

KURUKSHETRA UNIVERSITY, KURUKSHETRA

SCHEME OF EXAMINATIONS AND SYLLABUS

For

M.Sc. MICROBIOLOGY (I to IV Semester)

Under

CBCS-LOCF w.e.f. 2020-2021 in phased manner



DEPARTMENT OF MICROBIOLOGY

FACULTY OF LIFE SCIENCES

PROGRAM OUTCOMES (POs)

PO1. To acquaint students with recent knowledge and techniques in basic and applied biological sciences.

PO2. To develop understanding of organismal, cellular, biochemical and environmental basis of life.

PO3. To provide insight into ethical implications of biological research for environmental protection and good laboratory practices and biosafety.

PO4. To develop problem solving innovative thinking with robust communication and writing skills in youth with reference to biological, environmental and nutritional sciences.

PO5. To understand applications of biotic material in health, medicine, food security for human well being and sustainable development.

PO6. To impart practical and project based vocational training for preparing youth for a career in research and entrepreneurship in fields of life sciences for self reliance.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1- Analyse the fundamental concepts and biodiversity of microorganisms (bacteria fungi, actinomycetes, viruses, algae), enabling critical thinking in different fields of Microbiology. Understand prokaryotic and eukaryotic genetic systems & physiology, metabolism and biochemistry of microorganisms. Acquire basic Microbiology laboratory skills, techniques and expertise in the use of instruments applicable to research, clinical methods and analysis of the observations.

PSO2- Demonstrate the importance of immunity, pathogenesis, cultivation, diagnosis and control of pathogens through therapeutics and prophylaxis in various health and pharmaceutical domains.

PSO3- Evaluate and Identify the needs, potentials and impact of microorganisms relevant to food, soil and agriculture, ensuring environmental conservation and food safety.

PSO4- Design appropriate strategies in bio-processing and fermentation technology, with emphasis to gain familiarity with applications of microbes for industrial production of biomass and synthesis of valuable products through fermentation.

PSO5- Understanding of basics of recombinant DNA technology (RDT) and explore the application of genetic engineering to create GMO, transgenic plants, animals, gene therapy, etc. Apply the concepts of Genomics and Proteomics through analytical, molecular techniques for the betterment of society.

PSO6- Examine the significance of research using statistical tools and communicate the findings in research forums. Ensure bio-safety and bioethics for social responsibility, environmental sensitization and obtain Intellectual Property Rights (IPR) for various research findings. Apply computing, communicative and entrepreneurial skills for employability and lifelong learning.

MASTER OF SCIENCE IN MICROBIOLOGY
TWO YEAR FULL TIME PROGRAMME

The **Learning Outcomes based Curriculum Framework (LOCF)** is adopted by the Kurukshetra University with an aim to equip the students with knowledge skill, values and attitude.

The **M.Sc. Microbiology Programme** offered by Kurukshetra University is of two years' duration and is divided into four semesters. The various courses of the programme are designed to include lectures, laboratory work, project training, viva, seminars, assignments and field trips. At the end of the programme the student will be well-versed in basic microbiology as well as be familiar with the most recent advances in microbiology, and will have gained hands-on experience in microbiology, including fermentation technology and molecular biology techniques.

Three categories of courses will be offered:

Core Courses (twenty four mandatory courses offered by the Department),

Electives (discipline-specific, Student must opt for two out of four courses offered by the Department)

Open Elective (in 2nd and 3rd semester student may opt for any one open elective offered by other departments of the Kurukshetra University or MOOCs courses available on SWAYAM portal of Ministry of Education, Govt. of India).

The **Core Courses** are of various credits and include laboratory courses as well as classroom courses and seminars. A separate project training-based course that leads to a report and is worth six credits is also one of the Core Courses.

The **Electives** (discipline-specific) are of four credit classroom courses.

The **Open Elective** is a two credit classroom/ online course.

A student is required to accumulate a total of 102 credits to fulfill the requirements for a Master of Science degree in Microbiology.

Semester one will have a total of **six** Core Courses: four theory-based courses of four credits each (100 marks each) and two laboratory courses of four credits each (100 marks each).

Semester two will have a total of **eight** courses: four theory-based Core Courses of four credits each (100 marks each), two laboratory courses of four credit each (100 marks each); one credit seminar of one credits (25 marks) and one Open Elective of two credits (50 marks).

Semester three will have a total of **eight** courses: three theory-based Core Courses of four credits each (100 marks each), two laboratory courses of four credit each (100 marks each), and one Elective (discipline-specific) of four credits (100 marks); one credit seminar of one credits (25 marks) and one Open Elective of two credits (50 marks).

Semester four will have a total of **six** courses: two theory-based Core Courses of four credits each (100 marks each), one Elective (discipline-specific) of four credits (100 marks); one laboratory courses of four credits (100 marks each), one credit seminar of two credits (50 marks) and one core course of six credits (150 marks) which will be a project training (which is carried out during summer month during break between 2nd and 3rd semester in various research institutes/industries etc.) and will be evaluated on the basis of report submitted, report presentation and viva-voce.

The detailed syllabus for each paper is appended, along with a list of suggested reading which would be further supplemented with other books/papers. While older editions of books are recommended for some topics, the books generally prescribed would consist of the latest editions.

DEPARTMENT OF MICROBIOLOGY, K.U., KURUKSHETRA

**Scheme of examinations and syllabus for M.Sc. Microbiology under CBCS-LOCF w.e.f.
2020-21 in phased manner**

Semester I

Paper Code	Title of Paper	Type of Paper	Hours/Week	Credits	Internal Assessment	External Marks	Total Marks	Duration of exam (hrs)
MMB-101	Microbial World	Core	4	4	20	80	100	3
MMB-102	Microbial Genetics & Molecular Biology I	Core	4	4	20	80	100	3
MMB-103	Immunology & Virology	Core	4	4	20	80	100	3
MMB-104	Microbial Physiology Metabolism & Biochemistry	Core	4	4	20	80	100	3
MMB-105	Lab Course-1	Core	8	4	20	80	100	6
MMB-106	Lab Course -II	Core	8	4	20	80	100	6
Total				24			600	

Semester II

Paper Code	Title of Paper	Type of Paper	Hours/Week	Credits	Internal Assessment	External Marks	Total Marks	Duration of exam (hrs)
MMB-201	Biophysical & Biochemical Techniques	Core	4	4	20	80	100	3
MMB-202	Microbial Genetics & Molecular Biology II	Core	4	4	20	80	100	3
MMB-203	Medical Lab. Technology	Core	4	4	20	80	100	3
MMB-204	Environmental Microbiology	Core	4	4	20	80	100	3
MMB-205	Credit Seminar	Core	1	1	-	-	25	1
MMB-206	General Microbiology /MOOCs/Swayam portal	Open [#] Elective	2	2	10	40	50	3
MMB-207	Lab Course-III	Core	8	4	20	80	100	6
MMB-208	Lab Course-IV	Core	8	4	20	80	100	6
Total				27			675	

Project training for 2 months in various research institutes/industries etc. during Summer Vacations during break between 2nd and 3rd semester

#This paper is meant for M.Sc. students of any department of any faculty of KUK other than Microbiology. Microbiology students will opt for 'open elective' from some other department of any faculty of KUK or any MOOC course available on Swayam portal

