DNA, molecular organization of centromere and telomere.		

	2.3	Specialized types of chromosomes: Structure and functions of polytene and lampbrush, B-chromosomes and sex chromosomes.		
	2.4	Experimental approaches for studying cells, Cell Fixation and Staining.		
3		**Cell division, signaling and cell death.**	**15**	**25%**
	3.1	Cell division and cell cycle: Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle.		
	3.2	Cell Signaling**:** Cell signaling Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways.		
	3.3	Cellular communication: General principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, regulation of hematopoiesis, neurotransmission and its regulation.		
	3.4	Apoptosis and Programmed Cell Death (PCD).		
4		**Cancer: Introduction, development, Treatment**	**15**	**25%**
	4.1	Introduction to cancer biology.		
	4.2	Cancer development: Genetic rearrangements in progenitor cells, Oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer.		
	4.3	Cancer propagation: Metastasis, interaction of cancer cells with normal cells.		
	4.4	Cancer treatment: Therapeutic interventions of uncontrolled cell growth.		

Reference Books

1. Lodishet. al., 2007 Molecular Cell Biology, W.H. Freeman and Company, New York, USA 2.
2. Albertset. al., 2008 Molecular Biology of the Cell, Garland Science, Taylor & Francis Group, New York, USA. 3.
3. Sperelakis 2001 Cell Physiology Source Book : A Molecular approach,Academic Press, New York, USA.
4. Powar C. B. 1983 Cell Biology, Himalaya Publishing House, Mumbai, India.

Suggested Readings:

- Molecular Biology of the Cell
- Essential Cell Biology
- Cell biology by Thomas D. Pollard
- Karp's Cell Biology

Online Resources:

1. **www.shomusbiology.com**
2. **https://www.slideshare.net**
3. **https://byjus.com/**

Practical / Activities:

- Ion exchange chromatography
- Column chromatography
- Affinity chromatography
- Cell staining
- Blood smear preparation
- Microscopy view

MMIC105UPRA- MICROBIOLOGY PRACTICAL MODULE I

CREDIT: 03

PRACTICAL

Cell Biology

1. Differential staining of bacterial appendage
2. Isolation of chloroplast from given sample
3. Mitosis and the Cell Cycle in Onion Root-Tip Cells
4. Preparation of Buccal smear and Identification of Barr Body
5. Micrometry – Measurement of cell size

Molecular Biology and Genetics

6. Spectrometric analysis of DNA
7. Estimation of RNA by Orcinol method
8. UV survival and irradiation curve of E-coli
9. Simple problem solving task of Genetics
10. Preparation of Drosophila Polytene Chromosome Squashes
11. Isolation and Identification of Auxotrophic and Drug Resistant Mutants
12. Study of lytic cycle of bacteriophages and estimation of phage titer

MMIC106UPRA- MICROBIOLOGY PRACTICAL MODULE II

CREDIT: 03

PRACTICAL

Biodiversity and Ecology

1. To perform and study the population growth curve using bacteria
2. Determination of different population parameters:
    a. Density
    b. Abundance
    c. Diversity
    d. Dominance
3. Water and soil quality assessment
4. Study of positive and negative interactions amongst microorganisms
5. Rhizosphere and non rhizosphere diversity of microorganisms.

Microbial taxonomy

1. Morphological and Biochemical characterization for bacterial isolates
2. Morphological identification and characterization of fungi
3. Isolation of extremopliles
4. Special staining in Bacteria
5. Antibiotic sensitivity methods – Kirby-Bauer method and Stokes method
6. Microbial Growth curve

CO-PO & CO-PSO Mapping

Course Outcomes	Program Outcomes 1: Less relevant, 2: Mild relevant, 3: Highly relevant											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	2	1	1	-	1	-	1	-	2	2	2	1
CO2	3	1	1	-	2	-	-	-	3	3	3	-
CO3	3	1	1	-	2	-	1	-	2	3	2	2

Subject Code: MMIC102DSC **Semester: I**
Subject Name: Molecular biology and genetics

Teaching Examination Scheme:

Teaching (Hours/week)			Examination Scheme			
Lecture	Tutorial	Practical	Internal		External	Total
			Mid	CE		
04	00	01	20	10	70	100

Course Objective:

- Molecular biology deals with nucleic acids and proteins and how these molecules interact within the cell to promote proper growth, division, and development. It is a large and ever-changing discipline.
- This course will emphasize the molecular mechanisms of DNA replication, repair, protein synthesis.

Course Outcomes: At the end of the course, students shall be able to

CO1	Gain basic understanding on human genetics & hereditary
CO2	They learn about DNA, RNA and their replication, mutations, DNA repair mechanism.
CO3	Students learn about transgenic animal, their application in pharmaceutical industry, cloning and its importance.

Content

CREDIT: 04

Unit	Description in detail	Credit	Weightage
I	**DNA Replication, transcription and translation** Nucleic Acids: Composition of Nucleic Acids and Synthesis of Nucleotides; Molecular Organization and types of DNA and RNA. DNA Replication in Prokaryotes and Eukaryotes, Enzymes involved in Replication. Transcription in Prokaryotes and Eukaryotes, RNA Polymerases. Translation: Process of Protein synthesis.	1	25%
II	**Gene Cloning technique, Enzymes and vectors** Regulation of gene expression in Prokaryotes and Eukaryotes. Recombinant DNA technology: Classification of Restriction enzymes, Gene Cloning principles and technique. Prokaryotic and Eukaryotic cloning Vectors. Construction of Genomic and cDNA libraries, DNA synthesis and sequencing. PCR (Polymerase Chain Reaction), DNA Finger printing and DNA Microarray	1	25%

III	**Genetics part-1** Gene structure and expression: Gene vs allele, a new concept of Allelomorphism, fine structure of gene, cistron, recon and muton. Genetic code: Deciphering genetic code, properties of genetic code, initiation and termination codons, mutation. Wobble hypothesis, new genetic codes, second genetic code, overlapping and split genes. Extra chromosomal inheritance: Male sterility-origin, induction and application, inheritance of cholroplast and mitochondrial gene.	1	25%
IV	**Genetics part-2** Spontaneous and induced mutation, Physical and chemical mutagens, Molecular basis of gene mutations. Transposable elements in Prokaryotes and Eukaryotes, mutations induced by transposons, site-directed mutagenesis. Principal of Mendelian Genetics and Hardy – Weinberg genetic equilibrium. Factors affecting gene frequency- Natural selection and Genetic polymorphism and Genetic drift.	1	25%

Reference Books:

1. Lodishet. al., 2007 Molecular Cell Biology, W.H. Freeman and Company, New York, USA 2.
2. Sambamurty A.V. S. S. 2008 Molecular Biology, Narosa Publishing House, New Delhi.
3. Sandhu G. S. 2002 Molecular Cell Biology, Campus books, New Delhi.
4. Verma P. S. and Agrawal V. K. 2010 Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand & Company Ltd.

Suggested Readings:

- Molecular Biology of the Gene.
- The World of the Cell.
- Cell And Molecular Biology.
- Karp's Cell and Molecular Biology.
- Lewin's Essential Genes.
- Principles of Genetics.
- Gene Machine.

Online Resources:

- **www.shomusbiology.com**
- **https://www.slideshare.net**

Practical / Activities:

1) Isolation of RNA.
2) Polymerase chain Reaction Practical
3) Gel Electrophoresis and Microarray Techniques.

CO-PO & CO-PSO Mapping

Course Outcomes	Program Outcomes 1: Less relevant, 2: Mild relevant, 3: Highly relevant											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	1	1	-	-	-	1	2	2	-	2	-
CO2	2	2	1	2	-	2	2	-	2	**2**	2	2
CO3	3	2	1	2	2	1	1	1	2	-	2	2

Subject Code: MMIC103DSC **Semester: I**
Subject Name: Biodiversity and Ecology

Teaching Examination Scheme:

Teaching (Hours/week)			Examination Scheme			
Lecture	Tutorial	Practical	Internal		External	Total
			Mid	CE		
04	0	01	20	10	70	100

Course Objective:

a) To complement the students with the basic knowledge about Biological diversity.
b) Biodiversity deals with diversity of microorganisms based on species, genetics and ecosystem.
c) This course will emphasize the genetic variation of population, regulations of community and populations.

Course Outcomes: At the end of the course, students shall be able to

CO1	Student will gain an understanding of basic concept of biodiversity, Ecological services, Ecological concepts and its laws.
CO2	Biodiversity and Ecology gives depth knowledge of population growth curve and its regulation, role of parks in all life on earth and metapopulation concept for discussing species in disturbed habitats and viability of their populations.

Content

CREDIT: 04

Unit	Description in detail	Credit	Weightage
I	**Introduction: Biological diversity** 1.1 Biogeography of the world and basis of biological diversity. 1.2 Levels of biodiversity: Species, Genetic and Ecosystem diversity. 1.3 Biodiversity hotspots of the world. 1.4 Conservation significance and threats to biodiversity.	1	25%
II	**Strategies of Biodiversity conservation** 2.1 Ecological services of Biodiversity. 2.2 IUCN threat categories, Red data book, and role in biodiversity conservation. 2.3 National Biodiversity Act (2002). 2.4 Role of National Parks and Sanctuaries in biodiversity conservation in India.	1	25%

III	**Concept of Ecosystem** 3.1 Classical ecological concepts and laws. 3.2 Concept of productivity, food chain, food web and trophic levels. 3.3 Habitat and niches,niche width and overlap, fundamental and realized niche, resource partitioning, character displacement. 3.4 Ecological succession.	1	25%
IV	**Population and Community Ecology** 4.1 Characteristics of a population; population growth curves and regulation. 4.2 r and K selection, concept of Metapopulation. 4.3 Population and Community dynamics and regulations. 4.4 Population genetics: genetic variation, speciation.	1	25%

Reference Books:

1. Magguran, A.E. (1996). Ecological diversity and its measurements. PrincetonUniversity.
2. Gadgil, M. (2002) A methodology mannual for scientific inventorying, monitoring and conservation of Biodiversity.
3. Odum. E.P. 1996 Fundamentals of Ecology. Nataraj Publishers, Dehra Dun.
4. Smith, R.L.1986. Elements of Ecology. Harpet and Row Publishers, New York.
5. Berwer. A.1988 .The Science of ecology. Saunder's college publishing.

