

ST JOSEPH'S UNIVERSITY

BENGALURU-27



DEPARTMENT OF MICROBIOLOGY

SYLLABUS FOR UNDERGRADUATE PROGRAMME

For Batch 2024-2027

(STATE EDUCATION POLICY)

Part A		
1	Title of the Academic Program	B.Sc. Microbiology (Major)
2	Program Code	BCYM (Biochemistry, Biology, Microbiology), BCMZ (Biochemistry, Microbiology, Zoology), CMBY (Chemistry, Microbiology, Biology)
3	Name of the University	St. Joseph's University
4	Objectives of the University	<ol style="list-style-type: none"> 1. Academic Excellence 2. Character Formation 3. Social Concern
5	Vision of the University	To form men and women for and with others, who through holistic education, strive for a just, secular, democratic, and ecologically sensitive society which empowers the poor, the oppressed, and the marginalized.
6	Mission of the University	In keeping with the Jesuit heritage, the university aims at an integral formation of the staff and the students, to be men and women who will be agents of societal change, by enabling them to attain academic and human excellence in a teaching-learning environment that fosters intellectual curiosity, ceaseless enquiry, personal integrity, social commitment, creativity, critical thinking and innovation.
7	Name of the Degree	Bachelor of Science (B.Sc.)
8	Name of the Department offering the program	Microbiology
9	Vision of the Department offering the program	<ul style="list-style-type: none"> • The Department intends to inculcate in the students an interest to explore the world of Microbiology and contribute to the rapidly expanding field. We wish to offer the society, a generation of humble yet aspiring young minds eagerly striving towards unraveling the mystery of science.
10	Mission of the department offering the Program	<ul style="list-style-type: none"> • The Department of Microbiology aims at identifying one's potential to become a centre for augmenting and contributing continuously to the vibrant field of Microbiology. • We strive to create and provide an ambient learning atmosphere and prepare students for academia, industry and productive application of this knowledge in everyday life. • It emphasizes the impact of microbes on environment and the human activities.
11	Duration of the Program	3 years (Six semesters)
12	Total No. of Credits	132

16	Program Specific Outcomes (PSOs)	PSO1	Students graduating from the Microbiology program will gain knowledge and understanding of concepts of microbiology and its application in pharma, food, agriculture, beverages, nutraceutical industries, etc.
		PSO2	Students will understand the distribution, morphology and physiology of microorganisms and demonstrate the skills in aseptic culturing of microbes including isolation, identification and maintenance.
		PSO3	Students will be learning and practicing professional skills in handling microbes and contaminants in laboratories and production sectors, exploring the microbial world and analyzing the specific benefits and challenges.
		PSO4	Students will be able to apply the knowledge acquired to undertake studies and identify specific remedial measures for the challenges in health, agriculture, and food sectors.
		PSO5	Students will also learn and build on proficiencies in science communication, teamwork and collaboration, enabled by regular innovative assignments and activities.
		PSO6	Students will be able to demonstrate the ability to identify key questions in microbiological research, optimize research methods, and analyze outcomes by adopting scientific methods, thereby improving the employability.

SUMMARY OF CREDITS IN MICROBIOLOGY

Semester 1	Code Number	Title	No. of Hours of Instructions	Number of Hours of teaching per week	Number of credits	Continuous Internal Assessment (CIA) Marks	End Semester Marks	Total marks
Theory	MB 124	Basic Microbiology and Microbiological Techniques	45	03	03	40	60	100
Practical	MB1P1 24	Basic Microbiology and Microbiological Techniques	33	03	02	25	25	50
Total Number of credits:			05					
Semester 2	Code Number	Title	No. of Hours of Instructions	Number of teaching Hrs /week	Number of credits	Continuous Internal Assessment (CIA) Marks	End Semester Marks	Total marks
Theory	MB 224	Microbial Diversity I	45	03	03	40	60	100
Practical	MB2P1 24	Microbial Diversity I	33	03	02	25	25	50
Total Number of credits:			05					
Semester 3	Code Number	Title	No. of Hours of Instructions	Number of Hours of teaching per week	Number of credits	Continuous Internal Assessment (CIA) Marks	End Semester Marks	Total marks
Theory	MB 325	Microbial Diversity II	45	03	03	40	60	100
Practical	MB3P1 25	Microbial Diversity II	33	03	02	25	25	50
Total Number of credits:			05					
Semester 4	Code Number	Title	No. of Hours of Instructions	Number of teaching Hrs /week	Number of credits	Continuous Internal Assessment (CIA) Marks	End Semester Marks	Total marks
Theory	MB 425	Microbial Enzymology and metabolism	45	03	03	40	60	100
Practical	MB4P1 25	Microbial Enzymology and metabolism	33	03	02	25	25	50
Total Number of credits:			05					

Semester 5	Code Number	Title	No. of Hours of Instructions	Number of Hours of teaching per week	Number of credits	Continuous Internal Assessment (CIA) Marks	End Semester Marks	Total marks
Theory	MB 5126	Molecular Genetics	45	03	03	40	60	100
	MB 5226	Immunology and Medical Microbiology	45	03	03	40	60	100
	MB 5326	Microbes in Sustainable Agriculture and Environment	45	03	03	40	60	100
Practical	MB 5P 126	Molecular Genetics	33	03	02	25	25	50
	MB 5P 226	Immunology and Medical Microbiology	33	03	02	25	25	50
	MB 5P 326	Microbes in Sustainable Agriculture and Environment	33	03	02	25	25	50
Practical knowledge /Skill based	MB 5S 26	Foundations and applications of Bioinformatics	30	02	02	25	25	50
	MB 5RM 26	Elementary research methodology	30	02	02			
Total Number of credits:			19					
Semester 6	Code Number	Title	No. of Hours of Instructions	Number of Hours of teaching per week	Number of credits	Continuous Internal Assessment (CIA) Marks	End Semester Marks	Total marks
Theory	MB 6126	Dimensions and applications of Food and Dairy Microbiology	45	03	03	40	60	100
	MB 6226	Industrial Microbiology and Bioprocess Technology	45	03	03	40	60	100
	MB 6326	Genetic Engineering for a Sustainable Future	45	03	03	40	60	100
Practical	MB 6P1 26	Dimensions and applications of Food and Dairy Microbiology	33	03	02	25	25	50
	MB 6P2 26	Industrial Microbiology and Bioprocess Technology	33	03	02	25	25	50
	MB 6P3 26	Genetic engineering for a Sustainable Future	33	03	02	25	25	50
Practical knowledge/ Skill based	MB 6S 26	Microbial Data Analytics: from plate to plot	30	02	02	25	25	50
		Research Project			04			100
Total Number of credits:			21					

CORE COURSES (CC)	
Course Title	Code Number
Basic Microbiology and Microbiological Techniques	MB 124
Microbial Diversity I	MB 224
Microbial Diversity II	MB 325
Microbial Enzymology and metabolism	MB 425
Molecular Genetics	MB 5126
Immunology and Medical Microbiology	MB 5226
Microbes in Sustainable Agriculture and Environment	MB 5326
Dimensions and applications of Food and Dairy Microbiology	MB 6126
Industrial Microbiology and Bioprocess Technology	MB 6226
Genetic engineering for a Sustainable Future	MB 6326

VALUE ADDED COURSES (VAC)	
Course Title	Code Number
Principles of Genetic Engineering	MBCC 01
Food Technology	MBCC 02
Principles of Biomedical Techniques and Ethics	MBCC 03

Practical knowledge/Skill based	
Course Title	Code Number
Foundations and applications of Bioinformatics	MB 5S 26
Microbial Data Analytics: from plate to plot	MB 6S 26

DEPARTMENT OF MICROBIOLOGY

Semester	I
Paper Code	MB 124
Paper Title	Basic Microbiology and Microbiological Techniques
Number of teaching hours per week	03
Total number of teaching hours per semester	45
Number of credits	03

Objective of the Paper:

This paper introduces the students to the microbial world. It emphasizes on the contribution of scientists to the evolution of the field of Microbiology as an essential modern science. The students will have an in-depth understanding of the prokaryotic and eukaryotic cellular forms, using bacteria and protozoans as model organisms. The students will get equipped with microscopic, staining and sterilization techniques.

