ST JOSEPH'S UNIVERSITY

BENGALURU-27

DEPARTMENT OF MICROBIOLOGY

SYLLABUS FOR POSTGRADUATE PROGRAMME

From 2022 onwards

SUMMARY OF CREDITS

DEPARTMENT OF MICROBIOLOGY (PG) (2021-2023)								
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 7121	Microbial Diversity	60	04	04	50	50	100
Theory	MB 7221	Cell Biology	60	04	04	50	50	100
Theory	MB 7321	Microbial Genetics	60	04	04	50	50	100
Theory	MB 7421	Microbiological Techniques	60	04	04	50	50	100
Practical	MB 7P1	Microbial Diversity and Cell Biology	88	08	04	15	35	50
Practical	MB 7P2	Microbial Genetics & Microbiological Techniques	88	08	04	15	35	50
Total Number of credits:			**24**					
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 8121	Microbial Physiology	60	04	04	50	50	100
Theory	MB 8221	Immunology	60	04	04	50	50	100
Theory	MB 8321	Molecular biology	60	04	04	50	50	100
Theory	MB 8421	Food Microbiology	60	04	04	50	50	100
Theory (DE)	MBDE 8521 (Paper V-A) OR MBDE 8621 (Paper V-B)	Agricultural Microbiology OR Environmental Microbiology	60	04	04	50	50	100
Note: Students can choose one of the departmental electives from Paper V-A or V-B								
Practical	MB 8P1	Immunology and Microbial Physiology	88	08	04	15	35	50

Practical	MB 8P2a MB 8P2b	Food & Agricultural Microbiology Food & Environmental Microbiology	88	08	04	15	35	50
Total Number of credits:			**28**					
Semester 3	**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 9121	Recombinant DNA Technology	60	04	04	50	50	100
Theory	MB 9221	Medical Microbiology	60	04	04	50	50	100
Theory	MB 9321	Industrial Microbiology	60	04	04	50	50	100
Theory	MB 9421	Biostatistics And Bioinformatics	60	04	04	50	50	100
Theory (OE)	MBOE 9521	Microbes and Us	30	02	02	15	35	50
	-	Industrial Visit	-	-	-	-	-	-
Note: Students choose open elective from other departments.								
Practical	MB 9P1	RDT and Medical Microbiology.	88	08	04	15	35	50
Practical	MB 9P2	Industrial Microbiology.	88	08	04	15	35	50
Total Number of credits:			**26**					
Semester 4	**Code Number**	**Title**	**No. of Hours**		**Number of credits**			**Total marks**
Theory	MB 0421	Dissertation	360		12			350
		IGNITORS/ OUTREACH			04			
Total Number of credits:			**16**					
Total No. of Credits: 94								
KEYWORDS: DE – Departmental Elective and OE – Open Elective								

CORE COURSES (CC)	
Course Title	Code Number
Microbial Diversity	**MB 7121**
Cell Biology	**MB 7221**
Microbial Genetics	**MB 7321**
Microbiological Techniques	**MB 7421**
Microbial Physiology	**MB 8121**
Immunology	**MB 8221**
Molecular biology	**MB 8321**
Food Microbiology	**MB 8421**
Recombinant DNA Technology	**MB 9121**
Medical Microbiology	**MB 9221**
Industrial Microbiology	**MB 9321**
Biostatistics And Bioinformatics	**MB 9421**

DISCIPLINE SPECIFIC ELECTIVE COURSES (DSE)	
Course Title	Code Number
Agricultural Microbiology	**MBDE 8521**
Environmental Microbiology	**MBDE 8621**

GENERIC ELECTIVE COURSES	
Course Title	Code Number
Microbes and Us	**MBOE 9521**

SKILL ENHANCEMENT COURSE (SEC) –	
Course Title	**Code Number**
Biostatistics And Bioinformatics.	**MB 9421**
Dissertation	**MB 0421**
Microbial Diversity and Cell Biology	**MB 7P1**
Microbial Genetics & Microbiological Techniques	**MB 7P2**
Immunology and Microbial Physiology	**MB 8P1**
Food & Agricultural Microbiology Food & Environmental Microbiology	**MB 8P2a** **MB 8P2b**
RDT and Medical Microbiology.	**MB 9P1**
Industrial Microbiology	**MB 9P2**

Course Outcomes and Course Content

DEPARTMENT OF MICROBIOLOGY

Semester	I
Paper Code	**MB 7121**
Paper Title	**MICROBIAL DIVERSITY**
Number of teaching hrs per week	4
Total number of teaching hrs per semester	60
Number of credits	4

OBJECTIVE:
To study the origin and evolution of life and its diversification. To be able to comprehend, classify and have a detailed understanding of the types of microorganisms.

UNIT I

EVOLUTION AND MICROBIAL TAXONOMY **18**

Evolution of life on earth: Theories of origin, Selection and types: r and K selection and Molecular clocks. 2

Microbial Taxonomy:
Natural system of classification, binomial nomenclature. Concepts of taxon, species, strain. Criteria used for classification. Three domain classification, classification according to Bergey's manual of systematic bacteriology. Introduction to archaea domain-extremophiles
Recent trends in Microbial Taxonomy: **a)** Chemotaxonomy: cell wall components, lipid composition, isoprenoid-quinones, cytochrome composition. **b)** Molecular method: DNA homology, G + C ratio, rRNA sequencing (principle & type of rRNA used in specific microbe identification) **c)** Numerical taxonomy **d)** Genetic methods in taxonomy, Basic concept/overview of Next Generation Sequencing and Barcoding.
Phylogenetic trees, methods for tree building – UPGMA & maximum parsimony
Evaluating phylogenies evolutionary models.
Fungal classification by Alexopolus and Mims (up to class level). 10

Classification of viruses by the Baltimore system. 1

Extremophiles: 5

Classification of microbes based on pH, temperature, pressure, salt concentration (Acidophilic, Thermophilic, Barophilic and Osmophilic microbes).

Extremozymes & applications

UNIT II

BACTERIOLOGY **13**

Ultrastructure, Growth and Reproduction in Bacteria: 11

An overview of bacterial size, shape and arrangement, Bacterial cell wall, Plasma membrane, Internal membrane systems, Cytoplasmic matrix, nucleoid, Inclusion bodies, Ribosomes, Flagella and pili, Bacterial motility and Endospore and sporogenesis.

Reproduction by fission, budding, conjugation.

Cultivation of bacteria: Aerobic, anaerobic, batch and continuous, culture media. Preservation of bacteria.

The domain Archaea, Archeal cell walls, membranes, RNA polymerase, their metabolism and major groups of Archaea. 2

UNIT III

MYCOLOGY AND PHYCOLOGY **15**

Introduction to fungi: General characteristics of fungi, morphology and thallus organization; fungal cell, hyphae, mycelium, tissue, hyphal modifications. 1

Ultrastructure of fungal cells: fungal cell wall, plasma membrane, cytoplasmic matrix, flagella, nuclear components. 2

General aspects of fungal growth and reproduction: Nutritional and environmental requirements, effect of environment on growth: pH, temperature, mechanism of growth in fungi; asexual, sexual and parasexual reproduction. 4

Fungi and ecosystem: Types of fungi - saprophytic, parasitic, keratinophilic, coprophilous, epiphytic, endophytic; substrate successions

Parasitism & mutualism with plants and animals.

Economic importance of fungi. (Medical significance) 2

Salient features of classes Ascomycetes, Zygomycetes, Basidiomycetes, Deuteromycetes. 4

Introduction to algae: general features, distribution, thallus construction, general mode of reproduction, Ultrastructure of typical cyanophycean cell. 2

Economic importance of algae.

UNIT IV

VIROLOGY

14

General virology: Brief outline on discovery of viruses, morphology and ultrastructure: capsid and their arrangements, types of envelopes and their composition, viral genome; theories of origin of viruses, culturing of viruses; Virus related agents: viroid and prions. 4

Bacterial viruses: Bacteriophage structural organization, life cycle of lysogenic (lambda) phage, lytic lysogenic switch, one step growth curve. 4

Plant viruses: Classification, nomenclature, structure and life cycle, effect on plants: TMV, Cauliflower mosaic virus. 1

Animal viruses: Classification, nomenclature, structure and life cycle of RNA viruses: Paramyxoviridae (Measles virus), Reoviridae (Rotavirus), Picornaviridae (Polio virus)
DNA viruses: Poxviridae (Vaccinia), Adenoviridae (Adenovirus). 5

Overview/general concept- how viruses evolve & shift from one host to another- effect of host habits and environment on the same.

Introduction/overview of emerging viruses causing outbreaks (self study)

NOTE: 8 hours of self-study assigned from the above units.

REFERENCES:

1. Alexopolus, C.J. and Mims, C.W. Introduction to Mycology, Wiley.
2. Atlas and Bartha; Microbial Ecology.
3. Flint, Principles of Virology, ASM press.
4. J.W. Deacon, Modern Mycology, Wiley Press.
5. Leppard and Dimmock, Introduction to Modern Virology, Sixth Edition, Blackwell Publishing.
6. Nester *et al*, 2004, Microbiology a human perspective, Mac Graw Hill Higher education.
7. O.P Sharma, Introduction to Algae, McGraw Hill Publication.
8. Prescott, Harley & Klein's,(2008), Microbiology, Mac Graw Hill Higher education.
9. Staley, Jerome, Microbial life 2nd edition (2007), Sinauer Associates inc, Massachusetts.

BLUEPRINT

Code number: MB 7121

Title of the paper: MICROBIAL DIVERSITY

Chapter/ Unit number	Number of hrs	Total marks for which the questions are to be asked (including bonus questions)
I	18	21
II	13	15
III	15	18
IV	14	17
TOTAL	**60**	**71**
Maximum marks for the paper (Excluding bonus question)= 50		

Course outcome (MB7121: Microbial Diversity)

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

CO1	Gain an in-depth insight into the diverse and evolving world of microorganisms
CO2	Have a detailed understanding of the types of microorganisms
CO3	Illustrate the similarities and differences of the microbial world
CO4	Comprehend the relative importance of microorganisms
CO5	Critique the contribution of microorganisms to the larger living world
CO6	Construct evolutionary relationships among emerging microorganisms

DEPARTMENT OF MICROBIOLOGY

Semester	I
Paper Code	**MB 7221**
Paper Title	**CELL BIOLOGY**
Number of teaching hrs per week	4
Total number of teaching hrs per semester	60
Number of credits	4

OBJECTIVE:

Cell biology is a science that explores the structures and functions of prokaryotic and eukaryotic cells. It deciphers the mechanisms of interactions and methods of communications between cells and their environment, and helps understand the basis of various biological processes.

UNIT I

EMERGENCE OF CELL BIOLOGY **1**

UNIT II

ORGANIZATION OF PROKARYOTIC AND EUKARYOTIC CELL **21**

Structural organization of: Cell membrane- fluid mosaic model, bi-lipid layer 2

Endomembrane system: Endoplasmic reticulum, golgi apparatus, lysosome, peroxisomes, vacuoles, mitochondria, chloroplast and nuclear components 5

Cytoskeleton: Components and structural functions, types of filament: microtubules, intermediate filaments, microfilaments– assembly and disassembly, molecular motors and sarcomere regulation, eukaryotic cell motility 6

Transport across membrane: Transmembrane transport of small molecules; endocytosis and exocytosis

Protein trafficking; vesicular trafficking

Prokaryotic type I, II, III secretion systems 4

Integrating cells into tissues: Cell junctions and adhesions (cell-cell and cell-matrix), extracellular matrix 4

UNIT III

CELL DIVISION, CELL CYCLE AND REGULATION **13**

Cell division: Bacterial- FtsZ division protein, MinCDE proteins, Bacterial aging 6
Eukaryotic- mitosis
Events in cell cycle, regulation of cell cycle and cancer and relevance of cancer stem cells, apoptosis 7

UNIT IV

BACTERIAL ADHESION TO HOST CELLS **2**

Structures involved and molecular mechanisms of microbial adhesion, effect of adhesion on host cells, pathogenecity islands.