Suggested Readings:

1. Fundamentals of Ecology 1st edition (2018-19) by P.D. Sharma
2. Fundamentals of Ecology and Environment 2nd edition 2021 by Pranav kumar

Online Resources:

1. **https://www.onlinecourses.swayam2.ac.in.**
2. **www.shomusbiology.com**
3. **https://www.slideshare.net**

Practical / Activities:

1. An illustrated diagram of the fabric of biological life
2. Species in their ecological niche
3. A global map of biomes

CO-PO & CO-PSO Mapping

Course Outcomes	Program Outcomes 1: Less relevant, 2: Mild relevant, 3: Highly relevant											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	2	-	1	1	2	1	-	2	2	2	1
CO2	3	-	2	-	1	2	1	-	2	**2**	2	1

Subject Code: MMIC104DSC **Semester: I**
Subject Name: Microbial Taxonomy

Teaching Examination Scheme:

Teaching (Hours/week)			Examination Scheme			
Lecture	Tutorial	Practical	Internal		External	Total
			Mid	CE		
04	0	01	20	10	70	100

Course Objective:

(a) The course aims to provide students with an understanding of different bacterial groups based onshape, gram's reaction, cultural characteristics, biochemical characteristics, phylogenetic tree forevolutionary relationships, sexual and asexual reproduction in fungi, some diseases caused by Plasmodium.

Course Outcomes: At the end of the course, students shall be able to

CO1	Students will able to recall bacterial classification system including Whittaker five kingdom, hackle three kingdom.
CO2	Students will gain an understanding the concept of pathogenic characteristics of microorganisms include replicate using host resources , exit and spread to a new host, reproduction of virus by lysogenic and lytic cycle, ecological importance of spirulina.

Content

CREDIT: 04

Unit	Description in detail	Credit	Weightage
I	**Microbial taxonomy : Bacteria** 1.1 Brief account of general methods of classifying the bacteria. Whittaker's five kingdom concept, Cell arrangement and shapes of bacteria. 1.2 Major characteristics: Morphological, physiological, metabolical, ecological, cultural, serological, pathogenic, phylogenetic of microorganisms used in microbial taxonomy. 1.3 Bergey's manual and its importance in classification. 1.4 Brief account of different bacterial groups- sporulating bacteria, gram positive cocci, archaebacteria, actinomycetes, rickettsia & chlamydia, mycoplasma, spirochetes.	1	25%

II	**Classification and role of Fungi and Algae** 2.1 Fungi- Classification of fungi.Modes of Reproduction in fungi, Fungi as saprotrophs & their role in decomposition in cellulose, hemicellulose, pectin and lignin. 2.2 Types of mycosis, brief account of Dermatophytes, Chromomycosis, Cryptococcosis and Aspergillosis. 2.3 Algae- Structure, nutrition and Reproduction in algae. Distribution and classification of algae. 2.4 Economic importance of Algae as food, Source of agar-agar, alginate, diatomite and iodine etc, antibiotics from algae, use in fisheries and malaria control.	1	25%
III	**Virus and Protozoa** 3.1 Virus- Nomenclature, Classification and Properties of viruses, Morphology and Structure of viruses- Capsid and its symmetry with special reference to bacteriophage, Lytic and lysogenic cycle. 3.2 Viriods and Prions 3.3 Protozoa- Morphology, reproduction, modes of nutrition, modes of transmission, locomotory organelles in protozoa. Life cycle, pathogenic, mechanisms and control of parasitic infections viz. amoebiasis, toxoplasmosis, malaria, sleeping sickness. 3.4 Disease caused by protozoa**:** amoebiasis, toxoplasmosis, malaria, sleeping sickness, how it controlled, its mechanism etc.	1	25%
IV	**Microbial Systematics: Nomenclature classification, species concept** 4.1 General account of systematics, classification and nomenclature: Classification systems- artificial or phonetic, natural and phylogenetic. 4.2 Species concept in microbiology, monophyletic, paraphyletic, polyphyletic. 4.3 Newer approaches for exploring unculturable bacteria- molecular taxonomy, molecular phylogeny, molecular chronometers; Chemotaxonomy; Polyphasic taxonomy, Describing a new Prokaryotic species. 4.4 Valid publication of names of bacterial taxa, Culture collection.	1	25%

CO-PO & CO-PSO Mapping

Course Outcomes	**Program Outcomes 1: Less relevant, 2: Mild relevant, 3: Highly relevant**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	-	1	-	1	-	-	-	2	2	2	1
CO2	2	2	2	-	2	1	2	-	2	**2**	3	2

Subject Code: MMIC101SE **Semester: I**
Subject Name: Bioinformatics part - I

Teaching Examination Scheme:

Teaching (Hours/week)			Examination Scheme			
Lecture	Tutorial	Practical	Internal		External	Total
			Mid	CE		
02	00	00	10	05	35	50

Course Objective:

- To learn the concepts of Data Mining
- To utilize data mining techniques and enhance its application in acquiring Biological Data.
- To learn large scale biological data analysis using Bioinformatics Software.

Course Outcomes: At the end of the course, students shall be able to

CO1	To learn basic concept in proteomics and their role in life science research.
CO2	To learn theoretical concept in computer aided drug design and molecular modeling.
CO3	To apply the role of computational drug discovery methods using various tools in bioinformatics.

Content

CREDIT:02

Unit	Description in detail	Credit	Weightage
I	**Introduction of computer: Classification, Data, and Memory** 1.1 Basic structure, ALU, memory, CPU, I/O devices, Development of computers. Classification of computers:(Micro, mini frame, super computer, pc,server, workstations). 1.2 Data Representation With in Computer: BIT, BYTE, WORD, ASCII, EBCDIC, BCD Code, Introduction to Number system: Binary, Octal, Decimal and Hexadecimal. Conversation from one number system to another number system 1.3 Memory: RAM, ROM, PROM, EPROM, EEPROM,Base memory, extended memory, expanded memory, Cache memory,Storage devices Tape, FDD, HDD, CDROM, Pen Drive.	1	50%
II	**Computer: Biology in computer age, operating system & search engines** 2.1 Biology in the computer age - Computational Approaches to Biological questions. 2.2 Basics of computers - servers, workstations,	1	50%

	operating 2.3 systems, Unix, Linux. World Wide Web. Search engines, finding scientific articles - Pubmed - public biological databases.		

Reference Books:

- Bioinformatics - A Practical Guide to the analysis of Genes and Proteins-Andreas Baxevanis.
- Guide to Human Genome Computing-Martin J Bishop.
- An Introduction to Bioinformatics-Arthur M. ...
- Algorithmic Aspects of Bioinformatics (Natural Computing)- Hans-Joachim Bockenhauer & Dirk Bongartz.

Suggested Readings:

- Statistical Bioinformatics: with R.
- A Primer of Genome Science, Third Edition,
- R Programming for Bioinformatics.

Online Resources:

- **https** HYPERLINK "https://www.khanacademy.org/":// **HYPERLINK "https://www.khanacademy.org/"www. HYPERLINK "https://www.khanacademy.org/"khanacademy** HYPERLINK "https://www.khanacademy.org/". **HYPERLINK "https://www.khanacademy.org/"org**
- **www.shomusbiology.com**
- **https** HYPERLINK "https://www.slideshare.net/":// **HYPERLINK "https://www.slideshare.net/"www.slideshare** HYPERLINK "https://www.slideshare.net/". **HYPERLINK "https://www.slideshare.net/"net**

CO-PO & CO-PSO Mapping

Course Outcomes	Program Outcomes 1: Less relevant, 2: Mild relevant, 3: Highly relevant											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	2	2	3	-	2	2	2	-	2	1	1	2
CO2	2	2	1	-	1	2	2	-	2	**2**	1	2
CO3	2	2	2	-	1	2	2	-	2	-	-	2

Subject Code: MMIC201DSC **Semester: II**
Subject Name: Biochemistry

Teaching Examination Scheme:

Teaching (Hours/week)			Examination Scheme			
Lecture	Tutorial	Practical	Internal		External	Total
			Mid	CE		
03	0	01	20	10	70	100

Course Objective: The course aims to provide students with an understanding of Chemical bonds and Stabilizing interactions, Enzyme regulation, Information about Carbohydrates and its metabolism, Information about Lipid and its metabolism and as well as proteins.

Course Outcomes: At the end of the course, students shall be able to

CO1	Students will gain about Chemical bonds and Stabilizing interactions, ionization of water, Energy flow: principles of thermodynamics, free energy and chemical potential, redox reactions.
CO2	Students will learn basic knowledge about Carbohydrates, Glycolysis, Glycogenesis, TCA cycle, Electrone transport system, Oxidative phosphorylation and photophosphorylation, Hexose monophosphate shunt.
CO3	Students will learn basic knowledge about Amino Acids,lipids,proteins, Enzyme regulation: Allosteric enzyme regulation, Covenant modification.