UNIT-I Historical Perspective	4
<p>a. History and Scope of Microbiology: Relevance of Microbiology as a modern science Branches of Microbiology Scope of Microbiology and career opportunities in the field.</p>	2
<p>b. Contribution of Scientists to the field of Microbiology: Antonie Von Leeuwenhoek, Francisco Redi, Edward Jenner, Louis Pasteur, Joseph Lister, Robert Koch and Alexander Fleming.</p>	2
UNIT- II Introduction to the Microbial World	5
<p>Structure and Overview of Different Groups of Microbes (Brief overview of morphology and importance)</p> <p>a. Bacteria b. Fungi c. Algae d. Protozoa e. Virus</p>	

UNIT-III Introduction to prokaryotic microorganisms	10
<p>Bacteriology:</p> <p>a. Ultrastructure of a bacterial cell: detailed study of- flagella, pili and capsule, cell wall (gram positive and gram negative), cell membrane, mesosomes, ribosomes, and genetic material. Inclusion bodies and reserve food materials.</p> <p>b. Endospore – structure, function, sporulation and germination.</p> <p>c. Reproduction in bacteria: binary fission</p> <p>d. Bacteria with unusual properties: (Ultrastructure and functions) Mycoplasma Actinomycetes Rickettsia</p>	8 2
UNIT-IV Introduction to eukaryotic microorganisms	5
<p>a. Cellular organization of eukaryotes- General structure and intracellular organelles- cell membrane, cytoskeleton, Membrane-bound organelles- Endoplasmic reticulum, Golgi complex, Lysosomes, Vesicles, Nucleus, Mitochondrion, Chloroplast, Peroxisomes, and Ribosomes.</p> <p>b. Protozoology: General characters of protozoans. E.g.- Paramecium.</p>	3 2
UNIT-V Microbiological Techniques- Visualization of Microbes	11
<p>a. Microscopy Introduction to Concepts of Light- Reflection, Refraction, Diffraction, Interference, and Fluorescence. Light Microscopy-Bright field, Dark field, Fluorescence, Confocal Microscopy and Phase contrast Microscopy Electron microscopy -TEM and SEM</p> <p>b. Staining Techniques: Composition of stain and types Simple staining (Negative staining), Differential staining (Gram's staining), Structural staining (Endospore staining)</p>	8 3
UNIT VI Microbiological Techniques- Sterilization of Microbes	10

<p>Concept of sterilization and disinfection and its importance in Microbiology.</p> <p>i) Factors affecting antimicrobial activity: - Environment, organisms, physiological status, inoculum concentration, intensity of concentration of the antimicrobial agent, temperature, and time of action as factors affecting antimicrobial activity.</p> <p>ii) Physical methods of sterilization: Moist heat (Pasteurization) Moist heat under pressure (Autoclave) Dry heat (incineration, hot air oven) Filtration- membrane filter, HEPA filter Radiation (UV- rays, X- rays, Gamma rays, ultrasonic rays)</p> <p>iii) Chemical agents used in sterilization: Desired characteristics and mode of action of antimicrobial chemical agents. Alcohols, formaldehyde, phenol, halogens and heavy metals, and gaseous agents. Efficacy testing of chemical agents- Phenol coefficient test</p>	<p>2</p> <p>4</p> <p>4</p>
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NOTE: 10 hours of self-study (study materials and videos will be provided)

REFERENCES:

1	Black, J. G., & Black, L. J. (2008). <i>Microbiology: Principles and explorations</i> . Hoboken, NJ: John Wiley & Sons, Inc.
2	Madigan, M. T. (2017). <i>Brock Biology Of microorganisms</i> .
3	Murphy, D. B., & Davidson, M. W. (2012). <i>Fundamentals of Light microscopy and Electronic Imaging</i> . John Wiley & Sons.
4	O.P. Sharma. (1992), <i>Textbook of Algae</i> , New Delhi: Tata McGraw-Hill.
5	Talaro, K. P. (2008). <i>Foundations in Microbiology: Basic principles</i> , New York: McGraw-Hill, 11th Edition.
6	Willey, J. M., Sherwood, L., & Woolverton, C. J. (2017). <i>Prescott's Microbiology</i> .

BLUEPRINT:

Code number: MB 124

Title of the Paper: Basic Microbiology and Microbiological Techniques

Unit number	Number of Hrs	Total marks for which the questions are to be asked (including bonus questions)
Unit I	4	8
Unit II	5	10
Unit III	10	20
Unit IV	5	10
Unit V	11	22
Unit VI	10	20
	45	88
Maximum marks for the paper (Excluding bonus question) = 60		

Practical I
MB 1P1 24 - Basic Microbiology and Microbiological Techniques
(11 sessions 3hr/week)

Sr. No.	Experiment	Units
1	Microbiological laboratory standards and safety protocols.	1
2	Standard aseptic conditions of Microbiological laboratory.	
3	Study of a compound microscope.	1
4	Study of instruments - Autoclave, hot air oven, LAF and biosafety cabinets, incubator, membrane filter, colony counter. Applications of basic microbiological tools (Pipettes, Micropipette, Bunsen burner, Inoculation loop, Spreader).	
5	Preparation of media – NB, NA.	1
6	Isolation and identification of bacteria- Cultural characteristics and CFU calculation,	1
7	Pure culture techniques – pour plate, spread plate and streak plate (Simple, Continuous, Quadrant) methods.	1
8	Aseptic transfer techniques.	
9	Simple staining, Negative staining	1
10	Differential staining- Gram's staining	1
11	Structural staining- Endospore.	2
12	Bacterial motility- hanging drop.	1

Course outcomes for MB 124 and MB1P1 24

At the end of the course, the student will be able to:

CO1	Appreciate the contributions of Pioneers in the field of microbial research.
CO2	Get acquainted with different types of microbial life forms and their basic structure and functions.
CO3	Understand the basics of the structural organization of a prokaryotic and eukaryotic cell.
CO4	Apply the knowledge gained to identify and use various laboratory aids to culture, visualize and control microorganisms.
CO5	Assess the importance of microbes in all realms of life.
CO6	Apply the basic disinfection and sterilization techniques to maintain health and hygiene.

DEPARTMENT OF MICROBIOLOGY

Semester	II
Paper Code	MB 224
Paper Title	Microbial Diversity - I
Number of teaching hours per week	03
Total number of teaching hours per semester	45
Number of credits	03

Objective of the Paper:

This paper allows students to understand microbial systematics and methods to classify some of the microbes. It helps them explore the different types of microorganisms, their growth patterns, preservation techniques, and control methods.

UNIT I Microbial Taxonomy	10
a. Microbial Systematics - 5 kingdom classification system, 3 domain classification system Concept of 'species' in eukaryotes and prokaryotes, Nomenclature Phenetic classification, Phylogenetic classification, Genotypic classification	5
b. Classification on the basis of Classical characters and Molecular characters- Numerical taxonomy, chemotaxonomy and genetic analyses	4
c. Phylogenetic trees – rooted and unrooted	1
d. Classification based on pathogenicity. Biosafety level 1, 2, 3, and 4.	
UNIT II Bacteriology – Growth and control	20
Bacterial classification - Bergey's Manual of Bacteriology	2
Growth and maintenance of bacteria –	10
a. Nutritional requirements and types	
b. Types of Media for microbial growth- Differential and selective media, enrichment media, transfer media, defined and undefined media	
c. Bacterial growth curve and calculation of generation time. Diauxic growth curve.	

<p>Technique for determination of microbial growth - Spectrophotometry</p> <p>d. Long term maintenance of microorganisms- glycerol stocks, cryopreservation, lyophilization</p> <p>Control of bacterial growth -</p> <p>a. Development and classification of antibiotics.</p> <p>b. Mode of action and types–</p> <p>Antibacterial antibiotics: Cell wall synthesis inhibitors – Penicillin, Protein synthesis inhibitors- Tetracyclines and Chloramphenicol, DNA synthesis inhibitors- Fluoroquinolones, RNA synthesis inhibitors- Rifampin, mycolic acid synthesis inhibitors- isoniazid, membrane disruptors- Polymyxin B</p> <p>c. Development of Resistance to antibiotics, mechanisms of resistance and determination of antibiotic resistance.</p>	8
<p>UNIT III Virology</p>	15
<p>Viral Classification – Baltimore</p> <p>Structure, Reproduction and Significance of -</p> <p>Bacterial viruses - T4, Plant virus- TMV, Animal virus – HIV</p> <p>Cultivation of viruses, one step growth curve and plaque assay</p> <p>Antiviral therapies – concepts of antiviral therapies</p> <p>Phage therapy</p>	<p>1</p> <p>7</p> <p>4</p> <p>2</p> <p>1</p>

NOTE: 10 hours of self-study (study materials and videos will be provided).

REFERENCES:

1.	Black, J. G., & Black, L. J. (2008). <i>Microbiology: Principles and explorations</i> . Hoboken, NJ: John Wiley & Sons, Inc.
2.	Madigan, M. T. (2017). <i>Brock Biology Of microorganisms</i> .
3.	Primrose, S. B. (1974). <i>Introduction to modern virology</i> .
4.	Wilson, K. and Walker, J. (2010) <i>Principles and Techniques of Biochemistry and Molecular Biology</i> . Cambridge University Press, Cambridge.
5.	Willey, J. M., Sherwood, L., & Woolverton, C. J. (2017). <i>Prescott's Microbiology</i> .

BLUEPRINT:

Code number: MB 224

Title of the Paper: Microbial Diversity - I

Unit number	Number of Hrs	Total marks for which the questions are to be asked (including bonus questions)
Unit I	10	20
Unit II	20	39
Unit III	15	29
	45	88
Maximum marks for the paper (Excluding bonus question) = 60		

Practical II
MB 2P1 24 – Microbial Diversity - I

(11 sessions 3hr/week)

Sr. No.	Experiments	Units
1.	Bacterial growth on different types of media- NA, minimal agar, EMB, Mc Conkey agar	2
2.	Bacterial growth curve	1
3.	Growth of bacteria on various Carbon and Nitrogen sources	2
4.	Biochemical tests for the identification of bacteria- IMViC, starch hydrolysis, TSI, Gelatin liquefaction, catalase and oxidase test, Carbohydrate fermentation.	2
5.	Preparation of glycerol stocks	1
6.	Bacteriophage Plaque assay	2
7.	Antibiotic assay – Kirby Baur's	1

Course outcomes for MB 224 and MB 2P1 24**At the end of the course, the student will be able to:**

CO1	Demonstrate knowledge of microbial systematics, including the 5-kingdom classification system and the 3-domain classification system, and explain their significance in understanding microbial diversity.
CO2	Develop an understanding of nutritional requirements of various microorganisms for their subsequent growth/cultivation and control.
CO3	Perform basic experiments to culture, identify, classify and preserve microorganisms in the laboratory.
CO4	Carry out comparative analysis of growth requirements of various kinds of microorganisms.