Semester III

Paper Code	Title of Paper	Type of Paper	Hours/Week	Credits	Internal Assessment	External Marks	Total Marks	Duration of exam (hrs)	
MMB-301	Recombinant DNA Technology	Core	4	4	20	80	100	3	
MMB-302	Microbial Biotechnology & Industrial Microbiology	Core	4	4	20	80	100	3	
MMB-303	Microbial Pathogenicity	Core	4	4	20	80	100	3	
MMB-304A	Agriculture Microbiology	Elective * (Any one of the two)	4	4	20	80	100	3	
MMB-304B	Basics of Bioinformatics								
MMB-305	Credit Seminar	Core	1	1	-	-	25	1	
MMB-306	Applied Microbiology/ MOOCs	Open# Elective	2	2	10	40	50	3	
MMB-307	Lab course-V	Core	8	4	20	80	100	6	
MMB-308	Lab course-VI	Core	8	4	20	80	100	6	
Total				27				675	

***Students will opt for one paper out of MMB-304A and MMB-304B**

Semester IV

Paper Code	Title of Paper	Type of Paper	Hours/Week	Credits	Internal Assessment	External Marks	Total Marks	Duration of exam (hrs)	
MMB-401	Biostatistics and Computers	Core	4	4	20	80	100	3	
MMB-402	Food & Dairy Microbiology	Core	4	4	20	80	100	3	
MMB-403	Seminar based on Project Report	Core	2	2	--	50	50	1	
MMB-404A	Intellectual Property Rights & Entrepreneurship	Elective * (Any one of the two)	4	4	20	80	100	3	
MMB-404B	Computational Biology								
MMB-405	Lab Course-VII	Core	8	4	20	80	100	6	
MMB-406	Project Training Report & Viva	Core	12	6	--	150	150	6	
Total				24				600	
Grand Total (Semester I-IV)							2550		

***Students will opt for one paper out of MMB-404A and MMB-404B**

#This paper is meant for M.Sc. students of any department of any faculty of KUK other than Microbiology. Microbiology students will opt for 'open elective' from some other department of any faculty of KUK or any MOOC course available on Swayam portal

MMB-101 MICROBIAL WORLD

Max.Marks:100
(Ext. 80+ Int. 20)

Credit : 4
Time: 3 hrs

Objectives:

- Students will be able to understand the basic principles of microbiology along with various morphological and physiological characteristics of bacteria, fungi, algae and protozoa.
- The students will be aware with the control of microorganism and antimicrobial testing.

Course Outcomes: After reading this course

- CO1. Student will know the history and morphological features of bacteria.
- CO2. Student will be able to general characteristics of bacteria and archaea and specific key features of model archaeal organisms.
- CO3 Students will know how to control the microorganism using different methods and antimicrobial testing.
- CO4. Students will be able to identify the common features of fungi, algae and protozoa.

INSTRUCTIONS FOR THE PAPER- SETTERS AND CANDIDATES

- Nine questions of equal marks should be set.
- Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.
- Eight questions, two questions from each unit (I, II, III, IV) should be set.
- Candidates will be required to attempt five questions in all, selecting one question from each unit (I, II, III, IV) and the compulsory question 1.
- All questions will carry equal marks

Unit I

History, development and scope of microbiology: Prokaryotic and eukaryotic cellular organisation. Simple staining and Gram staining techniques of bacteria. Brief account of general methods of classifying the bacteria. Whittaker's five kingdom concept.

Morphological features and arrangement of bacterial cells: Gram-positive and Gram-negative bacteria; Extracellular appendages: flagella- arrangement, basic structure and locomotive function; pili- different types, their distribution among bacteria & related functions; fimbriae- occurrence, function and features distinguishing pili and fimbriae; glycocalyx- composition and role in bacteria; and capsule- microcapsule and slime. Reserve food, pure culture, culture characteristics, isolation; media; maintenance and preservation

Unit II

General characteristics: archaea cell, actinomycetes, rickettsia & chlamydia, mycoplasma, spirochetes. Bacterial cell wall & cell membrane: Detailed structure of gram negative and gram positive bacterial cell wall, outer membrane lipopolysaccharide (LPS), protoplasts, sphaeroplasts, peptidoglycan synthesis, L-forms, cell wall synthesis and its inhibitors including different antibiotics; periplasm; molecular and chemical structure of cell membrane;

cytoskeleton including tubulin and actin structural filaments and their role in bacteria. General characteristics of archaea; how archaea are different from eubacteria; key features of model archaeal organisms: *Halobacterium*; *Pyrococcus*; *Sulfolobus*; and *Methanococcus*. Bergey's manual and its importance in classification.

Unit III

Control of microorganisms: physical and chemical methods – Dry heat, moist heat, radiations, osmotic pressure, filtration methods; chemical methods - characteristics of an ideal antimicrobial chemical agent, phenols, alcohols, quaternary ammonium compounds, halogens, heavy metals and their compounds, aldehydes, ethylene oxide and their application.

Antibiotic susceptibility testing. Mode of action of antibiotics - cephalosporin, chloramphenicol, ciprofloxacin, polymyxin B, sulphonamides. Antimicrobial drug resistance - Mechanism and spread.

Unit IV

Fungi- Characteristics and classification of fungi. Kirk et al. system of classification. Modes of reproduction in fungi. Fungi as saprotrophs & their role in decomposition in cellulose, hemicellulose, pectin and lignin.

Algae- Structure, nutrition and reproduction in algae. Distribution and classification of algae. Economic importance of algae as food, source of agar-agar, alginate, diatomite and iodine etc, antibiotics from algae, use in fisheries and malaria control, as pollution indicator. Algae as photobioreactor.

Protozoa- Morphology, reproduction, modes of nutrition, modes of transmission, locomotory organelles, encystment, excystment.

Suggested readings:

1. Stainier RY, Ingraham JL, Wheelis ML & Palmer PR. General Microbiology, MacMillan.
2. Tortora GJ, Funke BR & Case CL. Microbiology: An introduction with Mastering Microbiology,. Benjamin Cummings.
3. Madigan MT, Martinko JM, Stahl DA & Clark DP. Brock Biology of Microorganisms. Benjamin Cummings
4. Mackie & McCartney Practical Medical Microbiology . Collee JG, Fraser AG, Marmion BP & Simmons A (eds.), Churchill Livingstone, Edinburgh.
5. Atlas RM, Parks LC & Brown AL. Laboratory Manual of Experimental Microbiology. MosbyYear Book, Inc., Missouri.
6. Willey JM, Sherwood LM & Woolverton CJ DA. Prescott, Harley and Klein's Microbiology. McGraw Hill International Edition, USA.
7. Arora DR & Arora B. Medical Parasitology, CBS Publishers, New Delhi.

Teaching learning process:

- **Lectures (online and offline mode):** Through white board, notes, power point presentation supported by smart class rooms and other online teaching platforms like Google meet and Google classroom. etc.
- **Doubt session :** once in a week
- **Assignments, seminars and different exercises**
- **Tests:** Learning level of the students will be tested through class tests, quizzes, surprise evaluation, assignments sessional exams and through interactive sessions.