Credit:04

Unit	Topic	Content	Hrs.	Weightage
1		**Basics of Biochemistry**	15	25%
	1.1	Chemical bonds and Stabilizing interactions: Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction		
	1.2	Water**:** weak interactions in aqueous systems, ionization of water, weak acids, and weak bases.		
	1.3	pH and buffer: pH and buffer and Buffering against pH changes in biological systems.		
	1.4	Energy flow: principles of thermodynamics, free energy and chemical potential, redox reactions, structure and function of ATP.		
2		**Biomolecules part- 1**	15	25%
	2.1	Carbohydrates: Classification, Occurrence, Structure, properties and functions of Monosaccharides (Triose, Pentose and Hexose), Disaccharides and Polysaccharides (Starch, glycogen and Cellulose).		
	2.2	Carbohydrate metabolism: Glycolysis, Glycogenesis, TCA cycle, Electrone transport system, Oxidative		

		phosphorylation and photophosphorylation, Hexose monophosphate shunt.		
	2.3	Lipids: Classification of Lipids, Occurrence, Structure, properties and Function of Simple lipids (Triglycerides and Waxes) and Complex lipids (Phospholipids and Sphingolipids).		
	2.4	Lipid metabolism: Biosynthesis of fatty acids and Phospholipids, Catabolism of fatty acids and β-Oxidation of fatty acids.		
3		**Biomolecules part- 2**	**15**	**25%**
	3.1	Amino Acids: Structure, Properties, and Classification of Amino Acids.		
	3.2	Amino acid metabolism: Biosynthesis and break down of amino acids, transamination and deamination.		
	3.3	Protein: Classification of Proteins, properties, Function and Conformation of Proteins (primary, secondary, tertiary and quartenary structure), Ramachandran Plot, protein domains and folds, Protein denaturation and stability.		
	3.4	Interrealtionship between metabolisim of Carbohydrate, Lipid and Protein.		
4		**Enzymes and Vitamins**	**15**	**25%**
	4.1	Enzymes: An introduction to Enzymes, Nomenclatur Classification of Enzymes. Properties of enzymes, Ap enzymes, coenzymes, cofactors and prosthetic groups.		
	4.2	Mechanisms of enzyme action, Kinetics of an enzyme-catalyzed reaction and inhibition.		
	4.3	Enzyme regulation: Allosteric enzyme regulation, Covenant modification.		
	4.4	Vitamins: Occurrence, Classification, Structure and function of various Vitamins and their deficiency diseases.		

Reference Books:

1. Harper H. A. 1993 Review of Physiological Chemistry (Lange Publications).
2. Lehninger A. l., Nelson D. L. and Cox M.M. 1993. Principles of Biochemistry (CBC Publishers).
3. Rastogi S. C. 2003 Biochemistry (Tata Mc GrawHill Publishing Co. Ltd.).

Online Resources:

- **www.shomusbiology.com**
- **https://www.slideshare.net**

Practical / Activities:

1. Estimation of reducing and non-reducing sugars from given sample
2. Estimation of total carbohydrates from given sample
3. To estimate total protein content from given sample
4. Colorimetric quantification of amino acids by Ninhydrin method

5. 5. Estimation of total lipid content from given samples
6. 6. Enzymatic assay of Catalase, peroxidase etc.

MMIC205UPRA- PRACTICAL MODULE-I

CREDIT: 03

PRACTICAL

Biochemistry

1. Estimation of reducing and non-reducing sugars from given sample
2. Estimation of total carbohydrates from given sample
3. To estimate total protein content from given sample
   a. Folin-lawry method
   b. Bradford method
   c. UV spectrometric method
4. Colorimetric quantification of amino acids by Ninhydrin method
5. Estimation of total lipid content from given samples
6. Enzymatic assay of Catalase, peroxidase etc.

Instrumentation and analytical Techniques

7. Agarose gel electrophoresis
8. Preparation of native and SDS-PAGE
9. Thin Layer chromatography
10. Paper chromatography
11. Principle and application of Instruments available in your department

MMIC206UPRA- PRACTICAL MODULE-II

CREDIT:03

PRACTICAL

Biostatistics

1 Computation of different measures of central tendency
   a. Arithmetic Mean
   b. Harmonic Mean
   c. Geometric Mean
   d. Median
   e. Mode
2 Computation of various measures of dispersion
   a. Range and Co efficient of Range
   b. Mean Deviation
   c. Standard Deviation
3 Estimating standard error and coefficient of variation
4 Estimating confidence intervals for population mean
5 To perform Student's t test:
   a. Paired t test
   b. Unpaired t test
6 To perform single factor Analysis of Variance (ANOVA) or F test
7 To study and perform regression analysis and prediction of future events
8 To study and perform correlation analysis
9 To perform Chi Square test of goodness of fit
10 To perform different non-parametric test:
   a) Sign test
   b) Rank test
   c) F max test
   d) U test

Research Methodology

1 Defining Goal, Objectives, Stakeholders and parameters of research
2 Risk identification and analysis
3 Scientific writing practice –I (Log frame and Review writing)

4 Scientific writing practice –II (Citation)

5 Scientific reference management

CO-PO & CO-PSO Mapping

Course Outcomes	Program Outcomes 1: Less relevant, 2: Mild relevant, 3: Highly relevant											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	2	-	1	-	2	2	-	-	2	-	2	1
CO2	3	-	2	-	1	-	-	-	2	2	2	1
CO3	3	-	1	-	1	-	-	-	2	2	2	1

Subject Code: MMIC202DSC **Semester: II**

Subject Name: Instrumentation and analytical techniques

Teaching Examination Scheme:

Teaching (Hours/week)			Examination Scheme			
Lecture	Tutorial	Practical	Internal		External	Total
			Mid	CE		
04	0	01	20	10	70	100

Course Objective:

- This course aims at analysing different process variables as well as composition of a substance.
- This course is designed to give the student an understanding in the operation and care of instruments used in the chemical laboratories of industry. chemical laboratory

Course Outcomes: At the end of the course, students shall be able to

CO1	Explain the basic principles of analyses and detection systems involved in photometric-fluorometric- and luminescence -based methods.
CO2	Explain principles of electrophoresis and immunochemical techniques and discuss how these techniques can be used in molecular medicine.
CO3	Discuss the use of enzyme kinetics in analytical methods.

Content

CREDIT: 04

Unit	Description in detail	Credit	Weightage
I	**Introduction: Laboratory Instruments** 1.1 Principle and working of pH meter, Laminar-air flow. 1.2 Centrifugation: Types of centrifuge machines, preparative and analytical centrifuges, differential centrifugation, sedimentation velocity, sedimentation equilibrium, density gradient methods and their applications.	1	25%
II	**Chromatographic techniques** 2.1 Principle and applications of Native-PAGE, SDS-PAGE, Agarose and 2D gel Electrophoresis. Capillary electrophoresis and its applications. 2.2 Principle, methodology and applications of gel – filtration, ion –exchange and affinity Chromatography; Thin layer and High Performance Thin Layer Chromatography (HPTLC). 2.3 Gas chromatography, High performance liquid chromatography (HPLC) and FPLC.	1	25%
III	**Techniques of Spectroscopy and microscopy** 3.1 Spectroscopy Technique: Principle and application of UV-	1	25%

	visible spectrometer, AAS and Plasma Emission Spectroscopy. 3.2 Mass Spectroscopy: Principle of MALDI, Types of Detectors. 3.3 Microscopic Techniques: Principle and applications of Light, Phase contrast and Fluorescence Microscopy, Principle and applications of SEM and TEM.		
IV	**Immunological Techniques** 4.1 Antibody generation, detection of molecules using ELISA, RIA, Western blot, immunoprecipitation, Immunofluorescence microscopy, detection of molecules in living cells- in-situ localization by FISH. 4.2 Principle and applications of Flow cytometry. 4.3 Radiolabeling techniques: Properties of different types of radioisotopes used in Biology, their detection and measurement, Autoradiography	1	25%

Reference Books:

1. Wilson, K. and Walker, J., (2010). Principles and Techniques of Biochemistry and Molecular Biology, 7th edition, Cambrige University Press (Low price edition), New York.
2. Webster J. G., (2009). Bioinstrumentation, Student edition, Wiley India (P) Ltd. New Delhi.
3. Sharma, B. K., (2005). Instrumental methods of chemical analysis, 24th edition, GOEL publishing house, Meerut

Suggested Readings:

- Quantitative Chemical *Analysis* by Daniel C.
- Instrumental *Methods* of *Analysis* by Hobart Hurd Willard.
- Chemical *Instrumentation* (Oxford Chemistry Primers)

Online Resources:

- www.shomusbiology.com
- https://www.slideshare.net

Practical / Activities:

1. Spectrophotometer studying
2. Chromatography methods
3. Gas analyzers
4. Dissolved component Analyzer
5. NMR Spectrometer detection

CO-PO & CO-PSO Mapping

Course Outcomes	Program Outcomes 1: Less relevant, 2: Mild relevant, 3: Highly relevant											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	2	2	1	-	1	2	2	-	2	-	2	2
CO2	3	2	1	-	1	2	2	-	2	1	2	2
CO3	2	-	1	-	1	-	-	-	2	2	2	2

Subject Code: MMIC203DSC **Semester: II**

Subject Name: Biostatistics and Research Methodology

Teaching Examination Scheme:

Teaching (Hours/week)			Examination Scheme			
Lecture	Tutorial	Practical	Internal		External	Total
			Mid	CE		
04	0	01	20	10	70	100

Course Objective:

(a) Students will be able to understand basic theoretical and applied principles of statistics needed to enter the job force.
(b) Students will be able to communicate key statistical concepts to non statisticians.
(c) It is a large and ever changing discipline.
(d) Students will gain proficiency in using statistical software for data analysis

Course Outcomes: At the end of the course, students shall be able to

CO1	Describe concepts of descriptive, inferential, parametric, non parametric, tests in biostatistics.
CO2	Describe concepts of categorical data analysis, association, prediction, reliability and validity in biostatistics.
CO3	Choose statistical analysis of data based on types of variables and objective of analysis using SPSS and interpret their outcomes.