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Semester	III
Paper Code	MB 325
Paper Title	Microbial Diversity - II
Number of teaching hours per week	03
Total number of teaching hours per semester	45
Number of credits	03

Objective of the Paper:

This paper allows the student to understand the nuances of the microbial world, emphasizing the significance of algae and fungi. The paper gives insight into the various interactions microbes undergo to sustain themselves in an environment. The microbial ecological implications are a fundamental way to understand the role microbes play in the environmental balance.

UNIT- I PHYCOLOGY	13
<ul style="list-style-type: none"> a. Cyanobacteria- Ultrastructure and reproduction. b. Economic importance of cyanobacteria. c. Algae - Occurrence, General characteristics, ultrastructure, pigments, flagella, eyespot food reserves, and reproduction of algae. d. Reproduction in Algae: <ul style="list-style-type: none"> i) Vegetative - fragmentation, fission, tubers, budding, hormogonia. ii) Asexual - Spore production. iii) Sexual - Isogamy, Anisogamy and Oogamy. iv) Overview of Life Cycles in Algae: Haplontic, Diplontic, Diplohaplontic, Haplobiontic, Diplobiontic. e. Economic importance of algae. 	2 1 3 6 1
UNIT-II MYCOLOGY	14
<ul style="list-style-type: none"> a. General Characteristics and morphology of Fungal cell - Yeast and Hyphal structure. b. Ultrastructure of fungal cell-Thallus organization, cell wall, cell membrane, and 	2

flagella.	2
c. Growth and cultivation of fungi.	
d. Reproduction in fungi- sexual, asexual, and parasexual.	2
e. Concepts of nomenclature and classification, fungal biodiversity.	2
f. Study of fungal classes (Alexopolus & Mims,1979)	1
Zygomycetes (<i>Mucor</i>), Ascomycetes (<i>Saccharomyces</i>), Basidiomycetes (<i>Agaricus</i>) and Deuteromycetes (<i>Alternaria</i>).	4
g. Economic importance of fungi.	1
UNIT-III EFFECT OF ENVIRONMENT ON MICROBES	5
a. Effect of environmental factors on the growth of microorganisms - Temperature, pH, oxygen, pressure, solute, and water activity.	4
b. Oligotrophic environments.	1
UNIT-IV MICROBIAL INTERACTIONS	13
a. Concept of symbiosis, symbiotic interactions - Mutualism (microbe-microbe mutualism), Cooperation, Commensalism, Parasitism, Predation, Amensalism, Competition.	8
b. Biofilm - formation; its clinical and economic implications.	2
c. Human-microbe interactions - normal microbiota of the human body (with special emphasis on the development of gut microbiota).	3

NOTE: 10 hours of self-study (video content and study material) will be provided.

REFERENCES:

1.	Wiley, J. M., Sherwood, L., & Woolverton, C. J. (2017). Prescott's Microbiology.
2.	Black, J. G., & Black, L. J. (2008). Microbiology: Principles and explorations. Hoboken, NJ: John Wiley & Sons, Inc.
3.	Sharma, O. P. (1986). Textbook of Algae. Tata McGraw-Hill Education.
4.	Sharma, O. P. (2011). Fungi & allied microorganisms. Tata McGraw-Hill Education.
5.	Talaro, K. P. (2008). Foundations in Microbiology: Basic principles, New York: McGraw-Hill, 11 th Edition.
6.	Staley, J. T. (2007). Microbial life. Sinauer Associates, Incorporated.
7.	Cole, L. A. (2016). Biology of life: Biochemistry, Physiology and Philosophy, Academic Press.

BLUE PRINT:

Code number: MB 325

Title of the Paper: Microbial Diversity II

Unit Number	Number Of Hours	Total marks for which the questions are to be asked (including bonus questions)
UNIT I	13	25
UNIT II	14	27
UNIT III	5	11
UNIT IV	13	25
TOTAL	45	88
Maximum marks for the paper (Excluding bonus question) = 60		

Practical III

MB 3P1 25– Microbial Diversity II

(11 sessions 3hr/week)

S. No.	Experiment	Units/sessions
1	Isolation and identification of bacteria and fungi.	2
2	Linear growth of fungi (pH 5-8)	2
3	Counting of yeast cells by hemocytometry.	1
4	Measurement of yeasts/ fungal spores by micrometry.	1
5	Observation of algae from environmental samples.	1
6	Effect of pH on growth of bacteria.	1
7	Effect of temperature on growth of bacteria.	1
8	Study of microbial interaction- Antagonism.	2

Course outcomes for MB 325 and MB 3P1 25

At the end of the Course, the Student will be able to

CO1	Understand the algal and fungal diversity.
CO2	Gain an insight into the significance of environmental factors in microbial growth.
CO3	Understand microbial interactions and their implications to humankind.
CO4	Use the knowledge of microbes to produce economically important products.
CO5	Obtain a broader perspective on the significance of microbial populations in generating a sustainable living.

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Semester	IV
Paper Code	MB 425
Paper title	Microbial Enzymology and Metabolism
Number of teaching hours per week	03
Total number of teaching hours per semester	45
Number of Credits	03

Objective of the Paper:

This paper enables a student to understand biomolecules and their role in various biochemical processes of microorganisms. It allows students investigate how specific enzymes catalyze biochemical reactions during aerobic and anaerobic respiration in different metabolic pathways of microorganisms. It also allows student to understand the structure, function, mechanisms, and regulation of enzymes to better elucidate their role in biochemical processes and apply this knowledge in fields like medicine, biotechnology, and industry

UNIT I BIOMOLECULES	8
a. Carbohydrates: Structure (mono, di and polysaccharides).	3
b. Amino acids and proteins: Structure, classification and properties of amino acids and proteins.	3
c. Overview of lipids and their importance	2
UNIT II MICROBIAL ENZYMOLOGY	15
a. Structure of enzyme, Apoenzyme, Holoenzymes, co-factors and co-enzymes.	2
b. Classification and nomenclature of enzymes.	1
c. Mechanism of action of enzymes: active site, transition state complex, activation energy, binding energy and allosteric site.	2
d. Lock and key hypothesis and Induced Fit hypothesis.	1
e. Significance of hyperbolic (Michaelis-Menten equation), double reciprocal plots (Lineweaver-Burk equation) of enzyme activity.	3
f. Definitions of terms – enzyme unit, specific activity and turnover number.	2

g. Effect of pH and temperature on enzyme activity.	1
h. Enzyme inhibition: competitive- sulfa drugs; non-competitive-heavy metal salts.	3
UNIT III CHEMOHETEROTROPHIC METABOLISM - AEROBIC RESPIRATION	12
a. Concept of aerobic respiration, anaerobic respiration and fermentation.	1
b. Sugar degradation pathways: Glycolysis, Entner–Doudoroff pathway, Pentose phosphate pathway, Tricarboxylic acid cycle.	6
Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, oxidative phosphorylation.	5
UNIT IV CHEMOHETEROTROPHIC METABOLISM- ANAEROBIC RESPIRATION AND FERMENTATION	5
a. Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate /nitrite and nitrate/ammonia respiration).	3
b. Fermentation - Alcohol fermentation, Lactate fermentation (homofermentative and heterofermentative pathways) and mixed acid fermentation.	2
UNIT V CHEMOLITHOTROPHIC AND PHOTOTROPHIC METABOLISM	5
a. Introduction to aerobic and anaerobic chemolithotrophy with an example each. Hydrogen oxidation and methanogenesis.	2
b. Introduction to phototrophic metabolism - groups of phototrophic microorganisms, oxygenic vs. anoxygenic photosynthesis.	3

NOTE: 10 hours of self-study (study materials and videos) will be provided

REFERENCES:

1.	Atlas, R. M. (1995). <i>Principles of microbiology</i> . St. Louis: Mosby.
2.	David L Nelson, Michael M Cox (7 th edition). <i>Lehninger Principles of Biochemistry</i> , Worth Publishers, Inc.
3.	Donald Voet, Judith Voet & Charlotte W. Pratt (4 th edition). <i>Voet's Principles of Biochemistry</i> , John Wiley and Sons.
4.	Gottschalk G. (1986). <i>Bacterial Metabolism</i> . 2nd edition. Springer Verlag.
5.	J. L. Jain, Sunjay Jain and Nitin Jain (2007). <i>Fundamentals of Biochemistry</i> . S. Chand &

	Company Ltd.
6.	Madigan MT, and Martinko JM (2014). <i>Brock Biology of Microorganisms</i> . 14 th edition. Prentice Hall International Inc.
7.	Moat AG and Foster JW. (2002). <i>Microbial Physiology</i> . 4th edition. John Wiley & Sons.
8.	Mary K. Campbell and Shawn O. Farrell (8 th edition). <i>Biochemistry</i> , Cengage Learning.
9.	Garrett, R. H., and Grisham, C. M. <i>Biochemistry</i> . 2 nd edition. Saunders College Publishing.
10.	Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). <i>General Microbiology</i> . 5th edition, McMillan Press.
11.	Willey JM, Sherwood LM, and Woolverton CJ. (2013). <i>Prescott's Microbiology</i> . 9th edition. McGraw Hill Higher Education.