UNIT V

CELL SIGNALING AND COMMUNICATION AMONG CELLS **23**

Signal transduction in prokaryotes: Two component systems
Quorum sensing in gram positive, gram-negative bacteria and interspecific, bioluminescence, Biofilms-organization, signals involved in their formation and dispersal, Quorum quenching and its applications 7

Signal transduction in eukaryotes: Overview of extracellular signaling- major classes of receptors, secondary messengers, common intracellular signaling proteins- GTPase switch proteins, protein kinases, adaptor proteins, application of small molecules for tracking signal transduction pathways. 3
G-protein coupled receptors and their effectors. 4
Receptor tyrosine kinases and Ras-MAP kinase pathway, JAK-STAT pathway 4
Intercellular receptor pathway- Ca^{2+} as messenger 2
Intracellular receptor pathway- NO as messenger 1

NOTE: 8 hours of self study assigned from the above units.

REFERENCES:

1. Gerald Karp 6th edition, Cell Biology, Wiley
2. Henderson *et. al* (2000), Cellular microbiology, John Wiley & Sons Ltd.
3. Lodish, Berk, Baltimore, (2000), Molecular Biology, 4th Edition, W.H. Freeman & co.
4. Bruce Alberts, 4th edition, Molecular Biology of the cell, Garland Science
5. Kostakioti M, Hadjifrangiskou M, Hultgren SJ. Bacterial biofilms: development, dispersal, and therapeutic strategies in the dawn of the post antibiotic era. Cold Spring Harb Perspect Med. 2013 Apr 1;3(4):a010306. doi: 10.1101/cshperspect.a010306. PMID: 23545571; PMCID: PMC3683961.
6. Deshpande N, Rangarajan A. Cancer Stem Cells: Formidable Allies of Cancer. Indian J Surg Oncol. 2015 Dec;6(4):400-14. doi: 10.1007/s13193-015-0451-7. Epub 2015 Aug 19. PMID: 27081258; PMCID: PMC4809849.
7. Costi D. Sifri, Quorum Sensing: Bacteria Talk Sense, *Clinical Infectious Diseases*, Volume 47, Issue 8, 15 October 2008, Pages 1070–1076, https://doi.org/10.1086/592072
8. Stewart EJ, Madden R, Paul G, Taddei F. Aging and death in an organism that reproduces by morphologically symmetric division. *PLoS Biol*. 2005;3(2):e45. doi:10.1371/journal.pbio.0030045

BLUEPRINT

Code number: MB 7221
Title of the paper: CELL BIOLOGY

Chapter/ Unit number	Number of hrs	Total marks for which the questions are to be asked (including bonus questions)
I	1	1
II	21	25
III	13	15
IV	2	3
V	23	27
TOTAL	**60**	**71**
Maximum marks for the paper (Excluding bonus question)= 50		

Course outcome (MB7221: Cell Biology)

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

CO1	Gain knowledge of organisms at the cellular level
CO2	Identify and understand the basic structure and functions of prokaryotic and eukaryotic cells
CO3	Acquire in depth knowledge of the structural complexities of cells, study the intracellular and intercellular interactions of cells.
CO4	Understand how prokaryotic and eukaryotic cells communicate amongst themselves using various diffusible signals.
CO5	Assess how pathogens can exploit cellular mechanisms to infect host cells and establish an infection.
CO6	Gain insight into applying the knowledge of cellular communications between pathogens to develop strategies to combat infections

DEPARTMENT OF MICROBIOLOGY

Semester	I
Paper Code	**MB 7321**
Paper Title	**MICROBIAL GENETICS**
Number of teaching hrs per week	4
Total number of teaching hrs per semester	60
Number of credits	4

OBJECTIVE:
This paper aims at gaining knowledge on the basic concepts and mechanisms in microbial genetics. It strengthens the understanding of the intricacies of cells at the molecular level.

UNIT I

NUCLEIC ACIDS **15**

a. Historical Perspective:

(i) DNA as the source of genetic information in bacteria and viruses: Griffith's experiment, Avery's experiment, Hershey and Chase experiment.

(ii) RNA as the source of genetic information in TMV - Frankel-Conrat's experiment, Retrovirus (HIV) 3

b. Organization and Molecular structure: DNA structure, forms of DNA, DNA topology, DNA supercoiling, VNTRs, mini and micro genomes, Satellite DNA, Structure of RNA (Unusual forms: Tetraloop, Pseudoknot and U:A:U base triple). Genome organization (prokaryotes). 9

c. Properties of DNA: Denaturation, Renaturation (Filter binding assay and concentration dependent renaturation) and DNA heteroduplexes, G-quadruplexes. 2

d. DNA constancy and C-value paradox. 1

UNIT II

DNA REPLICATION IN PROKARYOTES **8**

DNA replication in Prokaryotes: Origin of replication, replication fork, leading and lagging strand, semi conservative replication, rolling circle replication, enzymes involved in prokaryotic replication and DNA proof reading.

UNIT III

DNA MUTATION AND REPAIR **11**

a. Gene mutation: Genes as unit of mutation, Molecular basis of spontaneous and induced mutations and their role in evolution, mutagens, types of mutation, transposon mutagenesis, site-directed mutagenesis, Mutational hot spots, environmental mutagenesis and toxicity testing – AMES test. 6

b. Reversion: Same site revertant, Second site revertants, Second site revertants of frameshift mutations, intergenic reversion. 2

c. Repair: Biological indication of repair, Biochemical mechanisms for repair of thymine dimmers-Photoreactivation, Excision repair, Recombination repair, SOS repair. 3

UNIT IV

RECOMBINATION **7**

a. Recombination: Holliday Model; Double Strand Break Repair Model; Role of RecA, Rec BCD, RuvAB and RuvC in recombination. 2

b. Site-Specific Recombination: Types: Conservative site-specific recombination -recombination by serine recombinase; (ii) Transpositional recombination- Definition and mechanism of (a) DNA transposons-cut and paste mechanism, replicative mechanism; (b) viral-like retrotransposons- use of RNA intermediate and (iii) polyA retrosposons – reverse splicing mechanism. 4

c. Importance of mutation and recombination in the evolution of pathogens and Generation of knockouts. 1

UNIT V

TRANSPOSABLE ELEMENTS **5**

Overview of transposable elements in bacteria (IS elements, composite transposons and non composite transposons) and eukaryotes (yeast Ty elements, FB elements of *Drosophila*); Sleeping Beauty transposon system. Applications of transposons in genetic engineering.

UNIT VI

GENE TRANSFER MECHANISMS AND MAPPING **6**

Mechanism and Applications of bacterial transformation, Transduction, Conjugation, Complementation and Transfection. Transformation mapping, Mapping through interrupted mating, Transduction Mapping.

UNIT VII

PLASMIDS **4**

General features, Types of natural plasmids, F-factors- description and their used in genetic analysis, Colicins and Col factors. Plasmid DNA replication. Applications of plasmids in genetic engineering.

UNIT VIII

BACTERIOPHAGE **4**

Life cycle of bacteriophages and their uses in microbial genetics: T4, T7, P1, M13 and ϕX174.

NOTE: 8 hours of self study assigned from the above units.

REFERENCES:

1. Jocelyn E.Krebs, Elliott S. Goldstein and Stephen T. Kilpatrick (2011), Lewin's Genes X, 10th Edition; Jones and Bartlett Publishers, Canada.
2. Eldon John Gardner, Michael J. Simmons and Peter Snustad. S (2007), Principles of Genetics, 8th Edition, Wiley & Sons. (Asia) Pvt. Ltd, Singapore.
3. David Freifelder (2008), Molecular Biology, 2nd Edition, Narosa Publishing House Pvt. Ltd, New Delhi.
4. Benjamin A. Pierce (2008), Genetics-A conceptual Approach, 4th Edition, Kate Ahr Parker, W.H.Freeman and Company, England.
5. D.Peter Snustad and Michael J. Simmkons (2010) Principles of Genetics, 5th Edition, John Wiley & Sons (Asia) Pvt. Ltd, Singapore.
6. James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine and Richard Losick (2004), Molecular Biology of the gene, 5th Edition, Pearson Education, Inc. an Dorling Kindersley Publishing, Inc, California.
7. William S. Klug, Michael R. Cummings, Charlotte A. Spencer and Michael A. Palladino (2012) Concepts of Genetics, 10th Edition, Pearson Education, Inc, California.
8. David L. Nelson, Michael M. Cox (2017), Lehninger- Principles of Biochemistry, 7th Edition, W. H. Freeman and Company, New York.

BLUEPRINT

Code number: MB7321
Title of the paper: MICROBIAL GENETICS

Chapter/ Unit number	Number of hrs	Total marks for which the questions are to be asked (including bonus questions)
I	15	18
II	8	9
III	11	13
IV	7	8
V	5	6
VI	6	7
VII	4	5
VIII	4	5
TOTAL	**60**	**71**
Maximum marks for the paper (Excluding bonus question) = 50		

Course outcome (MB7321: Microbial Genetics)

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

CO1	Gain knowledge in the basic concepts of Microbial Genetics
CO2	Attain insight into the genetic processes of microbes
CO3	Execute the knowledge in practical demonstration of various genetic processes
CO4	Analyze distinct genomic datasets to construct linkage mapping.
CO5	Assess the importance of proteins and enzymes in genetic mechanisms
CO6	Design and conduct experiments in applied Microbiology

DEPARTMENT OF MICROBIOLOGY

Semester	I
Paper Code	**MB 7421**
Paper Title	**MICROBIOLOGICAL TECHNIQUES**
Number of teaching hrs per week	4
Total number of teaching hours per semester	60
Number of credits	4

OBJECTIVE:

This paper enables a student to identify microbes, analyse and characterise biomolecules using various techniques.

UNIT I

PROPERTIES OF WATER

Structure and interactions, water as a solvent, Proton mobility, Ionization of water, Non- covalent interactions of biomolecules.

ACIDS- BASES AND BUFFERS

Acid-base reactions (titration curve), Buffers (Henderson-Hasselbach equation), Biological buffers (Phosphate and Bi carbonate buffer) **5**

UNIT II

MICROSCOPY AND STAINING

a. Principles of Microscopy (Properties of light)
b. Light Microscopy
   Bright Field Microscope, Phase Contrast Microscope, Dark Field Microscope, Fluorescence Microscope, Stereo Microscope.
   Preparation and staining of specimen (simple, differential and structural staining),
c. Electron Microscopy
   Transmission Electron Microscope, Scanning Electron Microscope
d. Newer techniques in Microscopy
   Scanning Tunneling Microscope, Confocal Microscope, Atomic Force Microscope
e. Image analysis **15**

UNIT III

STERILIZATION TECHNIQUES

a. Control of microorganisms by physical agents
Fundamentals of control, Physical agents (high temperature, low temperature, desiccation, osmotic pressure, radiation, surface tension and interfacial tension, filtration) **4**

b. Control of microorganisms by chemical agents
Characteristics of an ideal antimicrobial chemical agent, Major groups of antimicrobial agents (phenol and phenolic compounds, alcohols, halogens, heavy metals, dyes, detergent, quaternary ammonium compounds, aldehydes, gaseous agents), Evaluation of antimicrobial chemical agents (tube dilution and agar plate techniques, phenol coefficient method) **4**

BIOASSAYS

Introduction to Bioassays, Antimicrobial assays, antiviral and anticancer assays, Microbiological assay of antibiotics, microbial susceptibility to chemotherapeutic agents **5**

UNIT IV

SEPARATION TECHNIQUES (PRINCIPLES, METHODS AND APPLICATIONS)

a. Chromatography (Thin layer chromatography, Ion exchange, Size exclusion, Affinity, gas and HPLC chromatography)
b. Centrifugation (Preparative and Analytical)
c. Electrophoresis (Horizontal and Vertical)
d. Cell sorting (FACS) **10**

SPECTROSCOPY TECHNIQUES (PRINCIPLES, METHODS AND APPLICATIONS)

Ultraviolet and Visible light spectroscopy, Fluorescence spectroscopy, IR spectroscopy, Mass spectroscopy (GC-MS, LC-MS, MALDI TOF), Circular dichroism, NMR. **12**

UNIT V

MOLECULAR METHODS OF MICROBIAL COMMUNITY ANALYSES

Phospholipids fatty acid analysis, nucleic acid techniques (DGGE/TGGE, RISA, SSCP, RAPD, PCR), fluorescent in situ hybridization (FISH). **5**

NOTE: 8 hours of self-study assigned from the above units.