CREDIT:04

Unit	Description in detail	Credit	Weightage
I	**Statistics: Parametric** 1.1 Definition and scope, Organizing a statistical survey and presentation of statistically analysed information. 1.2 Basic statistical methods: Measures of central tendency, dispersion and standard error; Probability distributions: binomial, poisson and normal distribution. 1.3 Statistical significance: Hypothesis testing, types of error, level of significance, Student's t test, F test and Chi square goodness of fit. 1.4 Simple linear regression and correlation analysis.	1	25%
II	**Statistics: Non parametric** 2.1 Comparing Parametric and Non parametric statistics, Rank test, F-max test, Mann–Whitney (U) test, and Sign test. 2.2 Applications of non parametric statistics in biological research. 2.3 Basic computing: MS Office ®, Internet. 2.4 Data base management, Use of computers in statistical analysis.	1	25%

III	**Research methodology** 3.1 Characteristics and types of scientific research. 3.2 Basics of research methodology. 3.3 Research and Experimental design. 3.4 Method of Data collection.	1	25%
IV	**Scientific communications** 4.1 Scientific Deliveries and Communications: Writing Research proposal, Paper, Thesis, Report and Citations. 4.2 Citations, H-Index, I10-Index, Impact factor and selection criteria of scientific journals for research publications. 4.3 Presenting scientific research: Power point presentations, Posters, Flyers, etc. 4.4 Publication processes, Review Processes and Significance of scientific communications.	1	25%

Reference Books:

1. Milton, J.S 1992 Statistical Methods in Biological and Health Science. McGraw-Hill Inc, New York.
2. Schefler, W.C. 1963 Statistics for biological sciences. Addition - Wesely Publication Co.,London.
3. Snedecor, G. Wand Cocham, W. G. 1967 Statistical Methods. Oxford Publication Co., NewDelhi.
4. Spiegel, M.R. 1981 Theory and problems of statistics, Schaum's Outline Series McGraw -HillInternational Book Co., Singapore.
5. Day R.A. 7th Edition. How to write and publish a scientific paper

Suggested Readings:

1. Research methodology (methods and techniques) 3rd edition by C.R. Kothari and GauravGarg
2. Introduction to biostatistics and Research methods 5th edition by Sunder Rao and J.Richard
3. Basics of Biostatistics 2nd edition by A.P. Kulkarni

Online Resources:

1. **https://www.khanacademy.org**
2. **https://www.onlinecourses.swayam2.ac.in.**
3. **www.shomusbiology.com**
4. **https://www.slideshare.net**

Practical / Activities:

1. Statistical analysis of data, S.D., significance test of the results obtained in eachexperiments
2. Hypothesis testing of statistical test

CO-PO & CO-PSO Mapping

Course Outcomes	Program Outcomes 1: Less relevant, 2: Mild relevant, 3: Highly relevant											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	2	2	2	-	2	-	-	-	2	2	1	2
CO2	2	2	1	-	1	2	1	-	2	2	1	2
CO3	2	2	1	-	1	-	-	-	2	1	1	1

Subject Code: MMIC204DSC **Semester: II**
Subject Name: Bioprocess and Biochemical Engineering

Teaching Examination Scheme:

Teaching (Hours/week)			Examination Scheme			
Lecture	Tutorial	Practical	Internal		External	Total
			Mid	CE		
04	0	01	20	10	70	100

Course Objective:

(a) This course aims to provide the students with an understanding of the role that microorganismsand/or enzymes could play in a variety of bioprocesses and the industrial applications of such processes.
(b) To provide general understanding of the basic concepts of microbiology, biochemistry, andgenetics.
(c) To apply chemical engineering principles to bioreactor design, downstream processing,bioprocess optimization and control.

Course Outcomes: At the end of the course, students shall be able to

CO1	Describe the growth of microorganisms.
CO2	Determine the reaction stoichiometry for bioreactors and understand the operation of bioreactors.
CO3	Recognize principles of bioreactor analysis and design.
CO4	Understands the microbial and enzyme reactions in upstream bioprocessing and be able to calculate reaction rates and apply reaction kinetics to biological system.

Content

CREDIT: 04

Unit	Description in detail	Credit	Weightage
I	**Introduction to bioprocess technology** 1.1 Isolation, primary and secondary screening, preservation, maintenance and improvement of industrially important organisms. 1.2 Raw materials for fermentation processes. 1.3 Medium optimization.	1	25%
II	**Bioreactor** 2.1 Bioreactor design: Laboratory, pilot and large scale reactors. Mechanical, pneumatic and hydrodynamic systems. Plug flow reactor. 2.2 Media sterilization. Scale up and Scale down and containment. 2.3 Mass transfer of oxygen: Agitation and aeration, Determination of KLa, Factor affecting KLa. Inoculum development, aseptic inoculation and sampling.	1	25%

III	**Bioprocess kinetics** 3.1 Bioprocess kinetics: Kinetics of growth and substrate utilization in batch, fed batch and continuous systems. 3.2 Process parameter control: Instrumentation for monitoring bioreactor and fermentation processes. 3.3 Sensors, Controllers, fermentation control systems and architecture, Incubation and sequence control, advanced control.	1	25%
IV	**Downstream processing** 4.1 Bioseparation: filtration, centrifugation, sedimentation, flocculation, cell disruption, liquid-liquid extraction. 4.2 Purification by chromatographic techniques, reverse osmosis and ultrafiltration, drying, crystallization, storage and packaging. 4.3 Economics in Fermentation technology.	1	25%

Reference Books:

1. Principles of Fermentation Technology By P F Stanbury Dr. A Whitaker
2. Principles of Fermentation Technology : Whitekar & Stanbury
3. Comprehensive Biotechnology : Murray Moo Young
4. Methods in Industrial Microbiology : Sikyta
5. Fermentation Microbiology and Biotechnology, El Mansi and Bryc
6. Stanbury P.F., Whitaker A., Hall S.J.,(1997) Principles of fermentation technology. 2nd ED, Aditya books(P) Ltd, New Delhi.
7. Okafor N. (2007) Modern industrial microbiology and biotechnology, Science publishers, USA.
8. Doran P.M. (2008) Bioprocess engineering principles, Academic press, California.

Suggested Readings:

1. Principles and applications of Fermentation Technology by A. Kuila, V. Sharma
2. Bioprocess Engineering basic concepts by Shuler
3. Biotechnology and Bioprocess engineering by Dr. C.M. Narayan
4. Bioprocesses and Engineering volume 40 by Springer

Online Resources:

1. **https://www.onlinecourses.swayam2.ac.in.**
2. **https://www.researchgate.net**
3. **www.shomusbiology.com**
4. **https://www.slideshare.net**

CO-PO & CO-PSO Mapping

Course Outcomes	Program Outcomes 1: Less relevant, 2: Mild relevant, 3: Highly relevant											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	-	-	-	1	-	-	-	2	2	3	1
CO2	2	2	1	-	1	2	1	-	2	1	1	1
CO3	2	2	1	-	1	2	2	-	2	-	1	2
CO4	3	-	1	-	1	-	-	-	2	-	1	1

Subject Code: MMIC201SE **Semester: II**

Subject Name: Bioinformatics part 2

Teaching Examination Scheme:

Teaching (Hours/week)			Examination Scheme			
Lecture	Tutorial	Practical	Internal		External	Total
			Mid	CE		
02	0	00	10	05	35	50

Course Objective:

- The primary goal of bioinformatics is to increase the understanding of biological processes.
- What sets it apart from other approaches, however, is its focus on developing and applying computationally intensive techniques to achieve this goal.

Course Outcomes: At the end of the course, students shall be able to

CO1	The program aims to utilize and understand biological databases to gather, store, retrieve, manage, analyze and integrate biological data for generating new knowledge.
CO2	The program aims to impart extensive understanding and learning of theoretical concepts in life sciences. Each semester exclusively devotes at least one core in life sciences in each semester.
CO3	Basic practical methodology is incorporated as practical sessions in laboratory courses in each semester.

Content

CREDIT: 02

Unit	Description in detail	Credit	Weightage
I	**Biological Database** 1.1 Bioinformatics Fundamentals, Biological Database and database design, Nucleotide sequence database: EMBL, gene bank, DDBJ. 1.2 Protein Database: Protein sequence database: PIR, Swiss-Prot, Structure database: PDB, MMDB. 1.3 Classification database: CATH, SCOPE , Sequence-based Database Searches: BLAST, PSI-BLAST, RPS-BLAST	1	50%
II	**Sequence analysis, Application of Bioinformatics** 2.1 Sequence analysis: Concept of sequence similarity, identity and homology, global and local alignment, scoring matrix, BLAST, FASTA. 2.2 Multiple sequence alignments (MSA): The need for MSA, Basic concepts of various approaches for MSA (e. g. progressive, hierarchical etc.), Introduction to CLUSTALW and PileUp. Concept of dandogram and its interpretation. 2.3 Application of Bioinformatics: Gene finding, PCR primer designing, microbial identification, comparative genomics, secondary and tertiary protein structure prediction.	1	50%

Reference Books:

1. Bioinformatics 1998. Baxevanis
2. Bioinformatics 2000. Higgins & Taylor. OUR
3. Nucleic Acids Research. 2001. Jan. Genome Database issue
4. Twyman R. (2008). Principles of Proteomics. Taylor & Francis Publisher, Oxon.
5. Primrose S. and Twyman R. (2006). Principles of Gene Manipulation & Genomics, 7th edition. Black well Publishing, Malden. ApplicationsOUP India
6. Xiong, J., (2009).Essential Bioinformatics, Cambridge University press.

Suggested Readings:

- Artificial Importance of Bioinformatics
- Computation in Bioinformatics

Online Resources:

- **www.shomusbiology.com**
- **https://www.slideshare.net**

Practical / Activities:

- Drug Discovery.
- Preventive Medicine.
- Biofuels.
- Plant Modelling.
- Gene Therapy.

CO-PO & CO-PSO Mapping

Course Outcomes	Program Outcomes 1: Less relevant, 2: Mild relevant, 3: Highly relevant											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	2	2	2	-	1	-	1	-	2	2	1	1
CO2	2	-	1	-	1	-	-	-	2	1	1	1
CO3	2	2	1	-	1	2	1	-	2	-	1	1

Subject Code: MMIC301DSC **Semester: III**

Subject Name: Bacteriology and Virology

Teaching Examination Scheme:

Teaching (Hours/week)			Examination Scheme			
Lecture	Tutorial	Practical	Internal		External	Total
			Mid	CE		
03	0	01	20	10	70	100

Course Objective:

- The study of microbes helps us to understand our world and our place within it.
- It gives us insights into the complexity of nature and society, which in turn provide many different healths, environmental, social, cultural, industrial and economic benefits.