BLUEPRINT:

Code number: MB 425

Title of the Paper: Microbial Enzymology and Metabolism

Unit number	Number of hours	Total marks for which the questions are to be asked (including bonus questions)
UNIT I	8	16
UNIT II	15	29
UNIT III	12	23
UNIT IV	5	10
UNIT V	5	10
	45	88
Maximum marks for the paper (Excluding bonus questions) = 60		

Practical IV

MB 4P1 25: Microbial Enzymology and Metabolism

(11 sessions 3 hr/week)

S.No	Experiments	Units
1.	Buffer preparations for enzymatic activity and Numerical problems to explain the concepts.	1
2.	Estimation of proteins by Lowry's method.	1
3.	Isolation and Screening of amylase producing bacteria	1
4.	Production of microbial enzymes (amylase) and estimation of its activity.	1
5.	Study the effect of substrate concentration on enzyme kinetics (K_m and V_{max}).	2
6.	Study the effect of temperature on enzyme activity.	1
7.	Study the effect of pH on enzyme activity.	1
8.	Study the effect of heavy metals on enzyme activity.	1
9.	Carbohydrate fermentation test, MRVP, Triple Sugar Ion (TSI), Nitrate reduction.	2

Course outcomes for MB 425 and MB 4P1 25

At the end of the course, the student will be able to:

CO1	Understand the properties of carbohydrates, amino acids, proteins and lipids.
CO2	Describe the multifarious function of enzymes; calculate enzyme activity and other quantitative and qualitative parameters of enzyme kinetics.
CO3	Understand the differentiating concepts of aerobic and anaerobic respiration.
CO4	Summarize the different metabolic pathways in microorganisms.
CO5	Critique the role of enzymes, coenzymes, and cofactors involved in different pathways.

DEPARTMENT OF MICROBIOLOGY

Semester	V
Paper Code	MB 5126
Paper Title	Molecular Genetics
Number of teaching hours per week	03
Total number of teaching hours per semester	45
Number of credits	03

OBJECTIVE OF THE PAPER

This course empowers students to: Understand the molecular structure and function of genetic material, investigate the mechanisms of genetic variation and genome maintenance and to analyse the central dogma and its regulatory mechanisms in prokaryotes.

UNITS	No. of Hours
UNIT I - MOLECULAR BASIS OF GENETIC INFORMATION	15
a. History and scope of Microbial Genetics	1
b. Central Dogma of Molecular Biology	1
c. Nucleotides and Nucleic acids	1
d. Historical Evidence of Nucleic Acids (Contributions of Friedrich Miescher, Phoebus Levene, Frederick Griffith, Avery, MacLeod, McCarty, Hershey & Chase, Watson, Crick and Franklin, Erwin Chargaff and Fraenkel Conrat)	3
e. DNA structure (Watson and Crick model), salient features of DNA double helix, Forms of DNA, Denaturation and Renaturation of DNA	2
f. RNA structure and types of RNA	2
g. DNA Topology	1
h. Genome organization in Viruses, Prokaryotes and Eukaryotes	2
i. Plasmids: Structural features, biological functions, and classification of natural plasmids	2
UNIT II – GENOME DYNAMICS	15
a. Mutations: Definition and types, Spontaneous and Induced, Physical and Chemical mutagens and their mode of action, Site directed mutagenesis.	4
b. DNA repair: Photo reactivation repair, nucleotide excision repair and	2

mutHLS repair system	
c. Prokaryotic transposable elements – Insertion Sequences, composite and non- composite transposons, Mechanism of transposition and applications of transposons.	2
d. Mechanism of Genetic Exchange and its Significance i) Transformation: Discovery and mechanism of natural competency and transformation ii) Conjugation: Discovery and mechanism of Conjugation iii) Transduction: Discovery and mechanism of Transduction	7
UNIT III - CENTRAL DOGMA PROCESSES AND REGULATORY MECHANISMS IN PROKARYOTES	15
a. DNA replication in prokaryotes: Messelson and Stahl’s experiment, Models of DNA Replication (Theta and Rolling circle) and mechanism of DNA Replication	4
b. Transcription: Definition, promoter - concept and strength of promoter, transcriptional Machinery and Mechanism of transcription	3
c. Translation - Genetic code, Translational machinery, charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptide synthesis	4
d. Overview of mechanisms (Unit III a,b, c) in eukaryotes	1
e. Regulation of gene expression in prokaryotes: Operon concept, Principles of transcriptional regulation, regulation initiation with examples: <i>lac</i> and <i>trp</i> operons	3

NOTE: 10 hours of self-study materials will be provided.

REFERENCES

Sl. No.	References
1	Nelson, D. L., & Cox, M. M. (2020). <i>Lehninger principles of biochemistry</i> (8th ed.). W.H. Freeman and Co.
2	Freifelder, D. (2020). <i>Molecular biology</i> (2nd ed.). Narosa Publishing House.
3	Strickberger, M. W. (2005). <i>Genetics</i> (4th ed.). Pearson.
4	Hartl, D. L. (2016). <i>Essential genetics: A genomics perspective</i> (6th ed.). Jones & Bartlett.
5	Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levin, M., & Losick, R. (2014). <i>Molecular biology of the gene</i> (7th ed.). Pearson.
6	Gardner, E. J., Simmons, M. J., & Snustad, D. P. (2020). <i>Principles of genetics</i> (9th ed.). John Wiley & Sons.
7	Snyder, L., & Champness, W. (2020). <i>Molecular genetics of bacteria</i> (4th ed.). ASM Press.
8	Lewin, B. (2020). <i>Genes XII</i> . Oxford University Press.

BLUEPRINT:

Code number: MB 5126

Title of the Paper: Molecular Genetics

Unit Number	Number of Hours	Total marks for which the questions are to be asked (including bonus questions)
Unit I	15	29
Unit II	15	29
Unit III	15	30
	45	88
Maximum marks for the paper (Excluding bonus question) = 60		

Practical V
MB 5P1 26- Molecular Genetics

(11 sessions; 3 hrs/week)

S.No	Experiment	Units/sessions
1.	Study the effect of physical (UV) mutagens on bacterial cells.	1
2.	Study the effect of chemical (Ethidium Bromide) mutagens on bacterial cells.	1
3.	Determination of mutagenicity of chemicals by AMES test.	2
4.	Study of Bacterial Conjugation.	2
5.	Isolation of bacterial genomic DNA.	1
6.	Agarose gel electrophoresis of Genomic DNA.	1
7.	Estimation of DNA by UV spectrophotometry (A260 measurement)	1
8.	Isolation of Plasmid DNA	1
9.	Agarose gel electrophoresis of Plasmid DNA and studying the conformation of plasmid DNA.	1

Course Outcomes for MB 5126 & MB 5P 126

At the end of the course, the students will be able to

CO1	Gain foundational knowledge of genes, their structure, expression, and regulatory mechanisms.
CO2	Develop a comprehensive understanding of genetic processes in microbial systems.
CO3	Acquire practical skills in isolating bacterial and plasmid DNA, gel electrophoresis, and genetic exchange and mutational analysis.
CO4	Critically analyze and interpret experimental data in molecular genetics
CO5	Recognize and compare genetic mechanisms across different microbial species.
CO6	Design and execute experiments related to molecular genetics.

DEPARTMENT OF MICROBIOLOGY

Semester	V
Paper Code	MB 5226
Paper Title	Immunology and Medical Microbiology
Number of teaching hours per week 03	03
Total number of teaching hours per semester	45
Number of credits	03

Objective of the Paper:

To acquire fundamental knowledge of the basic principles of immunology and to understand how these principles apply to the process of immune function.
The course also provides the conceptual basis for understanding pathogenic microorganisms and the mechanisms by which they cause diseases in the human body.

UNIT-I Basic concepts of Immunology	15
a. Immunity: Definitions, types (natural, acquired, active and passive).	2
b. Cells and organs of the immune system: Structure, function and properties. Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell. Immune Organs–Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT.	6
c. Antigens: Definitions, types of antigens, factors influencing immunogenicity.	2
d. Immunoglobulins: Definition, structure, types, properties and functions.	3
e. Principle and Production of monoclonal antibodies and their applications.	2
UNIT-II Immune Responses and Techniques	15
a. Immune response: AMI and CMI.	1
b. Techniques based on antigen-antibody interactions: Precipitation, agglutination, complement fixation, ELISA, RIA	3
c. Complement system: Properties, components, pathways and functions.	2
d. Hypersensitivity: Types (I, II, III, IV), mediators of hypersensitivity reactions, mechanism of mast cell degranulation and detection of Type I hypersensitivity.	2
e. Major histocompatibility complex (MHC): Classes, Structure, and function.	2
f. Transplantation immunology: Types, graft acceptance, genetic basis of graft rejection. Mechanism and manifestations of graft rejection.	2

g. Vaccines: Definition, types and examples.	3
UNIT-III Medical Microbiology	15
a. Infection: Definition, primary, nosocomial, inapparent, atypical. Sources of infection, methods of transmission of infection. Factors or mechanisms of microbial pathogenesis. Types of infectious diseases.	5
b. Normal human flora.	1
c. Important groups of pathogenic microorganisms: (signs, symptoms, antigenic structure, pathogenesis, diagnosis, epidemiology, prophylaxis and chemotherapy).	9
Bacterial	
a. Enterobacteriaceae (<i>Salmonella</i>).	
b. Gram +ve cocci (<i>Staphylococcus</i>).	
c. <i>Mycobacterium tuberculosis</i> .	
Protozoan	
a. <i>Plasmodium</i> .	
b. <i>Entamoeba</i> .	
Fungal	
a. <i>Candida</i> .	
b. <i>Aspergillus sp.</i>	
Viral	
a. Hepatitis B.	
b. Emerging pathogen - (Corona).	

NOTE: 10 hours of self-study materials will be provided.