CO-PO Mapping for MMB-101

	PO1	PO2	PO3	PO4	PO	PO6
CO1	2.5	2.0	3.0	1.0	2.0	1.0
CO2	2.5	2.0	3.0	1.0	2.0	1.0
CO3	2.5	2.0	2.0	1.0	3.0	2.0
CO4	2.5	2.0	2.0	1.0	2.0	1.0
Average	2.5	2.0	2.5	1.0	2.0	1.5

CO-PSO Mapping for MMB-101

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2.5	2.5	2.5	1.0	3.0	1.0
CO2	2.5	2.5	2.5	1.0	3.0	1.0
CO3	2.5	2.5	2.5	1.0	3.0	1.0
CO4	2.5	2.5	2.5	1.0	3.0	1.0
Average	2.5	2.5	2.5	1.0	3.0	1.0

MMB-102 MICROBIAL GENETICS & MOLECULAR BIOLOGY- I

Max.Marks:100
(Ext. 80+ Int. 20)

Credit : 4
Time: 3 hrs

Objectives:

- Students will be able to understand the essentials of structure and functions of DNA and RNA and nature of genetic material .
- How the structure is maintained and transmission of genetic information take place along with different mechanisms of genetic recombination in bacteria.

Course Outcomes: After reading this course

- CO1. Student will be able to describe the molecular structure of DNA and RNA and its dynamic nature through renaturation and denaturation.
- CO2. Student will be able to understand how structure of DNA is modified and damaged through mutagens and transposons and the consequences thereof and different repair mechanism for the same.
- CO3 Students will understand how faithful transmission of genetic information take place through replication, its enzymology and regulation of the process.
- CO4. Students will be able to follow how genetic recombination take place through different processes like conjugation, transformation and transduction.

INSTRUCTIONS FOR THE PAPER- SETTERS AND CANDIDATES

- Nine questions of equal marks should be set.
- Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.
- Eight questions, two questions from each unit (I, II, III, IV) should be set.
- Candidates will be required to attempt five questions in all, selecting one question from each unit (I, II, III, IV) and the compulsory question 1.
- All questions will carry equal marks

Unit - I

Essentials of nucleic acid: A brief overview of microbial genetics. Beginning of experimental proof of DNA as genetic material: Transforming principle, Experiments of Griffith, Macleod, Avery, McCarty, Hershey and Chase. RNA as a genetic material. DNA and RNA structure : X-ray crystallography, Chargaff's rules, phosphodiester bond, glycosidic bond, Watson and Crick model of DNA, unusual structures and different types of DNA. Brief account of organization of eukaryotic genomes, packaging of DNA as nucleosomes. DNA denaturation, DNA melting, T_m value, Renaturation kinetics, Cot value, C -value paradox, repetitive DNA. Relaxed DNA, positive and negative supercoiling, overwinding and underwinding and its significance, Topological properties, linking no, twist and writhe, superhelical density, topoisomers, mechanism of action of topoisomerases and DNA gyrases

Unit-II

Maintenance of Structure of DNA. DNA damage and repair: photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, SOS and error prone repair, and Recombination repair. Mutation : spontaneous and induced mutation, types of point mutation,

consequences of point mutation, molecular basis of spontaneous and induced mutation, Base analogues, chemical mutagens, intercalating agent, radiation as mutagens, mutation rate, reversion and suppression, Ames test, significance and harmful effects of mutations. Transposable genetic elements: structure of transposon, IS sequences, bacterial transposon, composite transposon, Tn3 transposon, phage Mu, replication and maturation of Mu DNA, mechanism and significance of transposition: duplication of a target sequences at an insertion sequences, replicative transposition, non replicative transposition, cointegrate as an intermediate in transposition of Tn3. Genetic phenomenon mediated by transposon in bacteria,

Unit-III

Maintenance of genetic information: Overview of DNA replication: initiation, elongation and termination, unidirectional and bidirectional replication, replication fork, origin of replication. primosomes, replisomes. Enzymology of DNA replication: different types of DNA polymerases, exonuclease, Nick translation and proof reading function. Different modes of DNA replication, rolling circle model of replication, Semiconservative replication, Meselson –Stahl experiment, priming reactions, leading and lagging strand synthesis, okazaki fragments. Replication in retroviruses. Plasmid replication. Regulation of bacterial chromosome replication. Inhibitors of DNA replication. Relationship between cell cycle and replication. Brief idea of eukaryotic replication

Unit-IV

Genetic recombination in Bacteria: Horizontal and vertical gene transfer. Bacterial Conjugation: Sex Factor, chromosomal transfer by F⁺ culture, Hfr, isolation of Hfr strains, F⁺ × F⁻ cross, Hfr transfer, interrupted mating and time of entry mapping genes in bacteria, rate of chromosome transfer, Isolation of F' plasmids, Bacterial Transformation: discovery of transformation, competence, DNA uptake, molecular mechanism of transformation, mapping by transformation. Bacterial Transduction- DNA transfer by phages, lytic and lysogenic cycle, Specialized and generalized transduction. co- transduction and linkage, mapping by co-transduction.

Suggested readings:

1. Maloy SR, Cronan JE Jr. & Freifelder D. Microbial Genetics, 2nd ed., Narosa Publishing House
2. Snyder L & Champness W. Molecular Genetics of Bacteria, 3rd ed., ASM Press
3. Gardner JE, Simmons MJ & Snustad DP. Principles of Genetics. John Wiley & Sons
4. Nelson DL & Cox MM. Lehninger's Principles of Biochemistry 5th ed., W.H. Freeman and Company
5. Klug WS and Cummings MR. Essentials of Genetics. Pearson Educational International.
6. Griffiths AJ, Wessler SR, Lewontin RC and Carroll SB. Introduction to genetic analysis. W.H. Freeman and Company, New York.
7. Lewin B. Gene IX. Jones and Bartlett Publishers.
8. Watson JD. Molecular Biology of the Gene 6th edition. Benjamin Cummings.

9. Alberts B *et.al* Molecular Biology of the Cell 5th edition. Garland Science, New York and London.

10. Stryer L Biochemistry 5th edition. W.H. Freeman and Company, USA.

Teaching learning process:

- **Lectures (online and offline mode):** Through white board, notes, power point presentation supported by smart class rooms and other online teaching platforms like Google meet and Google classroom. etc.
- **Doubt session :** once in a week
- **Assignments, seminars and different exercises**
- **Tests:** Learning level of the students will be tested through class tests, quizzes, surprise evaluation, assignments sessional exams and through interactive sessions.

CO-PO Mapping for MMB-102

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2.5	2.0	3.0	1.0	2.0	1.0
CO2	2.5	2.0	3.0	1.0	2.0	1.0
CO3	2.5	2.0	2.0	1.0	3.0	2.0
CO4	2.5	2.0	2.0	1.0	2.0	1.0
Average	2.5	2.0	2.5	1.0	2.0	1.5

CO-PSO Mapping for MMB-102

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2.5	2.5	2.5	1.0	3.0	1.0
CO2	2.5	2.5	2.5	1.0	3.0	1.0
CO3	2.5	2.5	2.5	1.0	3.0	1.0
CO4	2.5	2.5	2.5	1.0	3.0	1.0
Average	2.5	2.5	2.5	1.0	3.0	1.0

MMB-103 IMMUNOLOGY & VIROLOGY

Max.Marks:100
(Ext. 80+ Int. 20)

Credit : 4
Time: 3 hrs

Objectives:

- Students will be able to understand the essentials of immunology and various mechanisms of immunity.
- Student will be able to describe the defining viral attributes, the general properties of viruses, and steps in virus infection cycle

Course Outcomes: After reading this course

- CO1. Student will be able to describe the fundamental concept in immunology like immunity and antibodies.
- CO2. Student will be able to describe the immune responses and immunological disorders.
- CO3 Student will be able to describe the principle of virus classification, list the virus families, and virus replication.
- CO4. Student will be able to describe how viruses are grown and vaccines are made.