REFERENCES:

1. David, Friefelder. Physical Biochemistry: Applications to Biochemistry and Molecular Biology.
2. Black, Jacquelyn G. Microbiology: Principles and Explorations. 7th ed, Wiley.
3. Willey, Joanne M, Linda Sherwood, Christopher J. Woolverton, Lansing M. Prescott, and Joanne M. Willey. Prescott's Microbiology. New York: McGraw-Hill
4. Wilson, Keith, and John Walker. Principles and Techniques of Biochemistry and Molecular Biology. 7th ed., Cambridge University Press.
5. Michael J. Pelczar, Roger D. Reid and Eddie Chin Sun Chan; Microbiology, Tata McGraw Hill Education
6. Rahman, Atta-ur & Choudhary, Muhammad Iqbal & Thomson, W. (2005). Bioassay Techniques for Drug Development.
7. Rastogi G., Sani R.K. (2011) Molecular Techniques to Assess Microbial Community Structure, Function, and Dynamics in the Environment. In: Ahmad I., Ahmad F., Pichtel J. (eds) Microbes and Microbial Technology. Springer, New York, NY. https://doi.org/10.1007/978-1-4419-7931-5_2

BLUEPRINT

Code number: MB7421
Title of the paper: MICROBIOLOGICAL TECHNIQUES

Chapter/ Unit number	Number of hrs	Total marks for which the questions are to be asked (including bonus questions)
I	5	6
II	15	18
III	13	15
IV	22	26
V	5	6
TOTAL	**60**	**71**
Maximum marks for the paper (Excluding bonus question)= 50		

Course outcome (MB7421: Microbiological Techniques)

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

CO1	Develop a good understanding of various techniques and instruments used in Microbiology
CO2	Understand the basic concepts of different techniques used to study microorganisms and biomolecules and apply biophysical principles to biological processes.
CO3	Apply the knowledge to handle various basic/advanced techniques to isolate and characterize microorganisms.
CO4	Compare and contrast the significance of various techniques
CO5	Critically evaluate and communicate scientific data
CO6	Design experiments for research problems.

MB7P1: MICROBIAL DIVERSITY AND CELL BIOLOGY

Total: 88 Hours

BACTERIOLOGY

1. Isolation and identification of bacteria:
a. Cultural characteristics of bacteria on NA.
b. Pure culture techniques (Types of streaking).
c. Staining techniques: Gram's, Negative, Endospore, Capsule and Cell Wall.
2. Biochemical characterization of bacteria:
   IMViC, Carbohydrate fermentation test, Mannitol motility test, Gelatin liquefaction test, Urease test, TSI test, Nitrate reduction test, Catalase test, Oxidase test, Starch hydrolysis, Casein hydrolysis.
3. Isolation of cellulolytic and anaerobic sulphate reducing bacteria using a Winogradsky column.
4. Isolation and characterization of acidophilic, alkalophilic and halophilic bacteria.

MYCOLOGY

1. Isolation of different fungi: Saprophytic, Coprophilous, Keratinophilic.
2. Identification of fungi by lactophenol cotton blue method.

PHYCOLOGY

1. Type study of algae and Cyanobacteria – *Scytonema, Spirullina, Anabaena, Nostoc*.

VIROLOGY

1. Isolation of bacteriophages from sewage.

CELL BIOLOGY

1. Study of Mitosis.
2. Vital staining of mitochondria.
3. Isolation of chloroplast from spinach leaves by sucrose density gradient centrifugation.
4. Detection of chemoreceptor mediated chemotaxis using Chemical Gradient Motility Agar.
5. Production and quantification of biofilm by using microorganisms.

REFERENCES:

1. James G. Cappuccino and Natalie Sherman. Microbiology: A Laboratory Manual.
2. Kanika Sharma. Manual of Microbiology: Tools and Techniques.
3. Robert S. Burlage, Ronald Atlas, David Stahl, Gill Geesey, Gary Sayler, 1998. Techniques in Microbial Ecology, Oxford University Press. N.Y.
4. Samuel Singer, 2001. Experiments in Applied Microbiology, Academic Press.

MB7P$_2$: MICROBIAL GENETICS AND MICROBIOLOGICAL TECHNIQUES

Total:88 Hours

MICROBIAL GENETICS

1. Mutagenesis- by physical and chemical agents.
2. Isolation of antibiotic resistant bacterial population by gradient plate method.
2. Isolation of genomic DNA and analysis by agarose gel electrophoresis.
3. Isolation of plasmid DNA and analysis by agarose gel electrophoresis.
4. Conjugation in *E.coli*.

MICROBIOLOGICAL TECHNIQUES

1. Buffer preparation and titration.
2. Viability staining technique for bacteria.
3. Micrometry.
4. Haemocytometry.
5. Phenol Coefficient method to test the efficacy of disinfectants.
6. Effect of antibiotics and heavy metals on bacteria and fungi.
7. Separation of amino acids and peptides using Thin Layer Chromatography.

REFERENCES:

1. Cappuccino, James G, and Natalie Sherman. Microbiology: A Laboratory Manual. Pearson Education.
2. S. Sadashivam, A. Manickam. Biochemical Methods. New Age International (P) Limited.
3. Aneja, K.R. Experiments in Microbiology, Plant pathology and Biotechnology. New Age International (P) Limited

DEPARTMENT OF MICROBIOLOGY

Semester	II
Paper Code	**MB 8121**
Paper Title	**MICROBIAL PHYSIOLOGY**
Number of teaching hrs per week	4
Total number of teaching hrs per semester	60
Number of credits	4

OBJECTIVE:

It enables a student to understand microbial cell functions which includes the study of microbial growth and metabolism.

UNIT I

MICROBIAL NUTRITION AND TRANSPORT **8**

a. Nutritional types of microorganisms- Autotrophs, heterotrophs, phototrophs, chemotrophs.

b. Uptake of Nutrients: Passive and facilitated diffusion, Primary and Secondary Active transport, Group Translocation, Iron uptake, ATP linked Ion motive pumps (P-class, F-class, V-class pump and ABC superfamily).

c. Microbial stress responses- Osmotic stress, oxidative stress, thermal stress and heat shock response, nutrient stress and starvation stress response.

UNIT II

BIOMOLECULES AND BIOENERGETICS **15**

a. **Carbohydrates:** Structure (mono, di and polysaccharides).
b. **Amino acids and proteins:** Structure, classification and properties of amino acids. Structural organizations of proteins (primary, secondary, tertiary and quaternary structure).
c. **Lipids:** Structure, classification, physical and chemical properties.
d. **Nucleotides and nucleic acids:** Structure
e. **Bioenergetics**: Laws of thermodynamics, Applications to biological system, high energy compounds-ATP, NAD, FAD, FMN, CoA.

UNIT III

METABOLISM **20**

a. **Carbohydrate metabolism:** Glycogenolysis, Glycolysis, TCA cycle, Electron transport and Oxidative phosphorylation. Pentose phosphate pathway, Glyoxylate cycle, Gluconeogenesis, Biosynthesis of peptidoglycan, Entner-Duodroff pathway.
b. **Fermentation pathways:** Lactic acid fermentation, Alcoholic fermentation, acetic acid, butyric acid, mixed acid and propionic acid fermentation.
c. **Amino acid metabolism:** General aspects of amino acid metabolism (Transamination, deamination, decarboxylation), urea cycle, uric acid biosynthesis.
d. **Lipid metabolism:** Oxidation of saturated fatty acids – β oxidation pathway, Biosynthesis of straight chain even carbon saturated fatty acid (palmitic acid)
e. **Nucleic acid metabolism:** Biosynthesis and degradation of purine and pyrimidine nucleotides.

UNIT IV

ENZYMES **10**

a. Introduction, Classification
b. **Enzyme kinetics:** Michaelis-Menten equation for simple enzymes, Multisubstrate kinetics, Kinetics of allosteric enzymes. Factors affecting enzyme kinetics.
c. **Mechanism of enzyme action:** Active site and allosteric site. Lock and key theory, induced fit theory, acid-base catalysis, covalent catalysis, metal ion exchange.
d. **Regulation of enzyme action:** Enzyme inhibition: Reversible, Irreversible, Competitive, Uncompetitive and Non-competitive.
e. Isozymes, Ribozymes and abzyme.

UNIT V

PHOTOSYNTHESIS **7**

a. **General Features of Photosynthesis**
b. **Light reactions**: Oxygenic and anoxygenic photosynthesis.
c. **Dark reactions (**CO_2 fixation): Calvin cycle (C_3 pathway) and C_4 pathway. CO_2 fixation in microorganisms.

NOTE: 8 hours of self-study assigned from the above units.

REFERENCES:

1. Atlas, Ronald M. Principles of Microbiology. St. Louis: Mosby
2. Branden, C., and Tooze, J. Introduction to Protein Structure. 2nd edition.
3. Campbell, M. K., & Farrell, S. O. Biochemistry. 8th edition Singapore: Cengage Learning Asia.
4. Creighton, T. E. Proteins. Structure and molecular properties. 2nd edition. W.H.Freeman and Co., New York.
5. Garrett, R. H., and Grisham, C. M. Biochemistry. 2nd edition. Saunders College Publishing.
6. Nelson, David L., and Michael M. Cox. Lehninger Principles of Biochemistry. 7th edition, W.H. Freeman,
7. Moat, A.G. & Foster, J.W. Microbial physiology, Wiley-Liss.
8. Price, N.C., and Stevens, L. Fundamentals of Enzymology, 3rd edition. Oxford University Press.
9. Voet, Donald, and Judith G. Voet. Biochemistry. Hoboken, NJ: John Wiley & Sons.
10. Willey, Joanne M, Linda Sherwood, Christopher J. Woolverton, Lansing M. Prescott, and Joanne M. Willey. Prescott's Microbiology. New York: McGraw-Hill

BLUEPRINT

Code number: MB8121
Title of the paper: MICROBIAL PHYSIOLOGY

Chapter/ Unit number	Number of hrs	Total marks for which the questions are to be asked (including bonus questions)
I	8	9
II	15	18
III	20	24
IV	10	12
V	7	8
TOTAL	**60**	**71**
Maximum marks for the paper (Excluding bonus question) = 50		

Course outcome (MB8121: Microbial Physiology)

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

CO1	Develop a sound knowledge of biomolecules, bioenergetics, uptake and assimilation of nutrients during microbial growth.
CO2	Compare and contrast the different aspects of metabolic pathways that various organisms employ.
CO3	Experiment with /develop conditions for the growth of microorganism
CO4	Categorize microorganisms based on the assimilation pattern of nutrients and analyze biomolecules.
CO5	Critique the role of enzymes, coenzymes and cofactors involved in various pathways
CO6	Hypothesize the alternative pathways for assimilation of nutrients by metabolic engineering

DEPARTMENT OF MICROBIOLOGY

Semester	II
Paper Code	**MB 8221**
Paper Title	**IMMUNOLOGY**
Number of teaching hrs per week	4
Total number of teaching hrs per semester	60
Number of credits	4

OBJECTIVE:

To understand the ability of our immune system to defend against invading pathogens in a logical sequence. This includes our innate ability and mechanisms to defend against microorganisms (innate immunity). If this first line of defense fails, how we can fight infections (acquired immunity). If we react excessively, what price we pay (hypersensitivity); if our defense is misdirected, what are the consequences (autoimmunity) and very importantly, preventing pathogens from infecting us (vaccination).