Course Outcomes: At the end of the course, students shall be able to

CO1	Students will gain knowledge about the different cell organelles of microorganisms and their detailed functions.
CO2	Students will also study the growth and control of microbes as well as different bacteriological techniques involved in microbiology.
CO3	Students will learn about the biomolecules by studying their structures and types

CREDIT: 04

Unit	Topic	Content	Hrs.	Weightage
1		**General characteristics of Bacteria**	15	25%
	1.1	Occurrence, shape and arrangement of bacterial cells, structure of bacterial cell – cell wall (Gram positive or Gram negative, archaebacteria), capsule, plasma membrane, cytoplasm, ribosome, nucleoid,mesosomes, plasmids, flagella, pili (fimbriae), inclusion bodies, multiplication by cell division and endospore formation.		
	1.2	Characteristics of major groups of bacteria,Archaebacteria – general characteristics and classification; Eubacteria, Actinomycetes – general, characteristics and classification, diversity and distribution, economic importance.		
	1.3	Cyanobacteria – general characteristics and classification – ultra- structure, reproduction and economic importance. Mycoplasma, Rickettsia, Chlamydia, Photosynthetic bacteria and bioluminescent bacteria.		
2		**Bacteriological Techniques**	15	25%
	2.1	**Isolation and sampling techniques:** General isolation and sampling techniques for microorganisms from different sources.		

	2.2	*Microbial culture preservation*: Concept, types ofmicrobial culture preservation, type culture collections. Advantages and limitations of culture preservation techniques.		
3		**General method of diagnosis of Viruses**	**15**	**25%**
	3.1	Cultivation of viruses. Cell cultures- Primary and secondary cell culture, Suspension cell cultures, Monolayer cell cultures, Cell strain, cell line and transgenic system. Radioimmunoassay.		
	3.2	Serological methods: heamagglutination and HAI: Complement fixation, immunofluroscence method, ELISA .		
	3.3	Assays for viruses: Physical and chemical methods (Protein, nucleic acid, readioactivity tracers, electron microscopy)- Infectivity assay (plaque method, end point method), Infectivity assay of plant viruses.		
4		**Animal viruses and Plant viruses**	**15**	**25%**
	4.1	Epidemiology, Lifecycle, pathogenicity, Diagnosis and prevention of DNA and RNA viruses – classification of RNA viruses and DNA viruses.		
	4.2	viral vaccines: Conventional vaccine, genetic recombinant vaccine, newer generation vaccines, interferons and antiviral drugs. Drug discovery, clinical trials for newer viral epidemic.		
	4.3	Effect of viruses on plants: Appearance of plant, histology, cytology and physiology of plant. Common virus disease of plants: Paddy, cotton, tomato, sugarcane and other plants, Transmission of plant viruses with vector and without vectors. Diagnostic techniques of plant viruses. Prevention of crop loss due to viruses.		

Reference Books

1. J. Salle, Fundamental principle of Bacteriology
2. Pelczar M. J., Chan ECS, Kreig NR., Microbiology
3. Topley and Wilson: Text book on Principles of Bacteriology, virology and Immunology
4. Methews: Functionals of Plant virology
5. Lennetter EH: Diagnostic procesdure for viral and Reckettsial diseases

Suggested Readings:

1. Tortora GJ, Funke BR and Case CL.
2. Microbiology: An Introduction. Pearson Education
3. Madigan MT, Martinko JM, Dunlap PV and Clark DP. Brock Biology of Microorganisms. Pearson International Edition
4. Wiley JM, Sherwood LM and Woolverton CJ. Prescott's Microbiology. McGrawHill International
5. Atlas RM. Principles of Microbiology. WM.T.Brown Publishers.
6. Pelczar MJ, Chan ECS and Krieg NR. Microbiology. McGraw Hill Book Company.
7. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. General Microbiology. McMillan

8. Cappucino J and Sherman N. Microbiology: A Laboratory Manual. Pearson Education Limited
9. Salle A.J. Fundamental Principles of Bacteriology. Tata McGraw-Hill Education
10. Modi H.A, Elementary Microbiology Vol I, Fundamentals of Microbiology

Online Resources:

4. **www.shomusbiology.com**
5. **https://www.slideshare.net**

Practical / Activities:

1. Preparation of stained smears
2. Culturing of micro-organisms
3. Conducting immunology experiments
4. Performing tests to identify bacteria
5. Studying microbial growth control methods

MMIC305UPRA- PRACTICAL MODULE-I

CREDIT: 03

PRACTICAL

301: Bacteriology and Virology

1. Characterizing special group of microorganisms – actinomycetes, cyanobacteria, archaebacteria, bioluminescent bacteria.
2. Culture preservation techniques.
3. Lytic cycle of bacteriophage
   - One step growth curve
   - Brust (Titer) size
4. Tobacco mosaic virus (TMV)

302: Genetics of bacteria and virus

5. Transformation
6. Conjugation
7. Spontaneous mutation
8. Lac operon
9. Plasmid isolation

MMIC306UPRA- PRACTICAL MODULE-II

CREDIT: 03

PRACTICAL

303: Microbial physiology and development

1. Effect of pH, Temperature, carbon source, nitrogen source on growth curve.
2. Diauxic growth.
3. Estimation of photosynthetic pigments – Chlorophyll, Carotenoid, Xanthophyll.
4. Isolation and characterization of nitrogen fixing microorganisms. –Symbiotic bacteria, Non-symbiotic bacteria, Frankia.
5. Fermentative production of solvent – Ethanol, Acetone, Butanol.
6. Production and recovery of extracellular polysaccharide (EPS)

304: Immunology

1. Estimation of Hemoglobin (Hb)
2. WBC count.
3. RBC count.
4. Differential count of leukocyte.
5. Estimation of blood grouping.
6. Bleeding time.
7. Clotting time.
8. Estimation of Erythrocyte sedimentation rate (ESR)
9. Cross matching (compatibility testing).

CO-PO & CO-PSO Mapping

Course Outcomes	Program Outcomes 1: Less relevant, 2: Mild relevant, 3: Highly relevant											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	-	2	-	1	1	-	-	2	2	3	-
CO2	2	2	1	-	-	2	2	-	2	1	2	1
CO3	2	1	1	-	-	2	1	-	2	-	2	1

Subject Code: MMIC302DSC **Semester: III**
Subject Name: Genetics of bacteria and virus

Teaching Examination Scheme:

Teaching (Hours/week)			Examination Scheme			
Lecture	Tutorial	Practical	Internal		External	Total
			Mid	CE		
04	00	01	20	10	70	100

Course Objective:

- Microbial genetics and Virus is also important for understanding molecular techniques used to modify genes and proteins, manipulate bacteria, archaea, and eukaryotic organisms for fundamental research as well as practical applications in diverse areas of medicine and biotechnology.

Course Outcomes: At the end of the course, students shall be able to

CO1	To know Gene cloning and Gene cloning vehicles.
CO2	To know what are Restriction Enzymes and their applications in the field of Genetic Engineering.

Content

CREDIT: 04

Unit	Description in detail	Credit	Weightage
I	**Gene transfer mechanism** 1.1 Gene transfer mechanisms- Bacterial transformation (detection of transformation, development of competence, mechanism of transformation, transfection), conjugation-effective contact and pilli in 1.2 Conjugation, F-factor, the conjugal transfer process. high frequency recombination (Hfr) strains, the order of chromosome transfer, formation of F prime (F'). 1.3 transduction – generalized transduction; abortive transduction; specialized transduction, Sex duction.	1	25%
II	**Genetic recombination** 2.1 Genetic recombination – Mechanism of recombination. General recombination (Holiday model) 2.2 Genetic recombination – Mechanism of recombination. General recombination (Holiday model) 2.3 Genetic recombination – Mechanism of recombination. General recombination (Holiday model)	1	25%

III	**Genetics of bacteriophage** 3.1 Genetics of Bacteriophages – F – factors and their uses in genetic analysis, Col plasmid and colicins 3.2 cryptic plasmids, penicillinase plasmid, heavy metal resistance plasmids, degradative plasmids, Ti- plasmids and Ri-plasmids. 3.3 bacteriophages – lytic phages(T4, T7), lysogenic phages (phage λ, ΦX 174).	1	25%
IV	**Operon concept** 4.1 Operon concept, negative and positive regulation, catabolite repression. 4.2 Regulation of lac Operon, trp-Operon, arabinose Operon. 4.3 Divergent Operon, attenuator regulation, translational regulation, feedback inhibition.	1	25%

Reference Books:

1. Dorman CJ: The genetics of bacterial virulence. Blackwell Scientific Press, Oxford, England, 1994 .
2. Drlica K, Riley M (eds): The bacterial chromosome. American Society for Microbiology, Washington, DC, 1990 .
3. Harwood AJ (ed): Protocols for gene analysis. Methods in Molecular Biology vol. 31. Human Press, NJ, 1993 .
4. Holloway BW. Genetics for all bacteria. Annu Rev Microbiol. 1993;47:659. [PubMed]

Suggested Readings:

- Microbial genetics by Freifelder
- Gene Cloning by T A Brown.
- Principles of gene manipulation by Old and Primerose,
- Genes IX Lewin.

Online Resources:

- **www.shomusbiology.com**
- **https://www.slideshare.net**

Practical / Activities:

1. Replica Plate method for bacteria and viruses.
2. Gradient Plate Method for bacteria and viruses.

CO-PO & CO-PSO Mapping

Course Outcomes	Program Outcomes 1: Less relevant, 2: Mild relevant, 3: Highly relevant											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	2	2	1	1	1	1	-	-	2	2	2	1
CO2	2	2	1	2	1	2	-	-	2	-	1	2

Subject Code: MMIC303DSC **Semester: III**

Subject Name: Microbial Physiology and Development

Teaching Examination Scheme:

Teaching (Hours/week)			Examination Scheme			
Lecture	Tutorial	Practical	Internal		External	Total
			Mid	CE		
04	0	01	20	10	70	100

Course Objective:

(a) This course is designed for students of applied microbiology to cover the basic aspects of microbial physiology. To explain prokaryotic and eukaryotic structure and composition as well as the means by which nutrients are transported into cells across membranes.
(b) Student will learn the important metabolic processes that occur in microorganisms under different environmental conditions.
(c) Student will learn Kinetics of the energy and biochemistry of nitrogen fixation and the regulation of metabolism through control of gene expression and enzyme activity.

Course Outcomes: At the end of the course, students shall be able to

CO1	Define basic concept of microbial physiology.
CO2	Explain microbial growth, growth kinetics and factors affecting growth.
CO3	Evaluate the importance of central pathways off carbohydrate metabolism for microbial physiology
CO4	Explain nutrient uptake and protein excretion.
CO5	Explain the mechanism of nitrogen fixation and its regulation.