INSTRUCTIONS FOR THE PAPER- SETTERS AND CANDIDATES

- Nine questions of equal marks should be set.
- Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.
- Eight questions, two questions from each unit (I, II, III, IV) should be set.
- Candidates will be required to attempt five questions in all, selecting one question from each unit (I, II, III, IV) and the compulsory question 1.
- All questions will carry equal marks

Unit I

Immunity: Innate immunity, factors affecting innate immunity. Acquired immunity- natural and artificial immunity, active and passive immunity. Antigen, hapten and adjuvants.

Immunoglobulins: types, structure and functions. Molecular mechanisms responsible for generating diversity of antibodies and T cell receptors. Hybridoma technology and monoclonal antibodies, and its applications. Lymphoid organs and cells of immune system.

Unit II

Immune response: Cellular and humoral immune response. Brief account of Complement system and Major histocompatibility complex.

Mechanisms of autoimmunity; Immune checkpoints, Autoimmune components of diabetes mellitus (DM), multiple sclerosis (MS), pernicious anemia; Infections leading to autoimmune diseases. Immunodeficiency diseases. Tumor antigens, immune response to tumors and immunotherapy of tumors.

Unit III

Classification, Properties of viruses, Morphology and Structure of viruses- Capsid and its symmetry with special reference to bacteriophage, Lytic and lysogenic cycle. Viroids and Prions, Virus genome types. Double stranded DNA (dsDNA). Gapped DNA genomes. Single-stranded (ssDNA) genomes. Double stranded RNA (dsRNA). Single stranded RNA (ssRNA): (+) strand RNA. Single stranded (+) sense RNA with DNA intermediate. Single stranded RNA (-) sense.

Principal events involved in replication: Adsorption, penetration, uncoating nucleic acid and protein synthesis, intracellular trafficking, assembly, maturation and release, viral-host interaction, Host response to viral infection.

Unit IV

Virus growth: Primary cell, Diploid cell strains, Continuous cell lines. One step growth curve, Detection of virus growth in cell culture. Techniques for visualization and enumeration of viral particles, assays for virus estimation.

Vaccines & Anti-Viral drugs: Herd Immunity. Requirement of an effective vaccine. Different ways of making vaccine. Inactivated vaccine. Subunit vaccines. Subunit vaccines. Live attenuated vaccines. Polio eradication. Anti-Viral drugs. Search for antiviral drugs. The path for drug discovery. Mechanism based screens. Cell based screen. Antiviral screening. Resistance to antiviral drugs.

Suggested readings:

1. Carter JB & Saunders VA. Virology-Principles and Applications, John Wiley and Sons.
2. Flint S.J., Enquist L.W., Racaniello V.R., and Skalka A.M. Principles of Virology: Molecular Biology, Pathogenesis and Control of Animal Viruses. 2nd edition. ASM Press.
3. Dimmock N., Easton A. and Leppard K. Introduction to Modern Virology. 5th edition. Blackwell Publishing.
4. Kuby Immunology by J.A. Owen, J. Punt, S.A. Stranford. 7th edition. WH Freeman. 2013.
5. Abbas A.K., Lichtman A.H., Pillai S. Cellular and Molecular Immunology. 9th edition. Saunders Elsevier.
6. Murphy K. and Casey W. Janeway's Immunobiology. 9th edition. Garland Science Publishing.
7. Delves PJ., Martin S.J., Burton D.R., Roitt I.M.. Roitt's Essential Immunology. 13th edition. Blackwell Publishing.

Teaching learning process:

- **Lectures (online and offline mode):** Through white board, notes, power point presentation supported by smart class rooms and other online teaching platforms like Google meet and Google classroom. etc.
- **Doubt session :** once in a week

- **Assignments, seminars and different exercises**
- **Tests:** Learning level of the students will be tested through class tests, quizzes, surprise evaluation, assignments sessional exams and through interactive sessions.

CO-PO Mapping for MMB-103

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2.5	2.0	3.0	1.0	2.0	1.0
CO2	2.5	2.0	3.0	1.0	2.0	1.0
CO3	2.5	2.0	2.0	1.0	3.0	2.0
CO4	2.5	2.0	2.0	1.0	2.0	1.0
Average	2.5	2.0	2.5	1.0	2.0	1.5

CO-PSO Mapping for MMB-103

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2.5	2.5	2.5	1.0	3.0	1.0
CO2	2.5	2.5	2.5	1.0	3.0	1.0
CO3	2.5	2.5	2.5	1.0	3.0	1.0
CO4	2.5	2.5	2.5	1.0	3.0	1.0
Average	2.5	2.5	2.5	1.0	3.0	1.0

MMB-104 MICROBIAL PHYSIOLOGY METABOLISM & BIOCHEMISTRY

Max.Marks:100

Credit : 4

(Ext. 80+ Int. 20)

Time: 3 hrs

Objectives:

The major objective of this paper is to develop clear understanding of various aspects of microbial physiology along with diverse macromolecules and their metabolic pathways existing in bacteria in relation to its survival and propagation. In addition the students will have the understanding of enzymes and their kinetics.

Course Outcomes: After reading this course

CO1. Students will be acquainted with methods of measuring microbial growth, growth kinetic parameters. Students will gain in-depth knowledge of primary, secondary and group translocation transport systems along with intracellular signaling in bacteria in response to various nutritional and physiological stresses.

CO2.Students will have basic ideas of structure and functions of different macromolecules. Students will have learnt basic concepts of enzyme biochemistry, its kinetics and regulation.

CO3. Students will gather understanding of inorganic and organic nitrogen assimilation and its regulation. Students will understand details of lipid and nucleotide metabolism in *E. coli* and yeasts.

CO4. Student will learnt central metabolic pathways for carbon metabolism in bacteria. Students will also have brief ideas about bacterial photosynthesis, sulphur metabolism, methanogenesis.

INSTRUCTIONS FOR THE PAPER- SETTERS AND CANDIDATES

- Nine questions of equal marks should be set.
- Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.
- Eight questions, two questions from each unit (I, II, III, IV) should be set.
- Candidates will be required to attempt five questions in all, selecting one question from each unit (I, II, III, IV) and the compulsory question 1.
- All questions will carry equal marks

Unit-I

Growth and cell division: Bacterial growth and its measurement, growth curve, growth physiology, Factors affecting growth, Batch, continuous, synchronous and diauxic growth., growth yields, growth kinetics, cell division Modes of reproduction. Cultivation of microorganisms. Cell differentiation and sporulation in *Bacillus*. Reserve food material, polyβ hydroxyl butyrate, poly phosphate granules, sulphur inclusions, cyanophycin granules, cell cycles and its control.