UNIT I

Types of immunity: Definition, innate, acquired- active and passive with examples.
Factors affecting immunity**:** age, hormonal influence, nutrition.
Mechanisms of innate immunity: Anatomical, Physiological, Phagocytotic and Inflammatory response.
Hematopoiesis: Hematopoietic growth factors, genes that regulate hematopoiesis, regulation of hematopoiesis, programmed cell death, ontogeny, development and functions of cells in innate and adaptive immunity
Cells of the immune system (T-cells, B-cells, Natural Killer cells, Macrophages, Antigen presenting cells, Neutrophils, Eosinophils, Basophils, Mast cells and Dendritic cells).
Organs of the Immune system: Structure and function of Primary and Secondary Organs

15

UNIT II

Antigens: characteristics, types, cross reactivity, hapten, adjuvant, immunogenicity and antigenicity.
Immunoglobulins: types, structure and functions, Molecular biology of immunoglobulin synthesis, antibody diversity, isotype switching.
Immunotechnology: Production of monoclonal antibodies, Applications of Mab –Diagnostic, therapeutic and immunopurification. Antigen antibody interactions**:** Principles and methods of Precipitaions, Agglutinations**,** ELISA, RIA, Immunofluorescence, Complement fixation and Flow cytometry.

Mechanism of antigen recognition and activation by T and B cells. **18**

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UNIT III

Immune response: Humoral, primary and secondary responses, factors influencing antibody production and Cellular immune response.
Mechanisms of Immunological Tolerance: T and B cell tolerance.
Immune effector mechanisms: Cytokines properties and functions.
Complement System: General Properties, components, complement activation, Classical, alternate pathway. Regulations of the complement system, biological consequences of complement activation, and complement deficiencies.
Hypersensitivity: Anaphylaxis, cytotoxic, immune complex deposition and cell mediated.

12

UNIT IV

Immunity to infectious diseases: Bacterial, viral
Auto immunity: Classification and mechanisms of autoimmune diseases.
Structure and functions of class I and class II MHC molecules and HLA typing
Transplantation immunology: Graft versus host reactions, Principles of tumor immunology: Tumor antigens, immune response to tumor, and immunotherapy of malignancy.
Vaccines: classification: inactivated, live attenuated, subunit, synthetic, DNA and plant vaccine.
Vaccine production strategies, identification and analysis of vaccines **15**

NOTE: 8 hours of self-study assigned from the above units.

REFERENCES:

1. Abbas A.K., A.H. Liehtman and J.S. Pober 2000. **Cellular and molecular Immunology** 9th edition V.B. Saunders Company, London.
2. Charles A Janeway, Paul Travers, Mark Walport. **Immunobiology: The Immune System in health and Disease**. 6th Edition Churchill publication August 2004.
3. Coleman, R.M., Lombard, M.F., and R.E. Sicard, 1992, **Fundamental of immunology**, third edition, Wm.C. Brown Publishers, USA.
4. Cruse, J.M. and R. Lewis, 1999 **Atlas of Immunology**, third edition CRC Press, New York May 2010.
5. Janeway, Jr.C.A. andP.Travers 2001 **Immunobiology**, 9th edition Garland Publishing, London.
6. Jenni Punt, Sharon Stranford, Patricia Jones and Judith A Owen -**Kuby Immunology**, Eighth edition W.H. Freeman and Company, New York
7. Michael J.H Ratcliffe. **Encyclopedia of immunology,** first edition academic press 2016
8. Noel R. Rose, Robert G. Hamilton and Barbara Detrick (Eds.) **Manual of Clinical Laboratory and Immunology** 6th Edition. 2002, ASM Publications
9. Peter J. Delves, Seamus J.Martin, Dennis R Burton,Ivan Roit. **Roitt's Essential Immunology**,13th edition Wiley Blackwell
10. Richard Coico, Geoffery Sunshine and Eli Benjamin - **Immunology: A Short course**, 5th edition

- Wiley–Blackwell; (14 November 2003)
11. Sudha S.and Subhanghe Sonkatte- **A text book of basic and clinical immunology**- Orient Blackswan
12. Sulabh ha Pathak., U Palan Immunology **–Essential and Fundamental** 3rd edition Science publishers-2005

BLUEPRINT

Code number: MB 8221
Title of the paper: IMMUNOLOGY

Chapter/ Unit number	Number of hrs	Total marks for which the questions are to be asked (including bonus questions)
I	15	18
II	18	21
III	12	14
IV	15	18
TOTAL	**60**	**71**
Maximum marks for the paper (Excluding bonus question)= 50		

Paper Code (MB8221 Immunology)

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

CO1	Gain insight into the role and complexity of the defense/immune system against various threats posed to the body by infectious organisms.
CO2	Understand the basic principles, concepts and techniques pertaining to the immune system, its organization and the complex mechanisms used to perform various functions.
CO3	Apply serological techniques for diagnosis /research and to compare and contrast various immunological responses.
CO4	Critically examine the clinical data/reports
CO5	Assess and interpret the mechanisms/strategies for prevention and protection against diseases.
CO6	Gain insight into designing and developing vaccines, diagnostic kits and therapeutics.

DEPARTMENT OF MICROBIOLOGY

Semester	II
Paper Code	**8321**
Paper Title	**MOLECULAR BIOLOGY**
Number of teaching hrs per week	04
Total number of teaching hrs per semester	60
Number of credits	04

OBJECTIVE:

This paper aims at introducing the students to the finer aspects of life processes at the molecular level. It defines the regulation of gene expression and its diverse effects from metabolic utilization of sugars to complex events underlying the development of an organism. This paper is an attempt to peek into the vast subject of ever-evolvingving field of molecular biology which has promising research and industrial applications.

UNIT I

Structure of eukaryotic chromosome (Chromatin- Nucleosome model and packaging and chromosomal territories).

REPLICATION IN EUKARYOTES :

Pre replicative complex, DNA polymerase and enzymes involved in replication, Process of replication, End replication problem and telomerase.

Inhibitors of DNA replication.

Comparative account of prokaryotic and eukaryotic replication **5**

UNIT II

TRANSCRIPTION IN PROKARYOTES AND EUKARYOTES:

RNA polymerase – structure, properties and functions

Initiation – promoters – upstream & downstream sequence, Sigma and Transcription factors.

Elongation

Termination – Rho dependent and Rho independent.

Structure and function of mRNA and tRNA

Post transcriptional modifications of RNA (rRNA, tRNA and mRNA)

Inhibitors of transcription.

Reverse transcription – Reverse transcriptase. **15**

UNIT III

TRANSLATION:

Genetic code: Elucidation of Triplet code, code characteristics, codon dictionary.

Structure of Ribosomes and its constituents in prokaryotes and eukaryotes.

Amino acyl tRNA synthetase function and proof reading.

Process of translation in prokaryotes and eukaryotes.
Initiation – Initiation factors, Initiator tRNA, Amino acid activation, Shine-Dalgarno sequences, Initiation site.
Elongation – Elongation factors and Translocation.
Termination – Termination codons and releasing factors
Inhibitors of translation and control of translation in eukaryotes (SsrA rescue system, nonsense and nonstop mediated decay). **15**

UNIT IV

PROTEIN SORTING:
Signal hypothesis
Transport between nucleus, transport into mitochondria, chloroplast and ER.
Overview of the path of secretory protein (brief).
Post Translational modification and folding. **8**

UNIT V

A) REGULATION OF GENE EXPRESSION IN PROKARYOTES-
Operon concept – positive and negative mechanisms of control (general concepts).
Lactose system – Coordinate regulation, Lac operon, Positive and negative
regulation, Catabolite repression, lac mutant (problems on phenotype and genotype variation)
Tryptophan operon, Attenuation.
Arabinose operon and its regulation.
Role of sigma factor in regulation, antitermination and riboswitches. **9**

B) EUKARYOTIC GENE EXPRESSION REGULATION –
Britten Davidson model of gene regulation (concept).
Regulatory proteins.
Epigenetic regulation (HAT, HDAC, Methylation).
Chromatin remodeling (HAT and HDAC,), Hormonal regulation, Alternate splicing, RNA editing, Gene silencing.

8

NOTE: 8 hours of self-study assigned from the above units.

REFERENCES:

1. Benjamin A Pierce, Genetics- A conceptual approach, 4thedn., W H Freeman and Company, New York.
2. Benjamin Lewin, 2004, Genes VIII, Oxford University Press, New York.
3. Bruce Alberts et al, Molecular biology of the cell, 4thedn., Garland Science.
4. Freifelder, D., 2000, Molecular Biology, second edition, Naros Publishing House, New Delhi.
5. James D Watson, Tania Baker: Molecular biology of the gene, 5thEdn, Pearson Education.
6. Lehninger, 2010, Principles of Biochemistry, 5thedn., by Nelson & Cox, W.H. Freeman and Co., New York.
7. Lodish, Berk, Matsudiara, Kaiser; Molecular Cell Biology; 7th Edition; W H Freeman and Co, Macmillan Higher Education.
8. Snustad and Simmons, Principles of genetics, 6thedn., John Wiley and sons.
9. Turner, P.C., A.G. Mel.ennan., A.D. Bates and M.R. H. White, 1999, Instant Notes in Molecular Biology, Viva Books Ltd., New Delhi.
10. Voet, D., Voet, J.G. and Pratt, W.C., 2006, Fundamentals of Biochemistry, John Wiley and Sons.

BLUEPRINT

Code number: MB8321
Title of the paper: MOLECULAR BIOLOGY

Chapter/ Unit number	Number of hrs	Total marks for which the questions are to be asked (including bonus questions)
I	05	06
II	15	18
III	15	18
IV	08	09
V	17	20
TOTAL	**60**	**71**
Maximum marks for the paper (Excluding bonus question) = 50		

Course outcome (MB8321: Molecular Biology)

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

CO1	Gain knowledge on the intricacies of molecular functioning of a cell.
CO2	Understand the life processes and their regulation.
CO3	Apply the knowledge gained to compare between a healthy/unhealthy and faulty system.
CO4	Analyze the similarities and differences in the cellular functioning of a prokaryotic and eukaryotic system and draw inferences that can benefit translational research.
CO5	Assess how disruptions in the normal life processes can lead to diseased conditions.
CO6	Identify potential therapeutic targets to combat disorders and diseases.
CO7	Modify molecular processes to harness products of industrial and pharmaceutical importance.

DEPARTMENT OF MICROBIOLOGY

Semester	II
Paper Code	**MB 8421**
Paper Title	**FOOD MICROBIOLOGY**
Number of teaching hrs per week	4
Total number of teaching hrs per semester	60
Number of credits	4

OBJECTIVE:
This paper is designed to broaden an understanding of the potential applications of micro-organisms, modern techniques and safety involved in the field of Food Sciences.