REFERENCES:

1.	Ananthanarayan and Paniker (2006). <i>Text book of Microbiology</i> . 8 th Edition. Hyderabad. Orient Longman publication.
2.	David Greenwood, Richard C.B. Slack and John. F. Peutherer (2008). <i>Medical Microbiology</i> . 7 th Edition, New Delhi. Elsevier India Private Ltd.
3.	Jawetz, Melnick and Adelbergs (2010). <i>Medical Microbiology</i> . 25 th Edition. USA. McGraw Hill Companies.
4.	Jenni Punt, Sharon A Stranford, Patricia P Jones, Judith A Owen, Janis Kuby (2019). <i>Immunology</i> , 8 th Edition; New York. W.H. Freeman and Company.
5.	Kenneth Murphy, Caesar Weaver, Charles Janeway (2017). <i>Janeway's Immunobiology</i> . 9 th Edition. New York. Garland Science.
6.	Michael Barer, W L Irving (2018). <i>Medical Microbiology</i> 19 th Edition.
7.	Peter J. Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt (2017). <i>Roitts Essential Immunology</i> , 13 th Edition, Oxford. Wiley Blackwell.
8.	Linda Sherwood, Christopher J. Woolverton, Lansing M. Prescott, and Joanne M. Willey (2011). <i>Prescott's Microbiology</i> . 7 th Edition. New York: McGraw-Hill.

BLUEPRINT:

Code number: MB 5226

Title of the paper: Immunology & Medical Microbiology

Unit Number	Number of Hours	Total marks for which the questions are to be asked (including bonus questions)
I	15	29
II	15	29
III	15	30
Total	45	88
Maximum marks excluding bonus questions=60		

Practical VI
MB 5P 226 – Immunology and Medical Microbiology
(11 sessions; 3hrs/week)

S. no	Experiments	Units
1.	RID (Radial Immuno Diffusion)	1
2.	ODD (Ouchterlony Double Diffusion)	1
3.	Blood grouping	1
4.	WIDAL and RPR	1
5.	DOT ELISA	1
6.	Pregnancy (hCG) test and Coagulase test	1
7.	Study of bacterial flora of skin by swab method: Characterize bacteria on the basis of cultural, morphological and biochemical features. Gram's staining.	3
8.	Perform antibacterial sensitivity by Kirby-Bauer method	1
9.	Spotters: AFB, <i>Staphylococcus</i> , <i>Plasmodium</i> , <i>Entamoeba</i> , <i>Candida</i> .	1

Course outcomes for MB 5226 and MB 5P2 26

At the end of the Course, the Student will be able to

CO1	<ul style="list-style-type: none">a. Understand the basic concepts of the protective role of the immune system in the host against pathogens.b. Introduce and describe the importance of pathogenic microorganisms in human diseases and the various parameters of assessment of their severity and methods of diagnosis.
CO2	<ul style="list-style-type: none">a. Explain and distinguish the basic components and mechanism underlying the immune system and its response against pathogens.b. Gain knowledge of the pathogenic mechanisms in establishing diseases
CO3	<ul style="list-style-type: none">a. Compare and contrast between different pathogens.
CO4	<ul style="list-style-type: none">a. Apply the immunological techniques learnt in research and industry.b. Apply the knowledge gained to use various laboratory methods to culture, identify and control pathogens.
CO5	Assess and interpret strategies for diagnosis, prevention and control of diseases.

DEPARTMENT OF MICROBIOLOGY

Semester	V
Paper Code	MB 5326
Paper Title	Microbes in Sustainable Agriculture and Environment
Number of teaching hours per week	03
Total number of teaching hours per semester	45
Number of credits	03

Objective of the Paper:

This paper deals with the impact of the occurrence and explores the use of microorganisms in agriculture and environment highlighting both beneficial and detrimental effects in understanding the role of microbes in soil, air and water, diseases in plants, the process of degradation and clean-up of polluted environments provided by a large group of microbes.

AGRICULTURAL MICROBIOLOGY	
UNIT-I	8
Soil Microbiology	
a. Microbiology and biochemistry of root-soil interface; Soil profile, Rhizosphere- definition, structure, root exudation, role of root exudates, factors affecting rhizosphere microorganisms. Rhizosphere effect and soil enzymes. Promoting sustainable farming (soil health card)	4
b. Microbial transformations of carbon, nitrogen and phosphorus in soil.	2
c. Role of microorganisms in Humus formation	1
d. Mycorrhiza: Role of AMF in Agriculture.	1
UNIT- II	8
Plant-Microbe Interactions	

<p>a. Biofertilizers: General account of the microbes used as biofertilizers for various crop plants and their advantages over chemical fertilizers and Organic farming. (PKVY). Symbiotic N₂ fixers: <i>Rhizobium</i> - Isolation, characteristics, types, inoculum production and field application.</p>	2
<p>b. Cyanobacteria, Azolla - Mass multiplication, Role in rice cultivation.</p>	1
<p>c. Non - Symbiotic Nitrogen Fixers Free living: <i>Azotobacter</i>: isolation, characteristics, mass inoculum production and field application.</p>	1
<p>d. Phosphate Solubilizers, Mycorrhizal Biofertilizers: Importance of mycorrhizal inoculum, types of mycorrhizae, Mass inoculum production of AMF.</p>	2
<p>e. Bioinsecticides: <i>Bacillus thuringiensis</i>: production and mode of action.</p>	2
<p>Viruses – importance of Nuclear Polyhedrosis Viruses, Cytoplasmic Polyhedrosis Viruses, Granular Polyhedrosis Viruses.</p>	2
<p>UNIT-III Plant Pathology</p>	8
<p>a. Concept of plant disease- definitions of disease, disease cycle & pathogenicity, symptoms associated with microbial plant diseases, types of plant pathogens</p>	1
<p>b. Stages in development of a disease: Infection, invasion, colonization, dissemination of pathogens and perennation.</p>	1
<p>c. Downy mildew disease, Citrus canker and Tobacco mosaic disease.</p>	2
<p>d. General Principles and methods of plant disease control: Avoidance, Eradication, Chemical (Copper fungicides, Organomercurials and fumigants) and biological control.</p>	4
<p>ENVIRONMENTAL MICROBIOLOGY UNIT-IV Aeromicrobiology</p>	7
<p>a. Bioaerosols, Air sanitation and Air borne microorganisms (Bacteria: Legionellosis, Viruses: Viral meningitis, Fungi: Blastomycosis) and their impact on human health and environment, aero allergens</p>	3
<p>b. Air samplers: Impaction on solids (Roto rod sampler, Andersen's sampler) Impingement in liquid (Bead bubbler device, All Glass impinger) Sedimentation (Gravity slide and petridish technique).</p>	3
<p>c. Acid rain and Greenhouse effect.</p>	1
<p>UNIT-V Aquatic Microbiology</p>	7

a. Water borne pathogens and water borne diseases (Bacteria: Shigellosis, Protozoa: Giardiasis)	1
b. Clean water and sanitation; Microbiological Analysis of Water: Sample Collection, Treatment and safety of drinking (potable) water, methods to detect potability of water samples: i) Presumptive/MPN tests, confirmed and completed tests for faecal coliforms ii) Membrane filter technique	2
c. Liquid waste management: Composition and strength of sewage (BOD and COD)	2
d. Wastewater treatment: Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment.	2
UNIT VI Biodegradation, Bioremediation and Sustainability	7
a. Microbial degradation of cellulose, lignin and Pectin.	1
b. Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill).	2
c. Microbial leaching of ores - copper ore.	1
d. Affordable clean energy and Biofuels (Biogas).	1
e. Microbial Bioremediation: Scope and types of bioremediations. Bioremediation of ground water, oil spills and Xenobiotics).	2

NOTE: 10 hours of self-study materials will be provided.

REFERENCES:

1	Agrios, G. (2005) Plant Pathology. 5th Edition, Elsevier Academic Press, Amsterdam,
2	Environmental and Agricultural Microbiology Applications for Sustainability Edited by Bibhuti Bhusan Mishra Suraja Kumar Nayak Swati Mohapatra Deviprasad Samantaray Wiley Global Headquarters 111 River Street, Hoboken, NJ 07030, USA.
3	Singh, C., Tiwari, S., Singh, J. S., & Yadav, A. N. (Eds.). (2020). <i>Microbes in agriculture and environmental development</i> . CRC Press.
4	Rao, N. S. (Ed.). (2016). <i>Advances in agricultural microbiology</i> . Elsevier.
5	Microbiology for Sustainable Agriculture, Soil Health, and Environmental Protection" Deepak Kumar Verma <u>Apple Academic Press</u> .
6	Mitchell, R., & Gu, J. D. (Eds.). (2010). <i>Environmental microbiology</i> . John Wiley & Sons.
7	Bagyaraj, D. J., & Rangaswami, G. (2007). <i>Agricultural microbiology</i> . PHI Learning Pvt. Ltd..

8	"Environmental and Agricultural Microbiology: Applications for Sustainability" (2021) Mishra, Nayak, Mohapatra, and Samantaray, John Wiley & Sons
9	Pepper, I., Gerba, C. P., Gentry, T., & Maier, R. M. (Eds.). (2011). <i>Environmental microbiology</i> . Academic press.
10	Verma, D. K. (Ed.). (2019). <i>Microbiology for sustainable agriculture, soil health, and environmental protection</i> . CRC Press.