Solute Transport: Introduction, passive, facilitated, active transport, kinetics. Membrane transport proteins: porins and aquaporins, mechanosensitive channels, ABC transporter, group translocation PEP-PTS system, inducer exclusion and expulsion.

Physiological Adaptation and Intracellular signaling: Introduction to two component system. Response to physiological stress: aerobic-anaerobic shifts- Arc and Fnr system, osmotic homeostasis. Response to nutritional stress: phosphate supply- Pho regulon, and stringent response. Bioluminescence in bacteria.

Unit-II

Structure and classification of macromolecules: Proteins, carbohydrates, lipids and nucleic acids.

Enzymes: Introduction, classification, activation energy, enzyme kinetics, kinetic parameters, catalytic efficiency, activity units, turnover number. Methods of plotting enzyme kinetics data: Lineweaver –Burk plot, Michaelis Menten equation, saturation kinetics. Isozymes, ribozymes and abzyme, Enzyme inhibition, models and type of inhibition, allosterism and allosteric regulation.

UNIT III

Nitrogen metabolism: Inorganic nitrogen assimilation- nitrate and ammonia assimilation, regulation of glutamate synthetase, General reaction of amino acid and Stickland reaction. Glutathione: distribution in bacteria, biosynthesis and role in redox regulation. Outline of amino acid biosynthesis, urea cycle, protein utilization.

Metabolism of lipids and nucleotides: Biosynthesis and degradation of lipids and its regulation in *E. coli*, lipid accumulation in yeast. Purine and pyrimidine biosynthesis, deoxyribonucleotide synthesis, regulation of purine and pyrimidine biosynthesis, inhibitors of nucleotide biosynthesis.

Unit-IV

Central Metabolic Pathways and Regulation: Metabolites-primary, secondary and precursor. Glycolysis and its regulation, Gluconeogenesis, Pentose-Phosphate Pathway, Entner-Doudoroff Pathway, Citric Acid Cycle, alternate TCA, Glyoxylate Pathway and its regulation. CO₂ fixation, Examples of pathway engineering of carbon metabolic pathways to develop industrial useful strains: Co-metabolism of pentoses and hexoses, Succinic and citric acid production. Anoxygenic and oxygenic photosynthesis. Brief account of chemolithotrophy - Sulphur, iron and hydrogen oxidation, nitrification and methanogenesis.

Suggested Readings:

1. Gottschalk G. Bacterial Metabolism, Springer,
2. Caldwell DR. Microbial Physiology and Metabolism, 2nd ed., Star
3. Moat AG, Foster JW & Spector MP. Microbial Physiology, 4th ed., John Wiley and Sons
4. Nelson DL & Cox MM. Lehninger's Principles of Biochemistry, 5th ed., WH Freeman & Company
5. Berg JR, Tymoczko CZ & Stryer L. Biochemistry, 6th ed., W.H. Freeman and Company
6. Madigan MT, Martinko JM, Stahl DA & Clark DP. Brock Biology of Microorganisms, 13th ed., Benjamin Cummings.

7. Prescott LM, Harley JP & Klein DA. Microbiology, McGraw Hill International Edition, USA.
8. Atlas RM, Parks LC & Brown AL. Laboratory Manual of Experimental Microbiology. Mosby-Year Book, Inc., Missouri.
9. Brown AE. Benson's microbiological applications. TataMacGrawHill
10. White D, Drummond J, Fuqua C The Physiology and Biochemistry of Prokaryotes .4th Edition. Oxford University Press.
11. Cohen G N Microbial Biochemistry. 2nd Edition. Springer.

Teaching learning process:

- **Lectures (online and offline mode):** Through white board, notes, power point presentation supported by smart class rooms and other online teaching platforms like Google meet and Google classroom. etc.
- **Doubt session :** once in a week
- **Assignments, seminars and different exercises**
- **Tests:** Learning level of the students will be tested through class tests, quizzes, surprise evaluation, assignments sessional exams and through interactive sessions.

CO-PO Mapping for MMB-104

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2.5	2.0	3.0	1.0	2.0	1.0
CO2	2.5	2.0	3.0	1.0	2.0	1.0
CO3	2.5	2.0	2.0	1.0	3.0	2.0
CO4	2.5	2.0	2.0	1.0	2.0	1.0
Average	2.5	2.0	2.5	1.0	2.0	1.5

CO-PSO Mapping for MMB-104

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2.5	2.5	2.5	1.0	3.0	1.0
CO2	2.5	2.5	2.5	1.0	3.0	1.0
CO3	2.5	2.5	2.5	1.0	3.0	1.0
CO4	2.5	2.5	2.5	1.0	3.0	1.0
Average	2.5	2.5	2.5	1.0	3.0	1.0

MMB-105 LAB COURSE I

Max.Marks:100
(Ext. 80+ Int. 20)

Credit : 4
Time: 6 hrs

Objective: Student will learn about the basic practicals of microbiology

Course Outcomes:

CO1. The student will be versed with different sterilization processes and different staining techniques of given microbial isolate.

CO2. The student will learn different techniques for isolation and purification of bacteria, fungi, algae from different sources.

CO3. The student will learn the antimicrobial susceptibility testing and minimal inhibitory concentration (MIC) of an antibiotic.

CO4. The student will be able to perform genetic recombination in bacteria by conjugation, transformation and transduction.

1. Handling of general microbiological instrumentations (Hot air oven, Laminar air flow, micropipetting, autoclave, weighing balance, pH meter, BOD incubator, distillation apparatus, centrifuge.
2. Principles of sterilization techniques and their application in microbiology lab
3. Staining techniques: -
(a) Simple staining (b) Gram staining (c) Negative staining (d) Endospore staining. (e) Capsule staining
4. Study of different isolation techniques:
(a) Pour plate. (b) Spread plate. (c) Streak plate.
5. Standard plate count.
6. Isolation of bacteria, fungi, actinomycetes, algae.
7. Measurement and counting of conidia/spores of a mold.
8. To study antimicrobial susceptibility testing using antibiotic disc: agar well and disc diffusion.
9. Isolation of antibiotic resistant bacterial population by gradient plate and replica plate method
10. Determination of minimum inhibitory concentration (MIC) of antibiotics
11. Isolation of thermotolerant mutants of a bacterial /yeast culture
12. UV mutagenesis and isolation of mutants by replica plate method

13. Demonstration of genetic recombination in bacteria by conjugation, transformation and transduction

Suggested Reading:

1. Cappucino JG and Welsh CT. Microbiology: A laboratory manual. 11th edition. Pearson.
2. Thompson DA. Biochemistry Lab Manual. 3rd edition.
3. Segel IH. Biochemical calculations: how to solve mathematical problems in general biochemistry, Wiley, 2nd Edition.
4. Sambrook J & Russell D. Molecular Cloning: A laboratory manual. 4th edition. Cold Spring Harbor laboratory Press.
5. Collee JG, Fraser AG, Marmion BP & Simmons A (eds.). Mackie & McCartney Practical Medical Microbiology. Churchill Livingstone, Edinburgh.
6. Atlas RM, Parks LC & Brown AL. Laboratory Manual of Experimental Microbiology. MosbyYear Book, Inc., Missouri.