UNIT I

INTRODUCTION TO FOOD MICROBIOLOGY: **10**

Definition, concepts and scope. Food as substrate for microbes. Factors influencing microbial growth in food-Extrinsic and intrinsic factors. Hurdle effect. Predictive food Microbiology

CONTAMINATION AND FOOD SPOILAGE:

Sources of food contamination. Principles of food spoilage;
Spoilage of Cereals, sugar products, vegetables, fruits, meat and meat products, sea foods, poultry; spoilage of canned foods.

UNIT II

DAIRY MICROBIOLOGY: **10**

Composition and types of milk, Microbiology of raw and processed milk, Milk as a vehicle of pathogens, Change in microflora of milk
Analysis and Microbiological standards for milk - Rapid Platform Tests, SPC, DMC, Coliform count (MPN), Dye reduction tests
Prevention of contamination of raw milk - Pasteurization and its methods; Tests to determine the efficiency of pasteurization - alkaline phosphatase test & Lactoperoxidase test
Sources of contamination of milk and adulteration of milk
Spoilage and defects of milk and milk products

UNIT III

FERMENTED AND MICROBIAL FOODS: 12

Lactic starter cultures.
Fermented foods- curd, idli batter, Cheese, Yoghurt, acidopholous milk, Saeurkraut, Olives, Soy sauce, Sausages, Cocoa.
Probiotics, Prebiotics and Neutraceuticals
SCP and SCO.
Fortified foods.
Effect of food on normal gut flora.
Processed food: Definition and types, breakfast cereals, canned foods (vegetables and meat). Food designed for space exploration.

UNIT IV

FOOD PRESERVATION TECHNIQUES: 8

Principles of food preservation- Chemical preservatives and Food additives, asepsis, High temperature (D, F, Z values), Low temperature, Drying, Radiation, Canning and Packaging of foods- Types of packaging materials, properties and benefits.

UNIT V

FOOD BORNE ILLNESS: 8

Food borne diseases caused by Listeria, *Salmonella*, *Shigella*, *Campylobacter jejuni*, *Clostridium botulinum*, Mycotoxins and food borne viruses.

UNIT VI

MICROBIAL DETECTION AND FOOD SAFETY: 12

Indicator organisms - Coliforms, *Enterococci*, *Bifidobacteria*, Coliphages and Enteroviruses
Quantitative methods for microbial enumeration in foods
Test and detection of toxins in food.
Biosensors in pathogen detection.

FOOD SANITATION AND CONTROL:

GMP, Good Hygienic Practices, Hazard Analysis and Critical Control points. (HACCP), Food control Agencies - AGMARK, BIS, ISO 9000, ISO 22000, PFA.

NOTE: 8 hours of self study assigned from the above units.

REFERENCES:

1. Adams M. R., Mass, M. O. (1996). Food Microbiology. New Age International (P) Limited Publishers, New Delhi.
2. E-books -Hayes, P. R. Food Microbiology and Hygiene (1995). Published by Chapman & Hall, 2-6 Boundary Row, London SE 1 BHN.
3. E-books-Montrille T. J., Matthews, K. R. (2005). Food Microbiology, ASM Press, 175 2 S2 NW Washington, USA.
4. Encyclopedia of Bioprocess Technology, Fermentation, Biocatalysis and Bioseparation, Volumes 1 - 5, Flickinger and Drew, Wiley.
5. Fermentation and Biochemical Engineering Handbook - Principles, Process Design, and Equipment, Vogel and Tadaro, William Andrew Publishing.
6. Frazier, W. C., Westhoff, D. C. (1988). Food Microbiology, M. C. Graw-Hill Companies, Inc., New York.
7. Jay, M. J., Loessner, M. J., Golden, D.A. (2005). Modern Food Microbiology, Springer Science + Business Media Inc., New York.33

BLUEPRINT

Code number: MB 8421
Title of the paper: FOOD MICROBIOLOGY

Chapter/ Unit number	Number of hrs	Total marks for which the questions are to be asked (including bonus questions)
I	10	12
II	10	12
III	12	14
IV	8	10
V	8	9
VI	12	14
TOTAL	**60**	**71**
Maximum marks for the paper (Excluding bonus question) = 50		

Course outcome (MB8421: Food Microbiology)

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

CO1	Gain a broader insight into the positive and negative interactions of microbes in food along with the significance of food preservation and safety
CO2	Compare various strategies for microbiological analysis of food, food preservation and safety (regulations & compliance requirements)
CO3	Incorporate the principles of food microbiology in practical and real-world scenarios
CO4	Identify and analyze potential problems and causes of food contamination and spoilage, illness, safety and quality control
CO5	Assess various approaches and remedies to the identified issues and drawbacks in food microbiology
CO6	Design potential strategies to suit pertinent issues in food microbiology and food safety

DEPARTMENT OF MICROBIOLOGY

Semester	II
Paper Code	**MBDE 8521**
Paper Title	**AGRICULTURAL MICROBIOLOGY**
Number of teaching hrs per week	4
Total number of teaching hrs per semester	60
Number of credits	4

OBJECTIVE:
To understand the intricate microbial interactions, host parasite relationship and plant protection for a better growth and yield of crop plants.

UNIT I

Microbial Interactions

Nitrogen cycle: Fixation of atmospheric nitrogen, ammonification, nitrification, and denitrification. Symbiotic and non-symbiotic nitrogen fixation, *nif* genes, Nitrogenase enzyme.

Interaction between plants and microbes: Siderophores, Rhizosphere, Rhizoplane, Phyllosphere and Phylloplane. Taxonomy of Mycorrhizas and Actinorhiza, host fungus specificity, functional compatibility and the importance of mycorrhizae in agriculture, horticulture and forestry.

Characteristics of carrier based inoculants and strain selections. *Rhizobium, Azotobacter, Azospirillum*, Mycorrhiza, Phosphate solubilising microorganisms, Cyanobacteria, and *Azolla*. Production technology and application.

Mushroom cultivation and biogas production. **20**

UNIT II

Host Parasite Interactions: Role of host exudates; process of pathogen entry; role of enzymes, hormones and toxins produced by pathogens in pathogenesis; deranged host metabolism.

10

UNIT III

Host resistance: Passive and induced resistance; Phytotoxins and Phytoalexins; Hypersensitivity reaction.

Protection, Plant quarantine, Eradication, Chemical control- Systemic fungicides, Antibiotics. Acquired resistance of fungicides, Biological Control of pathogens, Genetic methods for crop improvement and Integrated Pest Management.

10

UNIT IV

Etiology, symptoms and control measures of plant diseases-

a. Bacterial blight of rice (*Xanthomonas oryzae*)
b. Citrus canker (*Xanthomonas citrii*)
c. Crown gall Disease (*Agrobacterium tumifaciens*)
d. Damping off (*Pythium* spp.)
e. Late blight of potato (*Phytopthora infestans*)
f. Downy mildew of crucifers (*Peronospora*)
g. Downy mildew of grapes (*Plasmopara viticola*)
h. White rust of crucifers (*Albugo candida*)
i. Wheat Rust (*Puccinia graminis*)
j. Tikka disease of groundnut (*Cercospora* spp.)
k. Red rot of sugar cane (*Colletotrichum falcatum*)
l. Early Blight of tomato (*Alternaria lycopersici*)
m. Ergot of rye (*Claviceps purpurea*)
n. Sandal spike
o. Little leaf of brinjal
p. Tobacco mosaic disease
q. Citrus exocortis

10

UNIT V

Microbial insecticide: Definition, selection, mode of action, methods of mass culture and production, advantages, limitation and quality control. Eg. *Bauveria bassiana*, NPV, CPV, GPV and *Bacillus thuringenesis*. Applications of Genetic Engineering in Agricultural Microbiology: Antisense RNA technology.

10

NOTE: 8 hours of self study assigned from the above units.

REFERENCES:

1. Mehrotra, R.S. 1983, Plant Pathology, Tata McGraw Hill publishing company Ltd., New Delhi.
2. Pandy, B.P., 1997, Plant Pathology (Pathogen and Plant Disease), S.Chand and Company Ltd., New Delhi.
3. Ray Chadhuri, S.P., 1977, A manual of Virus Diseases of Tropical Plants, Macmillan Company of India Ltd., Delhi.
4. Rengaswami, G and S.Rajagopalan, 1973, Bacterial Plan Pathology – Tamil Nadu Agriculture University, Coimbatore.
5. Subba Rao, N.S., 1995, Soil Microorganisms and Plant Growth, third edition, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

BLUEPRINT

Code number: MBDE 8521
Title of the paper: AGRICULTURAL MICROBIOLOGY

Chapter/ Unit number	Number of hrs	Total marks for which the questions are to be asked (inclucing bonus questions)
I	20	23
II	10	12
III	10	12
IV	10	12
V	10	12
TOTAL	**60**	**71**
Maximum marks for the paper (Excluding bonus question)= 50		

Course outcome (MBDE8521: Agricultural Microbiology)

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

CO1	Gain knowledge in the Intricacies of Plant-Microbe interactions (beneficial and harmful)
CO2	Have an in depth understanding of the Mechanisms of Biochemical changes in symbiotic and deranged metabolism in pathogenic associations
CO3	Apply the effectiveness of the agricultural-based microbial products from beneficial organisms for the growth of crops and control of plant pathogens
CO4	Compare and contrast the changes and effects of both positive and negative interactions for the exchange and uptake of nutrients
CO5	Exploit, apply and evaluate the activity of beneficial microbes in crop improvement and plant protection
CO6	Develop strategies for crop protection and harnessing the efficacy of microbes for better growth, yield and vigour of plants

DEPARTMENT OF MICROBIOLOGY

Semester	II
Paper Code	**MBDE 8621**
Paper Title	**ENVIRONMENTAL MICROBIOLOGY**
Number of teaching hrs per week	4
Total number of teaching hrs per semester	60
Number of credits	4

OBJECTIVE:

Understanding the intricate relationship between microorganisms and the environment. Studying the effect of microbial processes on environment and human life. Utilization of microbial processes for the remediation and protection of the environment.

UNIT I

Air Microbiology **8**

Air borne microorganisms – diseases and control measures – monitoring of airborne microbes – culture media. Biological indicators of pollution and biomonitoring – sick building syndrome.

Aeroallergens- Allergy due to inhaled microbes and pollens – Mechanism of Type-I hypersensitivity reaction – testing and therapy of allergy.

Air samplers-Anderson's sampler, Cascade Impactor, Hirst trap, Burkard sampler, Rotorod, vertical cylinder trap, slit sampler, types of impingers, identification of pollen and spores – pollen calendar; particle count.

UNIT II

Aquatic and Sanitary Microbiology **20**

Aquatic habitats- surface, subsurface and marine habitats, zonation of water ecosystems and food chain in aquatic ecosystems. Effect of acid rain on microbial processes in natural waters. Ground water contamination and remedial measures.

Role of microbes in 1. Sewage treatment: Primary, Secondary and Tertiary treatment.

2. Biological Treatment of Industrial effluents.

Water borne diseases and control measures- Indicator microbes of water pollution, testing procedure-BIS for commercial mineral water, ISI standard for potable water, water purification

UNIT III

Soil microbiology **15**

Microflora of soil, Microbial transformations of C, N, P, S and their Biogeochemical cycles
Role of microorganisms in complex organic matter decomposition (cellulose, hemi cellulose, lignin).

Solid waste disposal:

Composting, vermicomposting and sanitary landfill, incineration& harmful effects. Eco friendly alternates- bioplastics, biofertilizers and biopesticides

Biodegradation of pesticides:

2, 4-D, organophosphorous pesticides-Chlorpyrifos
Alternatives to pesticide use- transgenic plants- herbicide resistant

Metallophilic bacteria: Bioleaching of ore and metal corrosion, Bioaccumulation

Biodegradation of xenobiotics: PCBs, plastics.