BLUEPRINT:

Code number: MB 5326

Title of the Paper: Microbes in Sustainable Agriculture and Environment

Unit number	Number of Hours	Total marks for which the questions are to be asked (including bonus questions)
Unit I	8	15
Unit II	8	15
Unit III	8	16
Unit IV	7	13
Unit V	7	14
Unit VI	7	13
	45	88
Maximum marks for the paper (Excluding bonus question) = 60		

Practical VII

MB 5P3 26 - Microbes in Sustainable Agriculture and Environment

(11 sessions; 3hr/week)

S. No.	Experiment	Units
1	Isolation and identification of fungi from Rhizosphere soil	1
2	Isolation and study of <i>Rhizobium</i> from root nodules	1
3	Isolation of Phosphate solubilizing bacteria and fungi	1
4	Fungal type study- <i>Rhizopus</i> , <i>Aspergillus</i> , <i>Penicillium</i> , <i>Trichoderma</i> , <i>Fusarium</i> and <i>Alternaria</i>	1
5	Spotters- Plant pathology: Downy mildew disease, Citrus canker, Tobacco Mosaic disease	1
6	Isolation and identification of bacteria and fungi from water and air	1
7	Determination of BOD from waste water	1
8	Bacteriological quality testing of potable water- MPN	2
9	Degradation of cellulose by fungi	1
10	Spotters -Air samplers	1

Course outcomes for MB 5326 and MB 5P3 26

At the end of the course, the student will be able to:

CO1	Appreciate the role of microorganisms in nutrient cycling in the soil
CO2	Correlate the importance of microbial inoculum in enhancing the growth and yield of crops
CO3	Understand the concepts of microbial diseases and disease management in plants
CO4	Identify airborne microorganisms, allergens and their impact on human health
CO5	Assess the importance of water borne infections, microbes in potable water and treatment of water
CO6	Integrate the process of degradation, waste management. and methods of bioremediation to reduce the toxicity in the environment

Department of Microbiology

Semester	V
Paper Code	MB 5S 26
Paper Title	Foundations and Applications of Bioinformatics
No. of Teaching hours/week	2
Total no. of teaching hours per semester	30
No. of Credits	2

Objective:

To provide foundational knowledge and hands-on experience in the field of bioinformatics by exploring key biological databases, computational tools, and applications in genomics, proteomics, and personalized medicine.

Unit - I	15
a. Introduction to Bioinformatics	
Definition and scope of bioinformatics	1
Role in genomics, proteomics and drug discovery	1
b. Biological Databases	
Primary vs. secondary databases	1
NCBI, EMBL-EBI, DDBJ	2
UniProt, KEGG	1
Data retrieval using Entrez and BLAST	1
c. Sequence Alignment	
Pairwise alignment: global (Needleman-Wunsch), local (Smith-Waterman)	2
Tools: EMBOSS Needle, BLAST, FASTA	2
d. Multiple Sequence Alignment & Phylogenetics	
MSA algorithms: Clustal Omega, MUSCLE	1
Phylogenetic tree construction (UPGMA, NJ)	2
Evolutionary relationships and tree interpretation (MEGA)	1
Unit - II	15
a. Protein Structure and Proteomics	
Protein structure: primary to quaternary	1
Structural databases: PDB	1
Protein visualization using PyMOL	1
Target prediction tools: SWISS-Target prediction, PASS Target prediction, alphaFold2.	2

Bioinformatics Applications	
Personalized medicine, drug design	1
Molecular docking basics (Tools – Autodock)	4
Docking results visualization – Ligplot/PyMOL	1
Bioinformatics Pipelines (online resources)	
Introduction to Galaxy	1
Microbiome data analysis (16S rRNA sequencing workflows)	3

References

1	Bioinformatics: Sequence and Genome Analysis – David W. Mount.
2	Bioinformatics for Dummies – Jean-Michel Claverie & Cedric Notredame.
3	Introduction to Bioinformatics (<i>5th ed.</i>). <i>Oxford University Press Lesk, A. M. (2019).</i>
4	Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins (<i>3rd ed.</i>). <i>Wiley-Interscience Baxevanis, A. D., & Ouellette, B. F. F. (2004).</i>
5	Online Platforms: NCBI tutorials, EMBL-EBI Train Online, Galaxy

Course Outcomes for MB 5S 26

At the end of the Course, the Student will be able to

CO1	Explain the fundamental concepts, scope, and interdisciplinary applications of bioinformatics in genomics, proteomics, and drug discovery.
CO2	Retrieve and analyze biological data using major databases such as NCBI, EMBL-EBI and KEGG.
CO3	Perform sequence analysis using alignment tools (e.g., BLAST, FASTA, EMBOSS), and interpret results through multiple sequence alignment and phylogenetic tree construction.
CO4	Describe and analyze protein structures using structural bioinformatics tools like PDB and visualization software (e.g., PyMOL).
CO5	Utilize bioinformatics pipelines and platforms such as Galaxy to process microbiome data.
CO6	Design and present a mini-project related to sequence analysis and drug design.

Department of Microbiology

Semester	V
Paper code	MB 5RM 25
Paper title	Research Methodology
Number of teaching hours per week	2
Total number of teaching hours per semester	30
Number of Credits	2

Objective of the Paper

This course aims to provide undergraduate students of Microbiology with a comprehensive understanding of the principles and processes of scientific research. It is designed to develop scientific thinking and problem-solving abilities by introducing students to research design, experimental planning, and laboratory documentation. The course also emphasizes the importance of ethical conduct, biosafety, and integrity in biological research. In addition, it equips students with essential skills in scientific writing, research communication, and presentation, thereby preparing them for project work, higher studies, and research-oriented careers in microbiology.

UNIT I Introduction to Research & Scientific Thinking	8 Hours
<ul style="list-style-type: none"> a) Concept, meaning, and objectives of research. b) Types of research: basic, applied, and translational (with microbiology examples). c) Scientific method and logical reasoning in biological sciences. d) Scope and importance of research in microbiology. e) Identification of research problems in microbiology. f) Review of literature: Primary, secondary, and tertiary sources Introduction to online databases: PubMed, Google Scholar g) Identification of research gaps. h) Research questions and objectives. i) Hypothesis: concept, types, and formulation. 	
UNIT II Research Design & Experimental Planning	7 Hours
<ul style="list-style-type: none"> a) Research design: concept and importance b) Types of research designs: Exploratory, descriptive, and experimental c) Controls, replication, and randomization d) Sampling techniques in microbiology: Environmental samples, Clinical samples e) Experimental planning in microbiology: Culture-based experiments; Environmental microbiology studies; Clinical and diagnostic microbiology studies f) Validity, reliability, and reproducibility 	

UNIT III Data Collection, Laboratory Documentation & Biosafety	5 Hours
<ul style="list-style-type: none"> a) Types of data: qualitative and quantitative b) Methods of data collection in microbiology c) Laboratory record keeping: Research notebooks and data sheets d) Standard Operating Procedures (SOPs) e) Quality control in microbiological experiments f) Biomedical waste management and biohazard disposal g) Ethical handling and maintenance of microbial cultures 	
UNIT IV Scientific Writing, Ethics & Research Communication	10 Hours
<ul style="list-style-type: none"> a. Scientific Writing: b. Structure of a scientific paper: Title, abstract, introduction, materials and methods, results, discussion, references. c. Basics of writing a research proposal. d. Citation and referencing styles: Vancouver style (introductory). Tools for citation (Mendeley/Zotero) e. Plagiarism: Types, consequences, and prevention Plagiarism detection tools (overview) f. Research Ethics & Integrity: Ethics in scientific research; Research misconduct: fabrication, falsification, plagiarism; Human ethics and informed consent (overview); Animal ethics (CPCSEA – basic awareness). Responsible use of AI. g. Research Communication: Oral and poster presentations; Scientific report and project writing (basics). 	

References:

1.	Kothari, C. R. (2004). <i>Research methodology: Methods and techniques</i> (2nd ed.). New Age International Publishers.
2.	Day, R. A., & Gastel, B. (2012). <i>How to write and publish a scientific paper</i> (7th ed.). Cambridge University Press.
3.	Sinha, S. C., & Dhiman, A. K. (2002). <i>Research methodology</i> . Ess Ess Publications.
4.	Zar, J. H. (2010). <i>Biostatistical analysis</i> (5th ed.). Pearson Prentice Hall.
5.	University Grants Commission. (2019). <i>Publication ethics and research integrity</i> .
6.	Indian Council of Medical Research. (2017). <i>National ethical guidelines for biomedical and health research involving human participants</i> . ICMR.

Course Outcomes for MB 5RM 25: Research Methodology

After completing the course, students will be able to:

CO1	Identify research problems and formulate hypotheses in microbiology.
CO2	Design and plan microbiological experiments.
CO3	Maintain laboratory records and follow SOPs and biosafety guidelines.
CO4	Prepare basic scientific reports and research proposals.
CO5	Apply ethical principles and research integrity in microbiological research.

DEPARTMENT OF MICROBIOLOGY

Semester	VI
Paper Code	MB 6126
Paper Title	Dimensions and Applications in Food and Dairy Microbiology
Number of teaching hours per week	03
Total number of teaching hours per semester	45
Number of credits	03

Objective of the Paper:

Food and Dairy Microbiology paper deals with the role of microorganisms in food preparation and dairy products, its processing, control of microbial activity which causes spoilage of food and dairy products and infections in humans.