Content

CREDIT: 04

Unit	Description in detail	Credit	Weightage
I	**Microbial growth** 1.1 Definition of growth, balanced and unbalanced growth, growth curve, the mathematics of growth generation time, specific growth rate, batch and continuous culture. 1.2 Temperature: temperature ranges for microbial growth. Synchronous growth, diauxie growth curve. Measurement of cell numbers, cell mass and metabolic activity., classification based on temperature ranges and adaptations. 1.3 pH-classification based on pH ranges and adaptations, solutes and water activity, oxygen concentration, radiation and pressure.	1	25%

II	**Microbial diffusion** 2.1 Diffusion – Passive and facilitated, Primary active and secondary active transport, Group translocation (phosphotransferase system), symport, antiport and uniport, electrogenic and electro neutral transport, transport of Iron. Chemolithotrophic metabolism Carbondioxide fixation: Calvin cycle and reductive, TCA cycle. 2.2 Physiological groups of aerobic and anaerobic chemolithotrophs. Hydrogen oxidizing bacteria and methanogens. Phototrophic metabolism- Historical account of photosynthesis, diversity of phototrophic bacteria, anoxygenic and oxygenic photosynthesis. Photosynthetic pigments: action and absorption spectrum, type, structure and location. 2.3 physiology of bacterial photosynthesis: light reactions, cyclic and non-cyclic photophosphorylation.	1	25%
III	**Microbial nitrogen fixation** 3.1 Nitrogen Fixation – Physiology of nitrogen cycle. Assimilatory and dissimilatory nitrate reduction, biological nitrogen fixation. 3.2 Nitrogen fixers and mechanism of nitrogen fixation. Genetics of nitrogen fixation and regulation of nitrogenase activity and synthesis. 3.3 Alternate nitrogenase. denitrification, nitrate/nitrite respiration. Properties of nitrogenase, and ammonia assimilation	1	25%
IV	**Microbial development** 4.1 Mitochondrial and bacterial electron transport. Oxidation-reduction potential and energetic of electron transport. Fermentations: alcohol fermentation, Pasteur effect, lactate and butyrate fermentation. 4.2 Fermentation balances, branched versus linear fermentation pathways. Components of respiratory chain, and their inhibitors. Synthesis of polysaccharides – peptidoglycan- biopolymers as cell components. 4.3 Microbial development- sporulations and morphogenesis - Endospore – structure – properties –germination. Hyphae vs yeast forms and their significance.	1	25%

Reference Books:

1. Gallon JR and Chaplin AE. (1987). An Introduction to Nitrogen Fixation. Cassell Education Ltd.
2. Moat AG and Foster JW. (2002). Microbial Physiology. John Wiley and Sons
3. Caldwell DR. Microbial physiology and Metabolism. Brown publishers
4. Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag.
5. Lehninger A. (1982). Biochemistry. Worth Publ.

Suggested Readings:

1. Biochemistry 6th edition by U. Satyanarayan and U. Chakrapani
2. Biochemistry 9th edition by Jeremy M. Berg, John L. Tymoczko, Gregory J. Gatto Jr., Lubert Stryer
3. Bacterial Physiology and Metabolism by John R. Sokatch
4. Microbial Physiology 2nd Edition by S. Ram Reddy and S. M. Reddy

Online Resources:

1. **https://www.classcentral.com**
2. **https://npatel.ac.in.**
3. **www.shomusbiology.com**
4. **https://www.slideshare.net**

Practical / Activities:

1. Microbial diversity study : morphological and metabolic characterization.
2. Fermentative production of Glutamic acid.
3. Fermentative production of Protease.

CO-PO & CO-PSO Mapping

Course Outcomes	Program Outcomes 1: Less relevant, 2: Mild relevant, 3: Highly relevant											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	2	-	2	-	1	-	-	-	2	-	2	-
CO2	2	1	1	-	1	-	-	-	2	1	1	1
CO3	2	-	1	-	1	2	-	-	2	1	2	-
CO4	2	-	1	-	1	-	1	-	2	1	2	-
CO5	2	-	1	-	1	-	1	-	1	1	2	1

Subject Code: MMIC304DSC **Semester: III**

Subject Name: Immunology

Teaching Examination Scheme:

Teaching (Hours/week)			Examination Scheme			
Lecture	Tutorial	Practical	Internal		External	Total
			Mid	CE		
04	00	01	20	10	70	100

Course Objective:

- The students will be able to identify the cellular and molecular basis of immune responsiveness.
- The students will be able to describe the roles of the immune system in both maintaining health and contributing to disease.

Course Outcomes: At the end of the course, students shall be able to

CO1	Will be able to explain the immunological terms.
CO2	Defines the concept of immunology.
CO3	Interpret the concept of immunogen.
CO4	Discuss the concepts of antigen and antibody.
CO5	Interpret the organs of the immune system

Content

CREDIT: 04

Unit	Description in detail	Credit	Weightage
I	**Principles of medical microbiology** 1.1 Principles of Medical Microbiology: Classification of medically important microorganisms. 1.2 Normal microbial flora of human body. 1.3 Origin of normal flora; normal flora and human host.	1	25%
II	**Microbial infection** 2.1 Infection: Sources of infection for man; vehicles or reservoirs of infection. Exogenous Infection: 1. Patients; 2. carriers - (Healthy; convalescent; contact; paradoxical and chronic); 3. Infected animals (zoonosis); 4. Soil endogenous infection. 2.2 Mode of spread of infection: 1. Respiratory, 2.skin, 3. wound and burn infection, 4.Venereal infections, 5. Alimentary tract infection; 6. Arthorpod - borne blood infections 2.3 Laboratory infections. Pathogenesis: Microbial Pathogenicity: Transmissibility, Infectivity and Virulence. Opportunistic pathogens; True pathogens. Toxigenicity; Invasiveness, Other aggressins (Hyaluronidase), coagulase, Fibrinolysins or kinase; depolymerizing enzymes (mucinase, lipases, proteases, nucleases, collagenase, neuraminidase. Organofropism, variation and virulence	1	25%

III	**Immune system** 3.1 Immune system: Organs and cells involved in immune system and Immune response Lymphocytes their subpopulation, their properties and functions, Membrane bound receptors of lymphcells, HelperT cells in Immune response, Tcell suppression in Immune response; Antigens: types of antigens – antigens specificity - haptens. 3.2 Natural or Innate Immunity: Determinants of innate immunity; species and strains; individual differences; influence of age, hormonal influence, nutritional factors, mechanical barriers and surface secretions. 3.3 Non specific Immune mechanisms; surface defences, Tissue defences; Opsonization; Inflammatory reactions; hormone balance; Tissue metabolites with bacterial properties (Lysozymes,Nucleins, Histones, Protamines, Basic peptides of tissues - Leukins, phagocytins; Lecterin; Heme compounds) Interferon, properdin and complement.	1	25%
IV	**Immune response** 4.1 The Immune Response: Humoral, cellular, actively acquired, passively acquired Cellular Interaction in the induction of antibody formation - cellular interactions in the induction of immune T cells - Lymphoid cell interactions, in vivo – immune memory - control of antibody production 4.2 Theories of antigen recognition; types of immunity; immune tolerance and auto immunity; cytokines; form, dose and route of entry of antigen. 4.3 Defects in Immunoglobulin synthesis and cell mediated immunity: Primary defects; Secondary defects, Defective phagocyte mechanisms; Immuno suppression - specific; nonspecific.	1	25%

Reference Books:

- Barrett, J.T. "Textbook of Immunology (1983); An Introduction to Immunochemistry and Immunology".
- Mosby, Missouri. 2. Boyd, R.F., "General Microbiology", (1984): Times Mirror/Mosby (college publishing, St.Louis). 3. Broude A.I. (1981)
- Medical "Microbiology": and Infectious Diseases W.B. Saunders & Co.Philadelphia
- Chapel and Haeney, "Essentials of Clinical Immunology: (1984): Blackwell Scientific publication.

Suggested Readings:

- An Inquiry Into the Causes and Effects of the Variolae Vaccinae. by Edward Jenner.
- Microbe Hunters by Paul de Kruif.
- The Beautiful Cure: The New Science of Human Health. by Daniel M Davis.

Online Resources:

- www.shomusbiology.com
- https://www.slideshare.net

Practical / Activities:

- Isolation and structure of immunoglobulin's.
- Monoclonal antibodies.
- Production, purification and enzymatic fragmentation.
- Antibody interactions with antigens.
- Antibodies as probes.

CO-PO & CO-PSO Mapping

Course Outcomes	Program Outcomes 1: Less relevant, 2: Mild relevant, 3: Highly relevant											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	1	1	-	1	-	-	-	2	-	2	-
CO2	2	-	1	-	-	-	-	-	2	-	2	1
CO3	2	-	1	-	-	-	-	-	2	-	2	1
CO4	3	-	1	-	-	-	-	-	2	-	2	1
CO5	3	-	1	-	-	-	-	-	2	-	2	1

Subject Code: MMIC301SE **Semester: III**

Subject Name: Microbial diversity and extremophiles

Teaching Examination Scheme:

Teaching (Hours/week)			Examination Scheme			
Lecture	Tutorial	Practical	Internal		External	Total
			Mid	CE		
03	0	01	20	10	70	100

Course Objective:

- Microbial diversity represent a unique and irreplaceable resource.
- They have a critical role in protecting and enhancing human health, crop production or regulating biogeochemical fluxes of the major elements of the biosphere.

Course Outcomes: At the end of the course, students shall be able to

CO1	Apply the knowledge to understand the microbial physiology and to identify the microorganisms.
CO2	Understand the regulation of biochemical pathway and possible process modifications for improved control over microorganisms for microbial product synthesis.