Biodeterioration of paper and textiles

UNIT IV

Bioremediation **9**

Testing for biodegradability- Biosensors, efficacy testing, side effect testing. Approaches to bioremediation. Environmental modification for bioremediation- Bioengineering approaches. Bioremediation of various ecosystems- contaminated soil and aquifers, oil spills- super bug, bioremediation of air pollution

UNIT V

Microbial ecology and microbiome biology **8**

Microbial interactions, microbial evolution
Microbiome study- plant microbiome, effect of environment on human microbiome
Environmental metagenomics, study of unculturable bacteria

REFERENCES:

1. Atlas, R.M. and Bartha, R. 2000, Microbial Ecology Fundamentals and Applications 4th Edition, Addison Wesley Longman, Inc. New York.
2. Ian Pepper, Charles Gerba, Terry Gentry, Environmental Microbiology, 3rd edition, Elsevier.
3. Bitton, G, 1994. Wastewater Microbiology, Wiley-Liss Inc. New York.
4. On- farm composting methods, R.V Mishra, R.N.Roy, H. Hiraoka.
5. Symbiotic Nitrogen Fixation, Panagiota Mylona, Katharina Pawlowski, and Ton Bisseling The Plant Cell, Vol. 7, 869-885, July 1995 American Society of Plant Physiologists.
6. *Indian Standard*, DRINKING WATER — SPECIFICATION; **IS 10500 : 2012, BIS 2012**
7. Lenski, R. Experimental evolution and the dynamics of adaptation and genome evolution in microbial populations. *ISME J* **11,** 2181–2194 (2017). https://doi.org/10.1038/ismej.2017.69
8. Incineration process for solid waste management and effective utilization of by products, Pooja G. Nidoni. International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056.

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9. Wei X, Lyu S, Yu Y, Wang Z, Liu H, Pan D, Chen J. Phylloremediation of Air Pollutants: Exploiting the Potential of Plant Leaves and Leaf-Associated Microbes. Front Plant Sci. 2017 Jul 28;8:1318. doi: 10.3389/fpls.2017.01318. PMID: 28804491; PMCID: PMC5532450.
10. Bioleaching: metal solubilization by microorganisms, Klaus Bosecker, FEMS Microbiology Reviews. Volume 20, Issues 3–4, July 1997, Pages 591-604

BLUEPRINT

Code number: MBDE 8621

Title of the paper: ENVIRONMENTAL MICROBIOLOGY

Chapter/ Unit number	Number of hrs	Total marks for which the questions are to be asked (including bonus questions)
I	8	9
II	20	23
III	15	18
IV	9	11
V	8	10
TOTAL	**60**	**71**
Maximum marks for the paper (Excluding bonus question) = 50		

Course outcome (MBDE8621: Environmental Microbiology)

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

CO1	Appreciate various microbial environmental niches.
CO2	Learn microbial interactions, adaptations and their influence on the environment.
CO3	Perform experiments to study microorganisms living in varied environments and to assess different physical and chemical environmental parameters.
CO4	Appreciate the role of microorganisms in treatment of different kinds of wastes and bioremediation.
CO5	Assess the positive and negative impact of microorganisms on the environment and evaluate environmental problems on a global scale.
CO6	Innovate approaches in environmental problem solving and assert their roles towards the environment as responsible citizens.

PRACTICALS

MB 8P$_1$: IMMUNOLOGY AND MICROBIAL PHYSIOLOGY

Total :88 Hours

IMMUNOLOGY

1. Agglutination test- Blood grouping and WIDAL.
2. Precipitation tests (RIEP, CCIEP).
3. Identification of *Staphylococcus aureus* by coagulase test.
4. ELISA
5. Determination of nonspecific resistance to bacteria.
6. Determination of bactericidal activity of normal serum.

MICROBIAL PHYSIOLOGY

1. Determination of Growth – Bacterial Growth curve and generation time.
2. Estimation of DNA by Diphenylamine method.
3. Estimation of RNA by Orcinol method.
4. Estimation of Proteins by Lowry's method.
5. Estimation of amylase activity.
6. Determination of K_m and $V_{max.}$
7. Saponification value of fat.
8. Iodine number of fatty acids.
9. Estimation of Phosphatase and Catalase activity.

REFERENCES

1. Alcamo, I.E. 2001, Laboratory Fundamentals of Microbiology, Jones and Barlett.
2. Alexander J. Ninfa, 1998. Fundamental Laboratory approaches for Biochemistry and Biotechnology Fitzgerald Science Press, Inc., Bethesda, Maryland.
3. Bloom, Freyer, Meckler, 1996. Laboratory DNA Science, The Benjamin/Cummings Pub.
4. David T Plummer, 1996. An Introduction to Practical Biochemistry, 3 ed. Tata
5. Experiments with gene fusions 1994, T. Slave, Cold Spring Harbour Lab. Press.
6. Hudson, L and Hay, F.C. Tical Immunology, Blackwell Scientific Publications. McGraw-Hill.
7. Parkinson D, (1994) Methods in soil analysis, Part 2, Microbiology and Biochemical properties, SSSA book seriesm No.5 Soil Sciences Society of America, Madison, Wise, USA.
8. Short course in genetics, J.H. Miller 1992, CSH Laboratories.
9. Ted R. Johnson and Christine L Case, 2001. Laboratory Experiments in Microbiology.

MB 8P$_{2a}$: FOOD AND AGRICULTURAL MICROBIOLOGY

Total: 88 Hours

FOOD MICROBIOLOGY

1. Rapid platform tests, DMC and SPC of milk.
2. Rapid tests to detect the presence of common adulterants in food. (Milk and milk products, oils and fats, sweetening agents, food grains and spices).
3. Detection and determination of anaerobic mesophilic spore formers from food. (*Clostridium perfringens*)
4. Lactose estimation in milk.
5. Production of Yoghurt from starter cultures.
6. Preparation of bread and the role of Yeast in bread making.
7. To study browning reactions in food.
8. To induce and study ropiness in bread.
9. Production and detection of aflatoxins from spoilt food.
10. Food preservation by salt, sugar, sodium benzoate

AGRICULTURAL MICROBIOLOGY

1. Isolation of *Azotobacter* and *Azospirillum* from soil.
2. Isolation of phosphate solubilizing bacteria.
3. Isolation of *Rhizobium* spp., and study of root nodules of legumes
4. Staining and identification of VAM propagules
5. Bioassay of Biofertilizers
6. Mushroom cultivation
7. Study of plant pathogens
8. Screening of siderophore producing bacteria.

REFERENCES:

1. James G. Cappuccino and Natalie Sherman. Microbiology: A Laboratory Manual.
2. Kanika Sharma. Manual of Microbiology: Tools and Techniques.
3. Robert S. Burlage, Ronald Atlas, David Stahl, Gill Geesey, Gary Sayler, 1998. Techniques in Microbial Ecology, Oxford University Press. N.Y.

MB 8P$_{2b}$: FOOD AND ENVIRONMENTAL MICROBIOLOGY

Total: 88 Hours

FOOD MICROBIOLOGY

1. Rapid platform tests, DMC and SPC of milk.
2. Rapid tests to detect the presence of common adulterants in food. (Milk and milk products, oils and fats, sweetening agents, food grains and spices).
3. Detection and determination of anaerobic mesophilic spore formers from food. (*Clostridium perfringens*)
4. Lactose estimation in milk.
5. Production of Yoghurt from starter cultures.
6. Preparation of bread and the role of Yeast in bread making.
7. To study browning reactions in food.
8. To induce and study ropiness in bread.
9. Production and detection of aflatoxins from spoilt food.
10. Food preservation by salt, sugar, sodium benzoate

ENVIRONMENTAL MICROBIOLOGY

Air microbiology

1. Study of air samplers
2. Study of airborne microorganisms.

Water microbiology

3. Determination of biological oxygen demand.
4. Determination of COD.
5. Chemical and Bacterial analysis of water- determination of TDS, TSS, MPN

Soil microbiology

6. Estimation of organic carbon in soil
7. Isolation of methanogens
8. Composting.

REFERENCES

1. James G. Cappuccino and Natalie Sherman. Microbiology: A Laboratory Manual.
2. Kanika Sharma. Manual of Microbiology: Tools and Techniques.
3. Robert S. Burlage, Ronald Atlas, David Stahl, Gill Geesey, Gary Sayler, 1998. Techniques in Microbial Ecology, Oxford University Press. N.Y.

DEPARTMENT OF MICROBIOLOGY

Semester	III
Paper Code	**MB 9121**
Paper Title	**RECOMBINANT DNA TECHNOLOGY**
Number of teaching hours per week	04
Total number of teaching hours per semester	60
Number of credits	04

Objective of the Paper:

This paper enables the students to understand the basic principles of recombinant DNA techniques and equip them with the skills required in designing transgenic systems and to create professionals who can use Genetic Engineering techniques in diverse fields.

UNIT-I **18**

a. Introduction to Recombinant DNA Technology **1**

b. Tools in genetic engineering: **5**

- DNA manipulative enzymes:
- Restriction endonucleases – Nomenclature, classification, enzyme catalysis and applications.
- DNA Ligase - Types, enzyme catalysis and ligation strategies.
- DNA modifying enzyme: Polynucleotidyl kinase, alkaline phosphatase and terminal nucleotidyltransferase.

c. Cloning vectors: **12**

- Plasmids (pBR322, pUC-8, pGEM3Z and Ti plasmid)
- Bacteriophage (λ phage and M13 vectors)
- Cosmids, phagemids, expression vectors, shuttle vectors, BACs and YACs, Excretion Vectors and Animal viral vectors (Adeno virus and retro virus).
- Cloning and expression in bacteria and yeast.

UNIT-II **7**

a. Basic principles of gene cloning strategies. **1**

b. **Transformation techniques:** **6**
$CaCl_2$ mediated Transformation, Micro projectile Bombardment, Microinjections, Electroporation, Liposome mediated transfer, and Agrobacterium-mediated transfer**.**

UNIT-III

Genomic and cDNA library construction and their applications **4**

UNIT-IV **7**

Analysis of gene and gene products:

a. Direct methods – Selection by Complementation or Nonsense separation and marker inactivation techniques. **2**
b. Indirect methods – Restriction enzyme cleavage pattern, Hybridization techniques (Colony and Plaque hybridization), Blotting techniques, Chromosome walking, Detection of specific protein by invitro translation techniques, Immunological methods, Protein synthesis in mini cells and Maxi cells. **5**

UNIT-V **18**

a. PCR – Gene amplification, Primer designing, optimization, variation in the PCR, and types of PCR. **4**
b. DNA sequencing technology and its applications – Maxam Gilbert's method, Sanger, Coulsen's method, automated sequencing, next-generation sequencing. Applications of sequencing **3**
c. DNA fingerprinting and its applications **2**
d. DNA Microarrays – Types, features and their application in the study of gene expression **3**
e. Chemical synthesis of oligonucleotides: Phosphodiesters, Phosphotriester, Phosphitetriester approaches, enzymatic synthesis of DNA and applications of synthetic oligonucleotides. **3**
f. Site-directed Mutagenesis, Genome Editing (Crispr-cas, Zfn, Talen) and their applications **3**

UNIT-VI **6**

Applications of gene cloning

a. Transgenic systems 1
b. Applications of gene cloning in Medicine (Gene therapy), Agriculture (Transgenic plants – Insecticide resistant and herbicide-resistant). **3**

Ethical concerns and Safety of recombinant DNA technology: **2**

a. Ethical, Legal, Social and Environmental issues related to rDNA technology.
b. Restriction and regulation for the release of GMOs into Environment.

NOTE: 8 hours of self-study will be assigned from the above units.