UNIT – I Food Microbiology	7
a. Scope of food microbiology.	1
b. Food as a substrate for the growth of microorganisms. Chemical and physical properties of food– pH, water activity, redox potential, nutrients, antimicrobial compounds.	2
c. Sources of spoilage of foods and spoilage of cereals, fruits, vegetables, meat and canned foods.	2
d. Change in color and flavour, degradation of carbohydrates, proteins and fats, change in organoleptic properties.	2
UNIT-II	7
a. Fermented foods: Kimchi, Tempeh, Sauerkraut, Bread, Kombucha, and Cocoa.	5
b. Microbes: Food for the future- MP and SCO.	2
UNIT-III	9
Food preservation: Principles of food preservation.	
a. Physical methods: Low temperature preservation, Canning, Dehydration, Use of Radiations.	3
b. Use of chemical preservatives – Class I- Traditional preservatives: Salt, Sugar, Wood Smoke, Vinegar. Class II- Chemical preservatives: Organic acid (Benzoic acid, Sorbic acid, Propionic acid,) Nitrites, Nitrates, Sulphur dioxide, Ethylene dioxide, and bio preservation.	4
c. Food sanitation and control agencies-HACCP, FSSAI.	2
UNIT-IV	7

1. Microbial food intoxication and infection: Organisms causing food poisoning their sources and prevention. a. <i>Staphylococcus aureus</i> b. <i>Clostridium botulinum</i> c. <i>Bacillus cereus</i> d. <i>Clostridium perfringens</i> e. <i>Salmonella</i> f. <i>Listeria</i> .	4
2. Mycotoxins – Aflatoxin B1, G1 –structure, sources, detection, mode of action and detoxification methods.	1
3. Algal food toxins: Toxic syndromes associated with Marine Algal Toxins	1
4. Food packaging: Plastics, Paper, Cardboard, Glass, Metals, Edible materials and antimicrobial packaging.	1
UNIT-V Dairy Microbiology	8
a. Definition, composition and types of milk – skimmed, toned and whole.	1
b. Sources of microbial contamination of milk, microflora of raw milk Microbiological analysis of milk: Rapid Platform Tests, Dye reduction tests – MBRT and Resazurin Test. Total bacterial count, Brucella ring test and Test for Mastitis.	3
c. Spoilage of milk Succession of microorganisms in milk Color, flavor defects and biochemical changes in milk -sweet curdling, Stormy fermentation and Ropiness.	2
d. Pasteurization of milk: Methods of pasteurization – LHT, HTST, UHT. Tests for determination of efficiency of pasteurization- Alkaline Phosphatase and Lactoperoxidase tests.	2
UNIT-VI	7
a. Microbiology of Starter cultures in Dairy Fermentation: role of starter cultures, ecology, classification and types of starter cultures.	1
b. Use of microbial enzymes in dairy foods.	1
c. Milk products: long term preservation of milk (preparation of milk powder, condensed, sweetened milk, sterilized [tetra pack] milk Types and production of: Butter, Cheese (Cheddar and Cottage), Yoghurt.	2
d. Prebiotics, Probiotics, Synbiotics and Postbiotics: concept, definition, types, sources, significance on gut microflora. Other traditional fermented milk products – Kefir, Shrikhand, Acidophilus Milk.	3

NOTE: 10 hours of self-study (study materials and videos will be provided)

REFERENCES:

1.	Adams, M.R., & Moss, M. O. (1995). <i>Food microbiology</i> . The Royal Society of Chemistry.
2.	Dubey, R.C., & Maheswari, D.K. (1999). <i>A Textbook of Microbiology</i> (1st ed.). S. Chand Publishing.
3.	Frazier, W. C., & Westhoff, D.C. (2013) <i>Food Microbiology</i> (5th ed.). McGraw-Hill

	Education.
4.	Jay, J. M. (1992). <i>Modern food microbiology</i> (4th ed.). Van Nostrand Reinhold.
5.	Parihar, P., & Parihar, L. (2015). <i>Dairy microbiology</i> . Agrobios (India).

BLUEPRINT:

Code number: MB 6126

Title of the Paper: **Dimensions and Applications in Food and Dairy Microbiology**

Unit number	Number of Hrs.	Total marks for which the questions are to be asked (including bonus questions)
Unit I	7	13
Unit II	7	13
Unit III	9	19
Unit IV	7	13
Unit V	8	17
Unit VI	7	13
	45	88
Maximum marks for the paper (Excluding bonus questions) = 60		

Practical VI

MB 6P1 26 – Dimensions and Applications in Food and Dairy Microbiology

(3 hours/11 sessions)

S. No	Experiment	Units
1.	Isolation and identification of bacteria and fungi from stored and fermented foods.	2
2.	Isolation and Enumeration of <i>Salmonella</i> and <i>Staphylococcus</i> from processed meat/chicken and ready to eat street foods.	1
3.	Production of Aflatoxins from bakery products and detection by paper chromatography. Spotters – Aflatoxin (structure) and food borne pathogens(slide).	1
4.	Inhibitory effect of spices on microbial load in fish/ flesh food.	1
5	Detection of adulterants in food- Malachite green (green vegetables), Lead chromate (pulses), metanil yellow (chickpea powder).	1
6.	Enumeration of bacteria by SPC and DMC.	1
7.	Dye reduction tests-MBRT and Resazurin tests.	1
8.	Estimation of lactic acid and fat content in the milk.	1
9.	Estimation of lactose in milk whey.	1
10.	Detection of adulterants/ preservatives in milk- Cane sugar, Boric acid, formalin (Leach test), carbonates.	1

Course outcomes for MB 6126 and MB 6P1 26

At the end of the course, the student will be able to:

CO1	Gains insight into an understanding the role of microbes in food and dairy industry.
CO2	Have an understanding of the spoilage and preservation of food.
CO3	Apply the different techniques to prevent the spoilage of foods.
CO4	Compare the effects of microorganisms in food related illness.
CO5	Evaluate the role of different microorganisms for beneficial and harmful effects.
CO6	Develop strategies for beneficial product development for human consumption.

DEPARTMENT OF MICROBIOLOGY

Semester	VI
Paper Code	MB 6226
Paper Title	Industrial Microbiology and Bioprocess Technology
Number of teaching hours per week	03
Total number of teaching hours per semester	45
Number of credits	03

Objective of the Paper:

The objective of this paper is to provide students with a comprehensive understanding of the principles and applications of industrial microbiology, emphasizing the use of microorganisms and their metabolic processes for the production of commercially valuable products. The course aims to develop conceptual clarity in industrial fermentation processes, strain improvement strategies, media formulation, bioreactor design, and process control parameters. The paper will familiarize students with the concept of intellectual property rights in both national and international contexts.

UNIT-I	10
a. Introduction and scope of industrial fermentation process.	1
b. Isolation, screening and maintenance of industrially important microorganisms. Strain improvement methods: Mutation, Recombination and r-DNA technology.	7
c. Culture collection and types of culture collection centers.	1
d. Development of inoculum for industrial fermentations.	1
UNIT-II	12
a. Media for industrial fermentation process: Fermentation media: Natural media; synthetic media. Medium formulation- Carbon sources, Nitrogen sources, minerals, growth factors, buffers, precursors, inducers and inhibitors. Antifoaming agents.	2
b. Types of industrial fermentation process: batch culture, continuous culture, Fed batch culture. Surface and submerged fermentation processes.	3
c. Design of a fermenter: Basic features, design and components of a typical fermenter. Specialized bioreactors: stirred, airlift and fluidized bed bioreactor.	3
d. Sterilization of fermenter, medium, air supply; aseptic inoculation and sampling methods.	2 2
e. Control of process parameters – temperature, pH, O-R potential, aeration, agitation, contamination.	
UNIT-III	12

a. Upstream Bioprocess technology: Fermentative production of alcoholic beverages (wine), organic acids (citric acid), organic solvents (ethanol), vitamins (B12), antibiotics (Tetracycline) and enzymes (Protease).	6
b. Immobilization of enzymes and cells: methods, advantages and applications.	3
c. Nano-microbiology - Microbial synthesis of nanomaterials and their applications.	3
UNIT-IV	11
a. The recovery and purification of fermentation products (downstream processing): <ul style="list-style-type: none"> ▪ Removal of microbial cell and other solid matter ▪ Foam separation ▪ Precipitation ▪ Filtration (Rotary Vacuum filters) ▪ Centrifugation (Basket centrifuge) ▪ Cell disruption: (i) Physico-mechanical method -Ultrasonication (ii) Chemical method: Osmotic shock ▪ Liquid-Liquid Extraction-Flow current extraction system ▪ Solvent Recovery: (i) Continuous distillation (ii)Two phase aqueous extraction ▪ Chromatography for purifying low concentration of metabolic products-adsorption chromatography ▪ Drying 	8
b. Quality control and assurance.	1
c. Intellectual Property Rights (IPR): Patent, Copyrights, Trademarks, Trade secret, Geographical indications, Industrial designs. International regimes relating to IPR: TRIPS and other treaties (WIPO, WTO, GATT). Activity based learning: Recent advances in industrial microbiology.	2

NOTE: 10 hours of self-study (study materials and videos will be provided).

REFERENCES:

1.	Casida, Lester Earl Casida. <i>Industrial Microbiology</i> , Wiley Eastern Ltd., New Delhi.
2.	Crueger W and Anneliese Crueger (2005). <i>Biotechnology: A text book of Industrial Microbiology</i> , Panima Publishing Corporation, New Delhi.
3.	Peppler H.J and D. Perlman (2008). <i>Microbial Technology fermentation technology</i> , Academic Press, New York.
4.	Stanbury P.F, Whitaker A and S. J. Hall (2013). <i>Principles of Fermentation Technology</i> , Elsevier Science Ltd, Burlington.