CO-PO Mapping for MMB-105

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2.5	2.5	2.0	2.0	3.0	2.5
CO2	2.5	2.5	2.0	2.0	3.0	2.5
CO3	2.5	2.5	2.0	2.0	3.0	2.5
CO4	2.5	2.5	2.0	2.0	3.0	2.5
Average	2.5	2.5	2.0	2.0	3.0	2.5

CO-PSO Mapping for MMB-105

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3.0	2.5	2.5	-	1.0	1.0
CO2	3.0	2.5	2.5	-	1.0	1.0
CO3	3.0	2.5	2.0	-	1.0	1.0
CO4	3.0	2.5	2.0	2.0	1.0	1.0
Average	3.0	2.5	2.25	0.25	1.0	1.0

MMB-106 LAB COURSE II

Max.Marks:100
(Ext. 80+ Int. 20)

Credit : 4
Time: 6 hrs

Objective: The student will be made aware about the basic experiments related to microbial physiology, immunology and virology.

Course Outcomes:

CO1. The student will be able to determine concentration of sugar and protein in a given sample after drawing a standard curve.

CO2. The student will be able to study the growth rate of bacteria and effect of various parameters like temperature, pH, oxygen, osmotic pressure, heavy metals on bacterial growth.

CO3. The student can differentiate and count lymphocytes, neutrophils, monocytes, eosinophils, and basophils based on morphological and staining characteristics.

CO4. The student can perform various immunological tests like immunodiffusion and agglutination reactions.

1. Preparation of various buffers
2. To perform general test for carbohydrates (DNS, Molisch's, Anthrone Barfoeds, Bials, Mucic, Seliwanoffs) Proteins (Lowry, Biuret).
3. Preparation of growth curve of bacteria.
4. Determination of specific growth rate and generation time of a bacterial culture
5. Effect of temperature, pH, oxygen, osmotic pressure, heavy metals on bacterial growth
6. Determination of thermal death point (TDP) & thermal death time (TDT) of an organism
7. To perform different biochemical test to characterize the bacterial culture
8. Determination of size and motility (hanging drop technique) of given bacterial culture.
9. Enumeration of bacteriophage in a sample by plaque forming unit (PFU)
10. To study chemotactic behavior of given culture of bacteria
11. Determination of total leucocytes count
12. Determination of differential leucocytes count
13. Determination of total erythrocytes count
14. Ouchterlony Double Immunodiffusion technique
15. Radial Immunodiffusion technique
16. Agglutination reactions

Suggested Reading:

1. Cappucino JG and Welsh CT. Microbiology: A laboratory manual. 11th edition. Pearson.
2. Thompson DA. Biochemistry Lab Manual. 3rd edition.
3. Segel IH. Biochemical calculations: how to solve mathematical problems in general biochemistry, Wiley, 2nd Edition.
4. Sambrook J & Russell D. Molecular Cloning: A laboratory manual. 4th edition. Cold Spring Harbor laboratory Press.
5. Collee JG, Fraser AG, Marmion BP & Simmons A (eds.). Mackie & McCartney Practical Medical Microbiology. Churchill Livingstone, Edinburgh.
6. Atlas RM, Parks LC & Brown AL. Laboratory Manual of Experimental Microbiology. MosbyYear Book, Inc., Missouri.

CO-PO Mapping for MMB-106

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2.5	2.5	2.0	2.0	3.0	2.5
CO2	2.5	2.5	2.0	2.0	3.0	2.5
CO3	2.5	2.5	2.0	2.0	3.0	2.5
CO4	2.5	2.5	2.0	2.0	3.0	2.5
Average	2.5	2.5	2.0	2.0	3.0	2.5

CO-PSO Mapping for MMB-106

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3.0	2.5	2.5	-	1.0	1.0
CO2	3.0	2.5	2.5	-	1.0	1.0
CO3	3.0	2.5	2.0	-	1.0	1.0
CO4	3.0	2.5	2.0	2.0	1.0	1.0
Average	3.0	2.5	2.25	0.25	1.0	1.0

MMB-201 BIOPHYSICAL & BIOCHEMICAL TECHNIQUES

Max.Marks:100
(Ext. 80+ Int. 20)

Credit : 4
Time: 3 hrs

Objectives:

- Students will be able to understand the different instruments and techniques used in microbiology.

Course Outcomes: After reading this course

- CO1. Student will be able to understand the relationship between wavelength, magnification and resolution in various types of microscopy.
- CO2. Student will be able to understand the differences between different types of chromatographic and spectroscopic methods
- CO3 Students will be familiar with different types of hydrodynamics based separation methods and immobilization methods.
- CO4. Students will be able to understand the processes of electrophoresis for separation of macromolecules and applications of radioactivity in biology.

INSTRUCTIONS FOR THE PAPER- SETTERS AND CANDIDATES

- Nine questions of equal marks should be set.
- Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.
- Eight questions, two questions from each unit (I, II, III, IV) should be set.
- Candidates will be required to attempt five questions in all, selecting one question from each unit (I, II, III, IV) and the compulsory question 1.
- All questions will carry equal marks

Unit I

Microscopy: Basics of microscopy: image formation, magnification, resolution. Wave theory, Electromagnetic theory. Principles and working of bright field microscope, fluorescent microscope, phase contrast microscope, electron microscope (SEM & TEM), dark field microscopy. confocal microscopy. Principles of staining.

Flow cytometry- fluochromes, fluorescent probe and working principle and its applications.

Unit II

Chromatography: Gel filtration, ion exchange & affinity chromatography, paper chromatography, Thin Layer Chromatography. Basic principles and biological applications of HPLC and GC. Principles and used of MALDI-TOF and LC-MS platforms.

Spectroscopy: Basic concepts, principles and biological applications of different types of spectroscopy: UV, IR, NMR, Raman. X-ray diffraction, circular dichromism for microbiologists.

Unit III

Centrifugation: Basics of centrifugation based methods: viscosity, diffusion, sedimentation equilibrium, dialysis, solvent fractionation, centrifugation, Biological applications and interpretations of Density Gradient methods, Ultracentrifugation methods.

Methods of bacterial and enzyme immobilization, their advantages and applications.

Basics of Radioactive isotopes and radioactive decay, sample preparation, counting, Safety precautions during handling, biological applications.

Unit IV

PAGE: Polyacrylamide gel electrophoresis (PAGE), native PAGE, SDS-PAGE, 2D electrophoresis, iso electric. Types of Agarose gel electrophoresis.

Protein engineering and proteome analysis: Proteome analysis by 2D gel electrophoresis coupled to mass spectrometric analysis. PMF versus MS/MS. Protein arrays and their applications. DNA Microarray and its applications.

Suggested Reading:

1. Freifelder D. Physical biochemistry, Freeman Company.
2. Wilson K & Walker J. Principles and Techniques of Biochemistry and Molecular Biology, 6th ed., Cambridge University Press.
3. Sheehan D. Physical Biochemistry: Principles and Applications, John Wiley & Sons Ltd, Chichester, England,
4. Upadhyay, Upadhyay & Nath. Biophysical chemistry. Himalaya Publishing house.
5. Valeur B. Molecular Fluorescence: principles and Applications. 2nd edition. Wiley.
6. Govil G and Hosur RV. NMR – Conformation of Biological Molecules. 1st edition. Springer-Verlag.