REFERENCES:

1. Brown, T.A. 2000, *Gene Cloning and DNA analysis*, fourth edition, Chapman and Hall Publication, USA.
2. Brown, T.A. 2010, *Gene Cloning and DNA analysis*, sixth edition, Wiley-Blackwell.

3. Old R.W. and Primrose S.B., 1996, *Principles of Gene Manipulations*, Blackwell Science Publications, London.
4. Primrose S.B., and Twyman R.M., *Principles of Gene Manipulation and Genomics*, Seventh Edition, Blackwell Science Publications, London.
5. Sandhya Mitra, 1996, *Genetic Engineering*, Mac Millar India Ltd., New Delhi.
6. Winnaker E.L., 1987, From *Gene to Clone*: *Introduction to Gene Technology*, VCH Publications, Weinbem Federal Republic German.
7. Kreuzer H and Massey A; ASM;2006, *Recombinant DNA and Biotechnology*; 2nd Edition, American Society of Biology.
8. Sambrook & Russel: *Molecular Cloning*; 3rd Ed; Cold Spring Harbour Laboratory press, NY; 2001.

BLUEPRINT

Code number: **MB 9121**

Title of the paper: **RECOMBINANT DNA TECHNOLOGY**

Chapter number	Number of hrs	Total marks for which the questions are to be asked (including bonus questions)
I	18	21
II	07	8
III	04	6
IV	07	8
V	18	21
VI	06	7
Total	**60**	71
Maximum marks for the paper (Excluding bonus questions) : **50**		

Course outcomes (MB 9121: Recombinant DNA Technology)

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

CO1	Gain an understanding of the tools and processes used in rDNA technology.
CO2	Contrast different techniques used in analysis of gene and their expression.
CO3	Apply the techniques towards cloning genes in different biological systems.
CO4	Analyze enzymes used in recombinant DNA technology
CO5	Summarize applications of rDNA technology
CO6	Design a workflow to carry out rDNA technology experiment: Cloning, expression and down streaming.

DEPARTMENT OF MICROBIOLOGY

Semester	III
Paper Code	**MB 9221**
Paper Title	Medical Microbiology
Number of teaching hrs per week	4
Total number of teaching hrs per semester	60
Number of credits	4

Objective: Medical Microbiology seeks to empower students with knowledge and learning opportunities in the basic principles of medical microbiology and infectious disease. The ability to promote human health. It provides opportunities to develop informatics and diagnostic skills, including the use and interpretation of laboratory tests in the diagnosis of infectious diseases and use their knowledge in clinical research.

UNIT I 15

- **a.** Introduction to Medical Microbiology. Infections, Types of infections, methods of transmission.
- **b.** Laboratory Management: - Safety in a microbiology laboratory.
- **c.** Quality control in Clinical microbiology: - Internal and External (NABL)
- **d.** Biomedical waste management, quantity, types of biomedical waste and waste treatment.
- **e.** Introduction to Human microbiome- Description of factors and processes that influence community assembly and composition. Importance with special reference to gut microbiota (in health and diseases). Faecal Transplantation
- **f.** Factors responsible for pathogenesis.

UNIT II 14

Bacterial diseases

List of diseases of various organ systems and their causative agents. The following diseases in detail with Culture, Signs Symptoms, mode of transmission, virulence, pathogenesis, laboratory diagnosis, prophylaxis and control.

- **a.** Respiratory Diseases: *Streptococcus pyogenes, Mycobacterium tuberculosis.*
- **b.** Gastrointestinal Diseases: *Salmonella typhi, Vibrio cholerae, Helicobacter pylori.*
- **c.** Skin: *Staphylococcus aureus, Clostridium tetani.*
- **d.** *Treponema pallidum.*
- **e.** *Pseudomonas aeruginosa.*

UNIT III 17

Viral, Fungal and Parasitic diseases.

Viral diseases.

List of diseases of various organ systems and their causative agents. The following diseases in detail with Signs, Symptoms, mode of transmission, pathogenesis, laboratory diagnosis, prophylaxis and control;

a. DNA viruses - Herpes, Hepatitis B virus.
b. RNA viruses - Dengue, Zikka, H1N1, Corona.
c. Viral zoonoses – Rabies.
d. Oncogenic viruses.

Fungal diseases

a. Classification of medically important fungi.
Brief description of each of the following types of mycoses and one representative disease to be studied with respect to transmission, symptoms, culture, laboratory diagnosis, pathogenesis, prevention and control.
b. Cutaneous mycoses- Tinea pedis (Athlete's foot).
c. Yeast -*Cryptococcus neoformans.*
d. Yeast like - *Candida albicans.*
e. Filamentous –*Aspergillus spp.*
f. Dimorphic- *Histoplasma capsulatum.*

Parasitic diseases:

a. *Giardia lamblia,*
b. *Plasmodium spp.,*

(Any emerging infection to be included)

UNIT IV 14

a. Nosocomial infections: Microbiology of hospital infections, common type of infections, diagnosis, and control of infections.

b. Classification of antimicrobial agents and Mechanism of Action.
Antibacterial agents: Penicillin, Polymyxin, Tetracycline, Chloramphenicol, Sulphonamides.
Antifungal agents: Echinocandins- Caspofungin, Azoles, Polyenes -Griseofulvin, Nystatin and Terbinafine, Amphotericin B, Flucytosine
Antiviral agents: Amantadine, ritonavir, zidovudine, Acyclovir, Remdesivir,
Antiparasitic agents: Chloroquine, Metronidazole.
Antibiotic resistance: MDR, XDR, MRSA, AMR-TB, ESBLS NDM-1

c. Methods of testing drug sensitivity.

d. An overview of Clinical Trials.

NOTE: 8 hours of self-study assigned from the above units.

REFERENCES:

1. Baijayantimala Mishra (2022) *Textbook of Medical Virology***.** 2nd Edition. India. CBS Publishers.
2. David Greenwood, Richard C.B. Slack and John. F. Peutherer (2008). *Medical Microbiology*.7th Edition, New Delhi. Elsevier India Private Ltd.
3. Goering (2018). *Mims' Medical Microbiology and Immunology*, International , 6th Edition.

4. Jawetz, Melnick and Adelbergs (2019). *Medical Microbiology*. 28th Edition. USA. McGraw Hill Companies.
5. Kenneth Ryan , Nafees Ahmad , J. Andrew Alspaugh , W. Lawrence Drew , Michael Lagunoff , Paul Pottinger L. Barth Reller , Megan Reller (2018) *Sherris Medical Microbiology*, 7th Edition McGraw Hill.
6. Leonard C. Norkin (2010) *Virology: Molecular Biology and Pathogenesis*. 1st Edition. India. American Society for Microbiology.
7. Linda Sherwood, Christopher J. Woolverton, Lansing M. Prescott, and Joanne M. Willey (2011). *Prescott's Microbiology*.7th Edition. New York: McGraw-Hill.
8. Michael Barer ,W L Irving (2018). *Medical Microbiology* 19thh Edition.
9. Patricia. M.Tille (2015). *Bailey and Scotts Diagnostic Microbiology.*14th Edition. Mosby.
10. Patrick R. Murray, Ken s.Rosenthal, Michael A. Pfaller (2015). Medical Microbiology.8th Edition. India. Elsevier.
11. Reba Kanungo(2020).*Ananthanarayan and Paniker Text book of Microbiology. 11*th Edition. Universities Press.
12. W.W.W. Topley and Sir Graham S.Wilson (2006) *Topley & Wilson's Microbiology and Microbial Infections.*10TH Edition. London. Hodder and Arnold.
13. Yi-Wei Tang (2022) *Molecular Medical Microbiology*. 3rd Edition. Elsevier.
14. Villanova, PA; NCCLS: 2002.National Committee for Clinical Laboratory Standards (Now Clinical and Laboratory standards Institute, CLSI). Performance standards antimicrobial susceptibility testing; 12th information supplement (M100-S1).
15. Villanova, PA: NCCLS, 1997.National Committee for Clinical Laboratory Standards (now Clinical and Laboratory Standards Institute, CLSI). Methods for dilution antimicrobial susceptibility testing for bacteria that grows aerobically. Approved Standards M7-A4.

BLUEPRINT

Code number: MB 9221
Title of the paper: MEDICAL MICROBIOLOGY

Chapter/ Unit number	Number of hours	Total marks for which the questions are to be asked (including bonus questions)
I	15	18
II	15	18
III	16	19
IV	14	16
TOTAL	**60**	**71**
Maximum marks for the paper (Excluding bonus questions)= 50		

Course outcomes (MB 9221: Medical Microbiology)

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

CO1	a. Understand and gain knowledge of the workflow inside the clinical microbiology laboratory. b. Describe the importance of pathogenic microorganisms in human diseases and the various parameters of assessment of their severity and methods of diagnosis.
CO2	a. Learn molecular mechanisms of pathogenesis. b. Compare and contrast the similarities and differences between different pathogens and address the issues related to transmission and prevention of the diseases.
CO3	a. Assess and interpret antibiotic sensitivity tests. b. Highlight the importance and significance of the gut microbiome and antimicrobial resistance and control measures.
CO4	a. Select appropriate procedures for specimen collection, isolation and identification of pathogens. b. Interpret the possible suggested preventive and treatment methods for human pathogens.
CO5	a. Develop knowledge and skills in writing clinical research. b. Assess and interpret strategies for prevention and protection against diseases.

DEPARTMENT OF MICROBIOLOGY

Semester	III
Paper Code	**MB 9321**
Paper Title	**INDUSTRIAL MICROBIOLOGY**
Number of teaching hours per week	04
Total number of teaching hours per semester	60
Number of credits	04

OBJECTIVE:

Industrial microbiology provides an understanding of the processes involved in the production of variety of biological products; including biopharmaceuticals, therapeutics, diagnostics, etc. with the help of microorganisms, the course discusses variety of aspects of fermentation ranging from the equipment utilised, types of microorganisms, genetic modifications of these organisms required, to standardization of the processes for a large scale production to subsequent downstream processing of the products. It also offers some practical experience of production at a laboratory scale.

UNIT-I

a. Concepts and scope of fermentation technology **1**

UNIT-II **7**

a. Basic design and function of a fermenter.
b. Types of fermenters: stirred tank fermenters, tubular fermenters, tower fermenters, air-lift fermenters, membrane bioreactors, photo bioreactors, disposable fermenters, fluidized bed fermenters.
c. Solid-state fermenters: tray fermenters, drum fermenters.

UNIT-III **11**

a. Media sterilization, sterilization of fermenter, sterilization of air supply.
b. Aseptic inoculation methods, sampling methods, monitoring and control devices.
c. Fermentation media: media formulations, sources of carbon, nitrogen, vitamins and minerals.
d. Role of buffers, precursors, inhibitors, inducers and antifoam agents.
e. Development of inoculum for bacterial, fungal, and actinomycetes.
f. Substrate for solid state fermentation
g. Power requirement, Oxygen transfer kinetics.
h. Concepts of Newtonian and non-Newtonian fluids, plastic fluids, apparent viscosities

UNIT-IV 6

a. Microbial growth kinetics: Batch, Continuous and Fed-Batch culture.

UNIT-V 11

a. Isolation, preservation and improvement of industrial microorganisms:
Isolation methods, screening methods, preservation techniques, strain improvement, protoplast fusion, parasexual cycle and recombinant DNA techniques.
b. Immobilization of enzymes and cells: methods, advantages and applications

UNIT-VI 8

a. Scale-up of fermentation process: parameters used in scale-up and problems associated with scale-up.
b. Downstream processing: objectives and criteria, foam separation, precipitation methods, filtration devices and filter aids.
c. Industrial scale centrifugation and cell disruption methods, liquid-liquid extraction, solvent recovery, chromatography, microfiltration, ultrafiltration, drying devices, crystallization and whole broth processing.