BLUEPRINT:

Code number: MB 6226

Title of the Paper: Industrial Microbiology and Bioprocess Technology

Chapter Number	Number of Hrs	Total marks for which the questions are to be asked (including bonus questions)
Unit I	10	20
Unit II	12	23
Unit III	12	23
Unit IV	11	22
	45	88
Maximum marks for the paper (Excluding bonus question) = 60		

Practical VI
MB 6P2 26- Industrial Microbiology and Bioprocess Technology
(3 hours/11 sessions)

S. No.	Experiment	Units
1.	Screening and isolation of Protease producing microorganisms and their preservation.	2
2.	Production and assay of microbial proteases.	1
3.	Production of wine using different substrates by <i>Saccharomyces cerevisiae</i> .	1
4.	Estimation of total and volatile acidity from wine.	1
5.	Batch production and estimation of citric acid.	1
6.	Immobilization of yeast cells by sodium alginate method.	1
7.	Alcohol estimation by specific gravity method.	
8.	Bacteria mediated synthesis of Zinc nanoparticles, detection and determination of antimicrobial activity.	2
9.	Spotters: - study of different types of fermenters-stirred, airlift and fluidized bed bioreactor.	1
10.	Industrial visit.	1

Course outcomes (MB 6226 and MB 6P2 26)

At the end of the course, the student will be able to

CO1	Understand the importance of microorganisms in various industries and their economic importance.
CO2	Identify various strategies to improve the ability of industrially important microbes.
CO3	Assess the design and functioning of various fermenters and control parameters.
CO4	Evaluate the downstream processes employed for different products and analyze the microbial products.
CO5	Compare the process control strategies to improve the yield.
CO6	Evaluate applications of industrial microbiology in food and pharma sectors.

DEPARTMENT OF MICROBIOLOGY

Semester	VI
Paper Code	MB 6326
Paper Title	Genetic Engineering for a Sustainable Future
Number of teaching hours per week	03
Total number of teaching hours per semester	45
Number of credits	03

Objective of the Paper:

This course is designed to help students explore how tiny organisms can make a significant impact on science, health, agriculture, and the environment. By learning the fundamentals, tools, and techniques of genetic engineering, students will gain practical knowledge of DNA manipulation, cloning strategies, Gene sequencing, genome editing, and modern applications like recombinant vaccines and bioremediation. Along the way, students will also reflect on the ethical dimensions of genetic engineering, thereby developing both technical expertise and responsible scientific thinking.

UNIT-1 Fundamentals and Tools	7
a. Fundamentals and scope of genetic engineering. b. Tools for genetic engineering -DNA manipulative enzymes: DNA polymerases, Restriction endonucleases, DNA Ligases, and other DNA-modifying enzymes.	2 5
UNIT-II Gene Cloning Vectors	8
a. Plasmids – Properties and types- pBR 322, pUC, and Ti. b. Phage DNA vectors: Lambda phage, M13 Phage. c. Cosmids. d. Animal viral vectors: SV40 and Ad5.	3 2 1 2
UNIT-III Strategies to Construct Recombinant DNA and Screening	13

a. <i>In vitro</i> construction of r-DNA molecules: Isolation of passenger DNA from bacteria (gene of interest) and isolation of vector DNA (Bacteria), Cutting of DNA molecules- Physical methods, enzymatic methods & Joining of DNA molecules - Homopolymer tails, Linkers, Adapters.	5
b. Polymerase chain reaction (PCR) and its applications.	2
c. Transformation of r-DNA into target host organisms: Calcium chloride-mediated gene transfer, Agrobacterium-mediated DNA transfer, Electroporation, Microparticle bombardment.	3
d. Screening and selection of recombinant host cells: Insertional inactivation, in situ colony/DNA hybridization, and Immunological techniques, Blotting techniques (DNA, RNA, protein).	3
UNIT-IV Gene library construction and DNA sequencing	4
a. Genomic DNA libraries, cDNA synthesis - Principles, techniques, and applications.	2
b. DNA sequencing - Overview and applications of Maxam-Gilbert method, Sanger Sequencing, Illumina sequencing, and Nanopore sequencing	3
UNIT-V Genome Editing	3
a. Historical development, principles and applications of gene and genome editing techniques.	2
b. CRISPR-Cas9 (SDG 9- a catalyst for Industry and Innovation).	1
UNIT-VI Applied Genetic Engineering	7
a. Medicine and Health care: Molecular Diagnosis of diseases (RT-PCR for COVID-19); Recombinant Biologics (Insulin, Hepatitis B Vaccine), DNA fingerprinting (SDG 3 – Good health and well-being). Sequencing-based diagnostics.	4 2
b. Agriculture: Genetic control of fruit ripening; viricidal plants-Transgenic papaya resistant to Papaya Ringspot Virus PRSV (SDG 2 – Zero Hunger).	1
c. Environment: Genetically Engineered Microorganisms (GEMs) in bioremediation-Oil spill degrading <i>Pseudomonas putida</i> (SDG 13 – Climate Action).	1
UNIT-VII Ethical Concerns in Genetic Engineering	3
a. Definition and importance of Biosafety and Biosecurity.	1
b. Environmental impact of releasing GEMs and Genetically Modified (GM) crops into nature and safeguarding biodiversity (SDG 15- Life on Land).	1
c. Regulatory frameworks: International (Highlights of the Cartagena Protocol) and National (Highlights of the DBT Guidelines).	1

NOTE: 10 hours of self-study (study materials and videos will be provided)

REFERENCES:

1.	Brown, T. A. (2016). <i>Gene Cloning and DNA Analysis: An Introduction</i> . John Wiley & Sons.
2.	Glick, B. R., & Pasternak, J. J. (2003). <i>Molecular Biotechnology: Principles and Applications of Recombinant DNA</i> . Washington, D.C.: ASM Press.
3.	Old, R. W., & Primrose, S. B. (1981). <i>Principles of Gene Manipulation: An Introduction to Genetic Engineering</i> . Univ. of California Press.
4.	Sambrook, J. (2001). <i>Molecular Cloning: A Laboratory Manual</i> (3rd ed.). Cold Spring Harbor Laboratory Press.
5.	Satyanarayana, U. (2017). <i>Biotechnology</i> . Books and Allied (P) Ltd.

BLUEPRINT:**Code number: MB 6326****Title of the Paper: Genetic Engineering for a Sustainable Future**

Chapter Number	Number of Hrs	Total marks for which the questions are to be asked (including bonus questions)
Unit I	7	13
Unit II	8	16
Unit III	13	25
Unit IV	4	8
Unit V	3	6
Unit VI	7	14
Unit VII	3	6
	45	88
Maximum marks for the paper (Excluding bonus question) = 60		

Practical VI

MB 6P3 26- Genetic Engineering for a Sustainable Future

(3 hours/11 sessions)

S. No.	Experiment	Units
1.	Isolation and quantification of genomic DNA from bacterial cells.	2
2.	Extraction and purification of plasmid DNA from bacterial cells.	1
3.	Restriction enzyme digestion of DNA.	1
4.	DNA Ligation: Joining restriction-digested fragments for cloning.	1
5.	PCR-Based amplification of target DNA sequences.	1
6.	Separation and visualization of DNA fragments by Agarose gel electrophoresis.	2
7.	Bacterial transformation and determination of transformation efficiency.	2
8.	Demonstration of separation of proteins by SDS-PAGE (Sodium dodecyl sulphate-Polyacrylamide gel electrophoresis).	1

Course outcomes (MB 6326 and MB 6P3 26)

At the end of the Course, the student will be able to

CO1	Describe the fundamentals, scope, and tools of genetic engineering, including DNA enzymes and cloning vectors.
CO2	Demonstrate recombinant DNA construction techniques, PCR applications, and methods of gene transfer into host organisms.
CO3	Compare different cloning vectors, transformation strategies, and screening methods to evaluate their suitability in genetic engineering.
CO4	Assess gene library construction approaches and genome editing techniques for their scientific and practical impact.
CO5	Integrate genetic engineering in medicine, agriculture, and environmental applications to design innovative solutions for real-world problems.
CO6	Critically appraise biosafety, biosecurity, and ethical concerns, including national and international regulatory frameworks, in the responsible use of genetic engineering.

DEPARTMENT OF MICROBIOLOGY

Semester	VI
Paper Code	MB 6S 26
Paper Title	Microbial Data Analytics: From Plate to Plot
Number of teaching hours per week	02
Total number of teaching hours per semester	30
Number of credits	02

Objective of the Paper:

This course provides Microbiology students with practical, hands-on training in biostatistics, covering the complete data workflow—from data generation and collection to statistical testing, visualization, coding, and interpretation. Emphasis is placed on real microbiological datasets, software-based analysis, and experimental decision-making.

UNIT-I Types of Data & Dataset Familiarization	4
a. Types of datasets: CFU counts, Optical density (OD), Zone of inhibition, Biochemical test results.	1
b. Identifying independent and dependent variables.	1
c. Converting raw lab observations into analyzable datasets.	1
d. Understanding replicates and controls.	1
UNIT- II Descriptive Statistics and Graphical Representation of Microbiological Data	6
a. Choosing appropriate graph types.	1
b. Descriptive Statistics Calculating: - Mean, median, mode - Range, variance, standard deviation - Standard error and coefficient of variation.	2

REFERENCES:

1	Daniel, W. W. (2010). <i>Biostatistics: A foundation for analysis in the health sciences</i> (9th ed.). John Wiley & Sons.
2	Motulsky, H. (2014). <i>Intuitive biostatistics: A nonmathematical guide to statistical thinking</i> (3rd ed.). Oxford University Press.
3	Prescott, L. M., Harley, J. P., & Klein, D. A. (2017). <i>Microbiology</i> (10th ed.). McGraw-Hill Education.
4	Steve F (2019). <i>Introduction to Biostatistics with JMP</i> (1st ed). SAS Institute.
5	Zar, J. H. (2010). <i>Biostatistical analysis</i> (5th ed.). Pearson Education.

Course outcomes for MB 6S 26

At the end of the course, the student will be able to:

CO1	Identify and classify microbiological data types.
CO2	Perform descriptive and inferential statistical analyses.
CO3	Create dashboards for microbiological data visualization.
CO4	Analyze microbial data using spreadsheets and coding.
CO5	Interpret and report statistical results in microbiological context.