CREDIT: 02

Unit	Content	Hrs.	Weightage
1	**Introduction to microbial diversity** Introduction to microbial diversity – distribution – abundance –ecological niche. Oxidative transformation of metals – Sulphur oxidation – iron oxidation – ammonia oxidation and hydrogen oxidation. Microbial diversity in anoxic ecosystem: methanogens – reduction ofcarbon monoxide – reduction of iron, Sulphur, oxygen. Microbes andmechanism of metal reduction – Bioleaching of ore metal corrosion.	**15**	**50%**
2	**Extremophiles** Extremophiles: Acidophilic, alkalophilic, thermophilic, barophilic and osmophilic microbes. Mechanism and adoption, Halophiles: membrane variation – electron transport – application of thermophiles and extremophiles. Subterranean microbes – ground water contamination and microbial transformation. Bio-Magnificat bioaccumulation and bioremediation. Catabolic pathway of recalcitrant molecule degradation and mineralization.	**15**	**50%**

Reference Books:

1. Johri BN, Extremophiles
2. Colwd D. Microbial divesity

Suggested Readings:

- Diversity of Microbes
- Bryophyta: Diversity of Microbes and Cryptogams
- Microbes: Diversity and Biotechnology by M Belwal
- Molecular Mechanisms of Plant and Microbe Coexistence (Soil Biology) by V L Chopra and Chandra Shekhar Nautiyal

Online Resources:

- **www.shomusbiology.com**
- **https://www.slideshare.net**

Practical / Activities:

- Denaturing gradient gel electrophoresis (DGGE)
- Temperature gradient gel electrophoresis (TGGE)
- Denaturing gradient gel electrophoresis (DGGE)
- temperature gradient gel electrophoresis (TGGE)

CO-PO & CO-PSO Mapping

Course Outcomes	Program Outcomes 1: Less relevant, 2: Mild relevant, 3: Highly relevant											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	2	-	1	-	-	-	1	1	2	-	2	1
CO2	2	2	1	-	1	-	-	-	2	-	1	1

Subject Code: MMIC401DSC **Semester: IV**
Subject Name: Recombinant DNA Technology

Teaching Examination Scheme:

Teaching (Hours/week)			Examination Scheme			
Lecture	Tutorial	Practical	Internal		External	Total
			Mid	CE		
03	0	01	20	10	70	100

Course Objective:

- To illustrate creative use of modern tools and techniques for manipulation and analysis of genomic sequences.
- To expose students to application of recombinant DNA technology in biotechnological research.

Course Outcomes: At the end of the course, students shall be able to

CO1	Technical know-how on versatile techniques in recombinant DNA technology.
CO2	An understanding on application of genetic engineering techniques in basic and applied experimental biology.

CREDIT: 04

Unit	Topic	Content	Hrs.	weightage
1		**Introduction to r-DNA technology**	15	25%
	1.1	Core techniques and essential enzymes used in rDNA technology.		
	1.2	Restrictiondigestion, ligation		
	1.3	transformation		
2		**Cloning vector**	15	25%
	2.1	Cloning vectors - plasmids, phages and cosmids.		
	2.2	Cloning strategies. Cloning and selection of individualgenes.		
	2.3	Gene libraries: cDNA and genomic libraries.		
3		**Cloning strategies**	15	25%
	3.1	Specialised cloning strategies.		
	3.2	Expression vectors, Promoter probe vectors,		
	3.3	Vectors for libraryconstruction - artificial chromosomes.		

4		**Techniques in R-DNA technology**	**15**	**25%**
	4.1	PCR methods and application. DNA sequencing Methods; dideoxy and chemical method.		
	4.2	Sequence assembly, Automated sequencing.		
	4.3	Genome sequencing and physical mapping of genomes.		

Reference Books

1. Principles of gene manipulation. 1994. Old & Primrose. Blackwell ScientificPublications.
2. Molecular cloning. 3 volumes. Sambrose and Russell. 2000. CSH press.
3. Genome analysis. Four volumes. 2000. CSH Press.

Suggested Readings:

1. Molecular Biotechnology : Principles and Applications of Recombinant DNA
2. Biotechnology, applying the Genetic Revolution
3. Principles of Genetics

Online Resources:

1. **www.shomusbiology.com**
2. **https://www.slideshare.net**
3. ***https://www.coursera.org***

Practical / Activities:

1. Isolation of DNA
2. Gene cloning Techniques
3. Polymerase Chain reaction
4. genome Sequencing
5. Automated Sequencing

MMIC405UPRA-PRACTICAL MODULE-I

CREDIT: 03

PRACTICAL

401: Recombinant DNA technology

1. Isolation of Plasmid DNA
2. Transformation of Resistant gene.
3. Polymerase Chain Reaction (demonstration)
4. Amplification of gene by PCR (Universal primer)

402: Medical Microbiology

5. Study of Skin flora (isolation and Biochemical Test)
6. Bioassay of Penicillin
7. Drug MIC determination testing

8. Isolation and identification of Antimicrobial resistant bacteria from given sample
9. Detection of Mycotoxins from contaminated Groundnuts
10. Sterility testing

MMIC406UPRA- PRACTICAL MODULE-II

CREDIT: 03

PRACTICAL

403: Food Microbiology

1. Detection of bacteria in Milk by standard plate count
2. Microbial examination of Milk by coliform.
3. Reductase test for Milk - Methylene Blue / Resazurin
4. Isolation of *Lactobacillus* and *Streptococci* from curd / Milk products
5. Examination of microbial load in Soft drinks / ice creams / packaged food.
6. Microbial examination of spoiled foods and fruits

404: Air and Water Microbiology

1. Enumeration of microorganism from Air - Settle plate technique
2. Microbial assessment of water quality - MPN determination
3. Estimation of BOD
4. Estimation of COD

CO-PO & CO-PSO Mapping

Course Outcomes	Program Outcomes 1: Less relevant, 2: Mild relevant, 3: Highly relevant											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	2	1	-	1	1	1	-	2	-	2	2
CO2	2	2	1	-	1	-	-	-	2	-	2	2

Subject Code: MMIC402DSC **Semester: IV**
Subject Name: Medical Microbiology

Teaching Examination Scheme:

Teaching (Hours/week)			Examination Scheme			
Lecture	Tutorial	Practical	Internal		External	Total
			Mid	CE		
04	0	01	20	10	70	100

Course Objective:

(a) This course enables the students to provide basic knowledge about catabolism, anabolism, regulation of metabolism and pathway analysis.
(b) It also gives understanding of how enzymes and metabolites in living system work to produce energy and synthesizing different biomolecules.

Course Outcomes: At the end of the course, students shall be able to

CO1	The student will be able to identify common infectious agents and the diseases that they cause.
CO2	The student will be able to evaluate methods used to identify infectious agents in the clinical microbiology lab.
CO3	The student will be able to recall microbial physiology including metabolism, regulation and replication

Content

CREDIT: 04

Unit	Description in detail	Credit	Weightage
I	**Discovery of pathogenic microorganisms** 1.1 Early discovery of pathogenic microorganisms; development of bacteriology as scientific discipline; contributions made by eminent scientists. 1.2 Classification of medically important microorganisms; Normal microbial flora of human body. 1.3 Role of the resident flora; normal flora and the human host	1	25%
II	**Bacterial mechanisms** 2.1 Establishment, spreading, tissue damage and antiphagocytic factors; mechanism of bacterial adhesion, colonization and invasion of mucous membranes of respiratory, enteric and urogenital tracts. 2.2 Role of aggressions depolymerizing enzymes, organotropisms, variation and virulence. 2.3 Organs and cells involved immune system and immune response.	1	25%
III	**Classification of pathogenic bacteria** 3.1 Staphylococcus, Streptococcus, Pneumococcus, Neisseria, Corynebacterium Bacillus, Clostridium, non-sporing Anaerobes, 3.2 Organisms belonging to Enterobacteriaceae, Vibrio's 3.3 Non fermenting gram negative bacilli Yersinia; Hemophilus;	1	25%

	Bordetella, Brucella Mycobacteria, Spirochaetes, Actinomycete's; Rickettsia, Chlamdiae.		
IV	**Antimicrobial therapy** 4.1 Laboratory control of antimicrobial therapy; various methods of drug susceptibility testing, antibiotic assay in body fluids. 4.2 Brief account on available vaccines and schedules; passive prophylactic measures 4.3 Nosocomial infection, common types of hospital infections and their diagnosis and control.	1	25%

Reference Books:

1. Text of Microbiology, R. Ananthanarayanan and C.K. Jayaram Panicker Orient Longman, 1997.
2. Mackie and McCartney Medical Microbiology Vol.1: Microbial Infection.Vol.2: PracticalMedical Microbiology Churchill Livingstone, 1996.
3. Microbiology in Clinical Practice. D.C. Shanson, Wright PSG, 1982.
4. Bailey and Scott's Diagnostic Microbiology Baron EJ, Peterson LR and Finegold SM Mosby,1990.

Suggested Reading:

- Brock Biology of Microorganisms, 14th Edition.
- Microbiology: An Introduction, 13th Edition.
- Clinical Microbiology Made Ridiculously Simple, 6th Edition.
- Prescott's Microbiology, 10th Edition.

Online Resources:

- **www.shomusbiology.com**
- **https://www.slideshare.net**

Practical / Activities:

- Inoculation of Fungi
- Incubation of Saccromyces bacteria
- Isolation, Inspection (Observation), and Identification of Yeast

CO-PO & CO-PSO Mapping

Course Outcomes	Program Outcomes 1: Less relevant, 2: Mild relevant, 3: Highly relevant											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	2	-	-	-	2	-	-	-	2	-	2	1
CO2	2	2	1	-	1	-	1	-	2	-	2	2
CO3	2	1	1	-	1	1	-	1	2	-	2	-

Subject Code: MMIC403DSC **Semester: IV**
Subject Name: Food Technology

Teaching Examination Scheme:

Teaching (Hours/week)			Examination Scheme			
Lecture	Tutorial	Practical	Internal		External	Total
			Mid	CE		
04	0	01	20	10	70	100

Course Objective:

(a) The aim of the course is to provide knowledge of microorganisms associated with foods and theirorigin and role: knowledge of the factors that determine the presence, growth and survival of microorganisms in food knowledge of the main microbial groups involve bin the production of fermented foods. The knowledge require for the microbiological safety in food.
(b) To gain knowledge about fermentation techniques used in dairy industry and to gain skills tocontrol fermentation process.

Course Outcomes: At the end of the course, students shall be able to

CO1	Learn about fundamentals of food microbiology
CO2	Gain insight on spoilage of foods by microbes, microbial food poisoning.
CO3	Understanding the process of fermentation of milk and other food products.
CO4	Assessment of food quality in reference to microbial contamination.