UNIT-VII 16

MICROBIAL TECHNOLOGY

a. Production of: alcohol-beer and ethanol; Organic acids- citric acid; Amino acids- glutamic acid; Antibiotics- penicillin; Vitamins- Vitamin B12; Enzymes- protease; Biopolymers-: xanthan gum
b. Production of recombinant proteins- human insulin, interferon; Recombinant vaccine production - Hepatitis B vaccine; melanin biosynthesis in *E.coli*; Chymosin production in *E.coli* and yeast.
c. Biosafety regulation of products, microbial products and biosafety concerns – individual, society, national and international, biosafety regulations in laboratories, handling of recombinant products.
d. An overview of Pharmaceutical Microbiology.

NOTE: 8 hours of self-study will be assigned from the following topics. (Fermentation media, inoculum production and scope of fermentation technology)

REFERENCES:

1. Casida, J.F. (1968). Industrial Microbiology. Wiley Eastern Ltd.
2. Cruger, W. and Crueger, A. (2000). Second Edition, Biotechnology: A Text Book of Industrial Microbiology.,Panima Publishing Corporation, New Delhi.
3. Flickinger, M.C. and Drew, S.W. (1999). Encyclopedia of Bioprocess Technology, Biocatalysts and

Bioseparation. Vol. V., John Wiley and Sons Publications.
4. Pepper, H.J. and Pearman, D. (1979). Microbial Technology. Vol.I Academic Press, New York.
5. Stanbury, P.F., Whitaker, A. and Hall, S.J. (1995). Second Edition, Principles of Fermentation Technology. Aditya Book (P) Ltd., New Delhi.
6. Pirt, S.J. (1975). Principles of Microbe and Cell Cultivation. New York: Wiley.

BLUE PRINT

Code number: MB 9321
Title of the Paper: INDUSTRIAL MICROBIOLOGY

Chapter Number	Number of Hours	Total marks for which the questions are to be asked (including bonus questions)
I	1	2
II	7	8
III	11	13
IV	6	7
V	11	13
VI	8	9
VII	16	19
Total Marks	60	71
Maximum marks for the paper (Excluding bonus questions) = 50		

Course outcomes (MB 9321: Industrial Microbiology)

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

CO1	Gain an insight into the role of microbes in Industrial production of valuable products
CO2	Have an in-depth knowledge of the process parameters and vital requirements suited for microbial growth to enhance product production.
CO3	Standardise methods for production of products in the laboratory scale.
CO4	Compare the design of bioreactors and the processes necessary for industrial use.
CO5	Evaluate the effectiveness of microbial strains.
CO6	Develop concepts to design bioreactors and exploit the suitable strains of microorganisms for product formulation.

DEPARTMENT OF MICROBIOLOGY

Semester	III
Paper Code	**MB 9421**
Paper Title	**BIOSTATISTICS AND BIOINFORMATICS**
Number of teaching hrs. per week	4
Total number of teaching hrs. per semester	60
Number of credits	4

OBJECTIVE:
This paper aims at gaining knowledge on the basic concepts and techniques in the field of biostatistics and bioinformatics. It aims to facilitate students with the necessary tools to examine, understand and conduct statistically valid research. It also enables students to understand and appreciate the pivotal role played by bioinformatics in advancing our knowledge of the living world.

PART A – BIOSTATISTICS

UNIT I 8

Samples and Population, Variables in Biology, Sampling methods. 2
Frequency distribution, Graphic presentation of data-histogram, frequency curve and ogives 2
Introduction to statistics in R, Measures of Central tendency – mean, median and mode Measures of dispersion – range, mean deviation, standard deviation, standard error, variance. 4

UNIT II 8

Probability – addition and multiplication rules. Bayes theorem 1

Probability distribution binomial, poison and normal. Student “t” distribution. 2

Point estimation and interval estimation. Estimating the population mean, known and unknown. 1

Wilcoxon signed Rank test 1

Null and alternate hypothesis 1

Two tailed and one tailed test 1

Chi-square test – test of independence, goodness of fit and homogeneity 1

UNIT III **8**

Correlation – definition, types, and measurements of correlation. 2

Regression analysis – equation, estimation of unknown value from known value. 2

ANOVA – one way and two-way classification – Least significance difference (LSD) 2

Randomization – bootstrapping 2

UNIT IV **6**

Principles of parsimony, likelihood and Bayesian approach, Hypotheses Models, and their comparisons

PART B - BIOINFORMATICS

UNIT I **9**

Databases: Introduction to data bases-Relational databases- Oracle, SQL, Database generation, Sequence databases- NCBI – BLAST Resources- Human Genome Project (HGP), Microbial genomes, structural databases- protein data Bank (PDB), Organization of databases, Navigation through databases 3

Where in the Genome Does Replication Begin? Which DNA Patterns Play the Role of Molecular Clocks? 2

Tools For Data Bank - Pairwise Alignment - Needleman and Wusch Algorighm – Smith Waterman - Multiple Alignment - Clustral - Pras - Blast - Fast, Algorithms to analyse Sequence Data - Pdb, Cambridge Structure Data Base (Lsd) 4

UNIT II **7**

Principles behind computational analysis, Sequence analysis, sequence alignment and phylogenetic analysis with reference to nucleic acids, identification of ORF'S, sequence analysis, sequence alignment, phylogenetic analysis with reference to proteins, Selection analysis

UNIT III **7**

Protein Sequence Analysis - Introduction - Sequence Data Banks - Wbrf – Pir – Swissport - Databases, Data Mining - Algorithms of Proteomics And Its Applications – Protein 3

Expression Profiling - Protein - Protein Interaction - Protein Modifications. Automation - Nucleic Acid Data Bank – Embl Nucleotide Sequence Data Bank - Aids Virus Sequence Data Bank - Rna Data BanK. 2

'Next Gen' Sequence Analysis (RNA-Seq) / Metagenomics 2

UNIT IV **7**

Introduction to Hidden Markov Models 2

Analysis and interpretation of results: 2D Electrophoresis, HPLC, Mass Spectrometry, Mass Fingerprinting

5

REFERENCES:

PART A – BIOSTATISTICS

1. Schervish, M. J., & DeGroot, M. H. (2014). *Probability and statistics*. London, UK:: Pearson Education.
2. Borman, D. (2018). *Statistics 101: From Data Analysis and Predictive Modeling to Measuring Distribution and Determining Probability, Your Essential Guide to Statistics*. Simon and Schuster.
3. Krishnan, Vijaya (2011). Statistics for beginners.
4. Griffiths, D. (2008). *Head first statistics*. O'Reilly Germany.
5. Bulmer, M. G. (1979). *Principles of statistics*. Courier Corporation.
6. Freedman, D., Pisani, R., Purves, R., & Adhikari, A. (2007). Statistics.
7. Armstrong, R. A., & Hilton, A. C. (2011). *Statistical analysis in microbiology: statnotes*. Wiley-Blackwell.
8. Paulson, D. S. (2008). *Biostatistics and microbiology: a survival manual*. Springer Science & Business Media.
9. Jarvis, B. (2016). Statistical aspects of the microbiological examination of foods. Academic Press.

PART B – BIOINFORMATICS

1. Baxevanis, A. D., Bader, G. D., & Wishart, D. S. (Eds.). (2020). *Bioinformatics*. John Wiley & Sons.
2. Higgins, D., & Taylor, W. (Eds.). (2000). *Bioinformatics: Sequence, Structure and Databanks: A Practical Approach* (Vol. 236). OUP Oxford.
3. Attwood, T. K., & Parry-Smith, D. J. (2002). Introduction to bioinformatics.
4. Taxali, R. K. (1991). *Dbase III Plus Made Simple: With DBASE IV and FoxBASE*. Tata McGraw-Hill.
5. Shaik, N. A., Hakeem, K. R., Banaganapalli, B., & Elango, R. (2019). Essentials of Bioinformatics, Volume I.
6. Barnes, M. R., & Gray, I. C. (Eds.). (2003). *Bioinformatics for geneticists*. John Wiley & Sons.
7. Augen, J. (2004). *Bioinformatics in the post-genomic era: Genome, transcriptome, proteome, and information-based medicine*. Addison-Wesley Professional.
8. Ewens, W. J., & Grant, G. R. (2005). *Statistical methods in bioinformatics: an introduction* (Vol. 15). New York: Springer.
9. Luo, J. (2014). Teaching the ABCs of bioinformatics: a brief introduction to the Applied Bioinformatics Course. *Briefings in bioinformatics*, *15*(6), 1004-1013.

BLUEPRINT

Code number: MB 9421
Title of the paper: BIOSTATISTICS AND BIOINFORMATICS

Chapter/ Unit number	Number of hours	Total marks for which the questions are to be asked (including bonus questions)
Biostatistics		
I	8	9
II	8	9
III	8	9
IV	6	8
Bioinformatics		
I	9	11
II	7	9
III	7	8
IV	7	8
TOTAL	**60**	**71**
Maximum marks for the paper (Excluding bonus question) = 50		

Course outcome (MB 9421: BIOSTATISTICS AND BIOINFORMATICS)

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

PART A – BIOSTATISTICS

CO1	Apply the knowledge of the basic concepts of Biostatistics
CO2	Distinguish different hypotheses in the research papers
CO3	Execute the knowledge in practical demonstration of various concepts in R
CO4	Compile and interpret the different types of datasets and models

PART B – BIOINFORMATICS

CO1	Apply the knowledge of the basic concepts of Bioinformatics
CO2	Execute the knowledge in the practical demonstration of various bioinformatic tools and databases
CO3	Design and conduct experiments in applied Bioinformatics.
CO4	Analyze different datasets from distinct genomic and protein databases to appreciate various bioinformatic softwares.
CO5	Compile and interpret the different types of datasets and models.

PRACTICALS

MB $9P_1$: MOLECULAR BIOLOGY, RECOMBINANT DNA TECHNOLOGY AND MEDICAL MICROBIOLOGY

Total: 88 Hours

1. Collection and processing of clinical samples for microbiological examination.
2. Isolation and culture of medically important Anaerobes.
3. Antimicrobial susceptibility tests.
4. Differential Staining techniques: AFB, Leishman's.
5. Lab Study of various stages of malarial parasite.
6. Study diseases with the help of photographs -Corona, Ebola.
7. Institute Visit- Observation of a Clinical Microbiology Laboratory.
8. $CaCl_2$ mediated gene transfer.
9. Isolation of plasmid DNA by column chromatography.
10. Restriction digestion of isolated DNA (single and double digestion).
11. DNA ligation
12. DNA amplification by PCR.
13. Gene elution.
14. Expression of cloned genes in *E. coli*.
15. Purification of proteins by affinity chromatography.
16. RNA isolation
17. Southern blotting
18. Western blotting

MB9P$_2$: INDUSTRIAL MICROBIOLOGY

Total: 88 Hours

1. Screening and isolation of industrially important microorganisms (Enzyme - protease, and antibiotics) and their preservation.
2. Production of protease (SSF) and its estimation.
3. Production and estimation of wine using different substrates by *Saccharomyces cerevisiae.*
4. Batch production and estimation of citric acid.
5. Immobilization of cells by alginate method.
6. Sterility testing of pharmaceutical products.
7. Preparation of protoplast from bacteria and its fusion.
8. Clarification of banana juice using pectinase.
9. Demonstration of fermentation by using yeast.
10. Acetic acid oxidation (vinegar production) by *Acetobacter*.
11. Isolation of PHB producers and extraction of PHB.
12. Industrial visit.

DEPARTMENT OF MICROBIOLOGY

Semester	IV
Paper Code	**MB 0421**
Paper Title	**DISSERTATION**
Total number of hours	360
Number of credits	12