Teaching learning process:

- **Lectures (online and offline mode):** Through white board, notes, power point presentation supported by smart class rooms and other online teaching platforms like Google meet and Google classroom. etc.
- **Doubt session :** once in a week
- **Assignments, seminars and different exercises**
- **Tests:** Learning level of the students will be tested through class tests, quizzes, surprise evaluation, assignments sessional exams and through interactive sessions.

CO-PO Mapping for MMB-201

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2.5	2.5	2.0	2.0	3.0	2.5
CO2	2.5	2.5	2.0	2.0	3.0	2.5
CO3	2.5	2.5	2.0	2.0	3.0	2.5
CO4	2.5	2.5	2.0	2.0	3.0	2.5
Average	2.5	2.5	2.0	2.0	3.0	2.5

CO-PSO Mapping for MMB-201

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2.5	2.5	2.0	2.0	3.0	2.5
CO2	2.5	2.5	2.0	2.0	3.0	2.5
CO3	2.5	2.5	2.0	2.0	3.0	2.5
CO4	2.5	2.5	2.0	2.0	3.0	2.5
Average	2.5	2.5	2.0	2.0	3.0	2.5

MMB-202 MICROBIAL GENETICS & MOLECULAR BIOLOGY- II

Max.Marks:100

Credit : 4

(Ext. 80+ Int. 20)

Time: 3 hrs

Objectives:

- After learning this course, students will understand how flow of genetic information takes place from genes to proteins i.e., central dogma and how this flow of information can be exploited for genetic engineering, molecular biology, recombinant DNA technology for the benefit of mankind.

Course Outcomes: After reading this course

- CO1. Student will be able to understand the process of transcription, the first level of gene expression and its regulation.
- CO2. Student will be able to understand different events associated with the processing of newly synthesized RNA including the process of RNA interference and RNA editing
- CO3. Students will be able to describe translation mechanism in prokaryotes, regulation of translation, and post-translational processing including the significance of genetic code.
- CO4. Student will be able to explain positive and negative regulation of gene expression taking examples of lactose, tryptophan and arabinose operon.

INSTRUCTIONS FOR THE PAPER- SETTERS AND CANDIDATES

- Nine questions of equal marks should be set.
- Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.
- Eight questions, two questions from each unit (I, II, III, IV) should be set.
- Candidates will be required to attempt five questions in all, selecting one question from each unit (I, II, III, IV) and the compulsory question 1.
- All questions will carry equal marks

Unit-I

Transcription: History : linking genes and proteins , evidence for mRNA, transcription v/s replication : similarities and differences. General principle and steps of transcription: basic apparatus , initiation , elongation and termination. Classes of RNA : rRNA, mRNA and tRNA, structure and function . Types of RNA polymerases: prokaryotic and eukaryotic , structure of prokaryotic RNA polymerase, Monocistronic and polycistronic RNA, transcription bubble, structure of promoter, DNA binding assay for promoter finding , Abortive transcription, Regulation of transcription, Alternate sigma factor , rho dependent and independent termination , hairpin structure for termination . Brief idea of transcription in eukaryotes

Unit -II

Maturation and processing of RNA: Primary transcript, coding and non coding RNA, rRNA processing: Methylation and nucleolytic cleavage and ribonucleoproteins (RNPs), tRNA processing : cutting and degradation of tRNA, ribozymes , mRNA processing : poly A tail, capping, introns and its types and exons and their structure, splicing mechanism , transesterification reaction, self splicing and spliceosomes. Alternative poly A site and

alternative splicing. RNA editing and RNA interference (RNAi), miRNA. CRISPR-Cas systems for editing, regulating and targeting genomes.

Unit-III

Translation: Basic features of genetic code: Triplet code, deciphering of genetic code, degeneracy, characteristics of genetic code, variation in different organisms, universality, wobble hypothesis, significance of genetic code. Central dogma, Basic steps of translation: basic apparatus, initiation, elongation, termination, coupled transcription and translation, aminoacyl site (A site), peptidyl site (P site) and E site, initiation, elongation and termination factors, aminoacyl tRNA synthetases, leader sequences, in vitro translation system. Post translational modifications. Brief idea of translation in eukaryotes.

Unit-IV

Regulation of gene expression: Constitutive and inducible genes, Operon concept, structural genes, promoter, operator, regulator genes, concept of inducer and repressor, catabolite repression, Positive and negative regulation, lac, different mutations study of lac operon, trp operon and concept of attenuation and ara operon, stringent response, ppGpp, cAMP as regulatory molecules.

Suggested Readings:

1. Maloy SR, Cronan JE & Freifelder D. Microbial Genetics, Jones & Bartlett publishers.
2. Dale JW. Microbial Genetics of bacteria, Jones & Bartlett publishers.
3. Lewin B. Gene XI, Oxford University press.
4. Freifelder D. Molecular Biology Jones and Bartlett Publishers USA
5. Lodish *et al.* Molecular Cell Biology W.H. Freeman.
6. Maloy SR, Cronan JE Jr. & Freifelder D. Microbial Genetics, 2nd ed., Narosa Publishing House
7. Gardner JE, Simmons MJ & Snustad DP. Principles of Genetics. John Wiley & Sons
8. Nelson DL & Cox MM. Lehninger's Principles of Biochemistry 5th ed., W.H. Freeman and Company
9. Klug WS and Cummings MR. Essentials of Genetics. Pearson Educational International.
10. Griffiths AJ, Wessler SR, Lewontin RC and Carroll SB. Introduction to genetic analysis. W.H. Freeman and Company, New York.
11. Watson JD Molecular Biology of the Gene 6th edition. Benjamin Cummings.
12. Alberts B *et al.* Molecular Biology of the Cell 5th edition. Garland Science, New York and London.
13. Stryer L Biochemistry 5th edition. W.H. Freeman and Company, USA..

Teaching learning process:

- **Lectures (online and offline mode):** Through white board, notes, power point presentation supported by smart class rooms and other online teaching platforms like Google meet and Google classroom. etc.
- **Doubt session :** once in a week
- **Assignments, seminars and different exercises**
- **Tests:** Learning level of the students will be tested through class tests, quizzes, surprise evaluation, assignments, sessional exams and through interactive sessions.

CO-PO Mapping for MMB-202

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2.5	2.5	2.0	2.0	3.0	2.5
CO2	2.5	2.5	2.0	2.0	3.0	2.5
CO3	2.5	2.5	2.0	2.0	3.0	2.5
CO4	2.5	2.5	2.0	2.0	3.0	2.5
Average	2.5	2.5	2.0	2.0	3.0	2.5

CO-PSO Mapping for MMB-202

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2.5	2.5	2.0	2.0	3.0	2.5
CO2	2.5	2.5	2.0	2.0	3.0	2.5
CO3	2.5	2.5	2.0	2.0	3.0	2.5
CO4	2.5	2.5	2.0	2.0	3.0	2.5
Average	2.5	2.5	2.0	2.0	3.0	2.5

MMB 203 MEDICAL LAB TECHNOLOGY

Max.Marks:100
(Ext. 80+ Int. 20)

Credit : 4
Time: 3 hrs

Objectives:

- Students will be able to understand various types of cell adaptations and haematological disorders along with diagnosis of various infections.