Content

CREDIT: 04

Unit	Description in detail	Credit	Weightage
I	**Food as substrate for microorganisms** 1.1 Microorganisms important in food microbiology -Molds, Yeasts and Bacteria-General characteristicsclassification and importance. 1.2 Principles of food preservation. Asepsis - Removal of microorganisms, (anaerobic conditions, high temperatures, low temperatures, drying,). Factors influencing microbial growth in food - Extrinsic and intrinsic factors. 1.3 Chemical preservatives and Food additives. Canning, processing for Heat treatment- D, Z, and F values and working out treatment parameters.	1	25%

II	**Spoilage of food** 2.1 Contamination and spoilage: Cereals, sugar products, vegetables, fruits, meat and meat products. 2.2 Milk and Milk products- Fish and sea foods-poultryspoilage of Canned foods, Milk and Milk productsFish and sea foods-poultry-spoilage of Canned foods 2.3 Detection of spoilage and characterization.	1	25%
III	**Food-borne infection and intoxication** 3.1 Bacterial and nonbacterial- with examples of infective and toxic types - Brucella, Bacillus, Clostridium, Escherichia, Salmonella, Shigella, Staphyloco-ccus, Vibrio, Yersinia; Nematodes, protozoa, algae, fungi and viruses. 3.2 Foodborne outbreaks-laboratory testing procedures; Prevention Measures Food sanitation in manufacture and retail trade; 3.3 Food control agencies and its regulations, Plant Sanitation-Employee's Health standards-waste treatment-disposal quality control.	1	25%
IV	**Food fermentations** 4.1 Food fermentations: bread, cheese, vinegar. fermented vegetables, fermented dairy products; Experimental and Industrial production methods. 4.2 Spoilage and defects of fermented dairy products oriental Fermented foods, their quality standards and control. 4.3 Food produced by Microbes: Fermented foods, microbial cells as food (single cell proteins) -mushroom cultivation. Genetically modified foods.	1	25%

Reference Books:

1. Adams M.R. and Moss M.O (1995) Food Microbiology. Royal Society of Chemistry Publication, Cambridge.
2. Frazier WC and Westhoff Dc (1988). Food Microbiology. Tata McGraw Hill Publishing Company Ltd, New Delhi.
3. Stanbury, PR, Whitekar, A and Hall, S.J (1995) Principles of Fermentation Technology. 2ndEdition. Pergamon Press.
4. Banwart.GJ (1989) Basic Food Microbiology. CBS Publishers and Distributors, Delhi.
5. Hobbs BC and Roberts D.(1993) Food poisoning and Food Hygiene.Edward Arnold (A divisionof Hodder and Stoughton) London.
6. Robinson RK., (1990) Dairy Microbiology. Elsevier Applied Sciences, London.

Suggested Readings:

1. Modern Food microbiology 7th edition by James M. Jay, Martin J. Loessner and David A. Golden
2. Food microbiology fundamentals and frontiers 5th edition by Michael P. Doyle, Francisco Diez Gonzales and Collin Hill
3. Modern Food microbiology by K.R. Aneja

Online Resources:

1. **https://www.classcentral.com**
2. **https://www.researchgate.net**
3. **https://www.onlinecourses.swayam2.ac.in.**
4. **www.shomusbiology.com**
5. **https://www.slideshare.net**

Practical / Activities:

1. Microbial examination cheese
2. Microbial examination of canned food and vegetables
3. Detection of bacteria in yogurt.

CO-PO & CO-PSO Mapping

Course Outcomes	Program Outcomes 1: Less relevant, 2: Mild relevant, 3: Highly relevant											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	2	-	1	-	1	1	-	-	2	-	2	-
CO2	2	-	1	-	1	-	-	-	2	-	2	1
CO3	2	-	1	-	1	1	-	-	2	-	1	1
CO4	3	1	1	-	1	-	-	-	2	-	2	1

Subject Code: MMIC404DSC **Semester: IV**
Subject Name: Air and Water Microbiology

Teaching Examination Scheme:

Teaching (Hours/week)			Examination Scheme			
Lecture	Tutorial	Practical	Internal		External	Total
			Mid	CE		
04	0	01	20	10	70	100

Course Objective:

(a) The study of microbes helps us to understand our world and our place within it.
(b) It gives us insights into the complexity of nature and society, which in turn provide many different health, environmental, social, cultural, industrial and economic benefits.

Course Outcomes: At the end of the course, students shall be able to

CO1	Understand the basic microbial structure and functions of various physiological groups of prokaryotes and eukaryotes and also learn the theory and practical skills in microscopy handling and staining techniques Know various Culture media and their applications
CO2	Understand various physical and chemical means of sterilization and also learn various techniques for isolation of pure cultures

Content

CREDIT: 04

Unit	Description in detail	Credit	Weightage
I	**Aerobiology** Droplet nuclei, aerosal, assessment of air quality, - solid - liquid - impingment methods. - Brief account of air borne transmission of microbes - viruses -bacteria and fungi, their diseases and preventive measures.	1	25%
II	**Aquatic microbiology** Aquatic microbiology: Water ecosystems - types - fresh water (ponds, lakes, streams) -marine habitats (estuaries, mangroves, deep sea, hydrothermal vents, saltpans, coralreefs). Zonations of water ecosystems - upwelling - eutrophication – food chain. Potability of water -microbial assessment of water quality – water purification brief account of major water borne diseases and their control measures.	1	25%
III	**Waste water treatment** Waste treatment: Wastes - types - solid and liquid wastes characterization - solid - liquid; treatments - physical, chemical, biological - aerobic - anaerobic -primary - secondary - tertiary; solid waste treatment-, liquid waste treatment - trickling - activated sludge - oxidation pond – oxidation ditch. Subterranean microbes and bioremediation.56	1	25%

IV	**Positive and negative roles of micro-organisms** Positive and negative roles of microbes in environment: - biodegradation of recalcitrant compounds - lignin - pesticides; bioaccumulation of metals and detoxification - biopesticides; biodeterioration - of paper - leather, wood, textiles -metal corrosion - mode of deterioration -organisms involved - itsdisadvantages - mode of prevention. GMO and their impact.	1	25%

Reference Books:

1. Michel. R. Introduction to environmental microbiology. 1999
2. ASM book.

Suggested Reading

- Textbook for introductory majors microbiology,
- Brock Biology of Microorganisms

Online Resources:

- www.shomusbiology.com
- https://www.slideshare.net

Practical / Activities:

- Microbiological analysis of Air
- Microbiological Analysis of Water
- Coliform test
- Settling plate/ sedimentation technique

CO-PO & CO-PSO Mapping

Course Outcomes	Program Outcomes 1: Less relevant, 2: Mild relevant, 3: Highly relevant											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	3	2	1	-	1	2	2	-	2	-	2	1
CO2	2	2	1	-	1	2	1	-	2	-	2	1

Subject Code: MMIC401SE **Semester: IV**

Subject Name: Drug discovery and clinical research

Teaching Examination Scheme:

Teaching (Hours/week)			Examination Scheme			
Lecture	Tutorial	Practical	Internal		External	Total
			Mid	CE		
02	0	01	10	05	35	50

Course Objective:

- The goal of a preclinical drug discovery program is to deliver one or more clinical candidate molecules, each of which has sufficient evidence of biologic activity at a target relevant to a disease as well as sufficient safety and drug-like properties so that it can be entered into human testing.

Course Outcomes: At the end of the course, students shall be able to

CO1	Monitor drug therapy of patient through medication chart review and clinical review
CO2	Obtain medication history interview and counsel the patients
CO3	Identify and resolve drug related problems
CO4	Detect, assess and monitor adverse drug reaction

CREDIT: 02

Unit	Content	Hours	Weightage
1	**Drug Discovery** Drug Discovery process and Drug designing: Overview of Drug discovery process, Cost of Drug development, Protein StructurePrediction: Comparative and Homology modeling, The Critical Assessment of protein Structure Prediction (CASP), Superposition of proteins using different tools, RMSD, Presentation of protein conformations, Hydrophobicity factor, Shape complementary. MolecularDocking Studies: Structure-based De Novo Ligand design, Drug Discovery – QSAR, Different types of docking approaches (Structure- based, Ligand-based), Mode of interaction studies, Pharmacophore prediction based on the docking analysis.	**15**	**50%**
2	**Clinical research** Clinical research: Scope of Clinical Research, Good Clinical Practices (GCP), History of clinical research, Types of clinical trials, clinical trials Phases, Special Clinical Trials, Medical Devices Trials, Un-anticipated risk in clinical research. SOP in Clinical Trials, Clinical Trial Monitoring, Role of CRA, QA and QC in Clinical Trials, CRF Design.	**15**	**50%**

Reference Books:

1. Susanna Wu-Pong, YongyutRojanasakul, and Joseph Robinson (2006): Biopharmaceutical DrugDesign and Development.
2. Fundamentals of Clinical Trials By Lawrence M. Friedman, Curt D. Furberg, DavidDeMets
3. Management of data in clinical trials by Eleanor McFadden
4. Principle and Practice of Clinical Research by John I. Gallin, Frederick P Ognibene
5. Clinical Data Management By Richard K. Rondel, Sheila A. Varley, Colin F. Webb
6. Principles and Practice of Clinical Research By John A Gallin

Suggested Readings:

1. S.K. Gupta
2. Drug Discovery and Development
3. Drug Discovery and Clinical Research
4. principles of Drug Discovery

Online Resources:

6. **www.shomusbiology.com**
7. **https://www.slideshare.net**

Practical / Activities:

1. De Novo Ligand designing
2. QSAR (Quantitative structure-activity relationship)
3. phenotypic drug discovery

CO-PO & CO-PSO Mapping

Course Outcomes	Program Outcomes 1: Less relevant, 2: Mild relevant, 3: Highly relevant											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	2	2	1	-	1	2	-	-	1	-	2	1
CO2	2	2	1	-	-	2	2	-	2	1	1	-
CO3	1	2	1	-	-	1	2	-	1	-	2	-
CO4	2	2	-	-	1	1	2	-	1	1	2	-