Course Outcomes: After reading this course

- CO1. Student will be able to describe the various types of cell injuries and adaptations also how sample are transported.
- CO2. Student will be able to understand various types of haematological disorders.
- CO3 Students will understand various antigen antibody interactions.
- CO4. Students will be able to follow diagnosis of various pathogens and disposal of hospital waste.

INSTRUCTIONS FOR THE PAPER- SETTERS AND CANDIDATES

- Nine questions of equal marks should be set.
- Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.
- Eight questions, two questions from each unit (I, II, III, IV) should be set.
- Candidates will be required to attempt five questions in all, selecting one question from each unit (I, II, III, IV) and the compulsory question 1.
- All questions will carry equal marks

Unit I

Cell Injury and Cellular Adaptations. a) Normal Cell b) Cell Injury- types of cell injury, etiology of cell injury, morphology of cell injury, cellular swelling. c) Cell death : types- autolysis, necrosis, apoptosis & gangrene. d) Cellular adaptations-atrophy, hypertrophy, hyperplasia & dysplasia. Collection and Transportation of Specimen General Principles, Containers, Rejection, Samples- Urine, Faeces, Sputum, Pus, Body fluids, Swab, Blood. 8. Care and Handling of Laboratory Animals Fluid, Diet, Cleanliness, Cages, ventilation, Temperature, Humidity, handling of Animals, Prevention of disease.

Unit II

Hematological Disorders: Classification of Anemia : Morphological & etiological. Iron Deficiency Anemia : Distribution of body Iron, Iron Absorption, causes of iron deficiency, lab findings. Megaloblastic Anemia : Causes, Lab findings. Hemolytic Anemia : Definition, causes, classification & lab findings. Bone Marrow: Cell composition of normal adult Bone marrow, Aspiration, Indication, Preparation & Staining, Special Stain for Bone Marrow -Periodic Acid Schiff, Sudan Black, Myeloperoxidase. Leukemia : Classification, Blood Picture, Differentiation of Blast Cells.

Unit III

Features of antigen/antibody Reaction- - Precipitation - Agglutination - Complement fixation test - Neutralization - Opsonization - Immune adherence - Immuno fluorescence - Immuno electron microscopic test. Comparative study of Type I-V hypersensitivities with examples, Vaccination program and schedule.

Unit IV

Cutaneous & Sub cutaneous and Systemic Mycosis - Lab diagnosis of fungal infections.

Lab diagnosis of viral infections.

Disposal of Laboratory/Hospital Waste: Non-infectious waste, Infected sharp waste disposal, infected non-sharp waste disposal.

Suggested Readings:

1. Barbara JB, Bates I and Mike A. Dacie and Lewis Practical Haematology 9th edition Elsevier
2. Marshal L, Joseph P, Kenneth K, Marcel L, et al. Williams Manual of Hematology, Ninth Edition, Mac Graw hill
3. Richard AM and Matthew RP. Henry's Clinical Diagnosis and Management by Laboratory Methods. Elsevier
4. Nader, F. Tietz Textbook of Clinical Chemistry and Molecular Diagnostics. Elsevier.
5. Frances TF and Margaret AF. Fischbach's A Manual of Laboratory and Diagnostic Tests 10th Edition. Wolters Kluwers

Teaching learning process:

- **Lectures (online and offline mode):** Through white board, notes, power point presentation supported by smart class rooms and other online teaching platforms like Google meet and Google classroom. etc.
- **Doubt session :** once in a week
- **Assignments, seminars and different exercises**
- **Tests:** Learning level of the students will be tested through class tests, quizzes, surprise evaluation, assignments sessional exams and through interactive sessions.

CO-PO Mapping for MMB-203

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2.5	2.5	2.0	2.0	3.0	2.5
CO2	2.5	2.5	2.0	2.0	3.0	2.5
CO3	2.5	2.5	2.0	2.0	3.0	2.5
CO4	2.5	2.5	2.0	2.0	3.0	2.5
Average	2.5	2.5	2.0	2.0	3.0	2.5

CO-PSO Mapping for MMB-203

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2.5	2.5	2.0	2.0	3.0	2.5
CO2	2.5	2.5	2.0	2.0	3.0	2.5
CO3	2.5	2.5	2.0	2.0	3.0	2.5
CO4	2.5	2.5	2.0	2.0	3.0	2.5
Average	2.5	2.5	2.0	2.0	3.0	2.5

MMB-204 ENVIRONMENTAL MICROBIOLOGY

Max.Marks:100

(Ext. 80+ Int. 20)

Credit : 4

Time: 3 hrs

Objectives: The major objective of this paper is to impart knowledge about structure, composition and functioning of microbial communities of diverse environment. The use of microbial population in agriculture, mineral recovery, management of various types of pollutants and conversion processes of various types of wastes into value added products will be discussed.

Course Outcomes:

Upon successful completion of the course :

CO1. Students will gain insight in the field of environmental microbiology. Students will be acquainted with various cultural, biochemical and molecular techniques used in understanding microbial diversity.

CO2. Students will be knowledgeable about the diversity, adaptations and biotechnological applications of microbes of extreme environment. They will be able to describe the role of soil microbes in nutrient transformation, plant-microbe interactions and potability of water.

CO3. Understands the role of microbes in management of waste plant biomass and will study the role of microbes in bioremediation of environmental pollutants.

CO4. Student will be able to describe the role of microbes in solid and liquid waste management, gaining knowledge of various methods employed in sewage treatment and solid waste treatment.

INSTRUCTIONS FOR THE PAPER- SETTERS AND CANDIDATES

- Nine questions of equal marks should be set.
- Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.
- Eight questions, two questions from each unit (I, II, III, IV) should be set.
- Candidates will be required to attempt five questions in all, selecting one question from each unit (I, II, III, IV) and the compulsory question 1.
- All questions will carry equal marks

Unit-I

Development in field of environmental microbiology: Development of microbial ecology and emergence of field of environmental microbiology, significant applications of microbes in solving environmental pollution problems

Culture-dependent and culture-independent approaches for understanding microbial diversity in the environment: Understanding microbial diversity in the environment by culture-dependent and culture-independent approaches, Analysis by FAME, measuring metabolic capabilities using BIOLOG, G+C analysis, slot-blot hybridization of community DNA, and fluorescent *in situ* hybridization of intact cells, metagenomic analysis of solid and aquatic sediments.

Unit-II

Microbial diversity in extreme environments: Occurrence, diversity, adaptations and potential applications of oligotrophs, thermophiles, psychrophiles, organic solvent and radiation tolerants, metallophiles, acidophiles, alkaliphiles and halophiles. Biotechnological applications of the same

Soil and water microbiology: Importance of soil microorganisms, nutrient transformation processes, plant-microbe symbiosis, microbial antagonism, biofilms and their biotechnological applications, drinking water microbiology and quality control.

UNIT III

Biomass waste management of plant's residues: Lignocellulolytic microorganisms, enzymes and their biotechnological applications in: (i) biopulping, (ii) biobleaching, (iii) textiles (iv) biofuels, (v) animal feed production.

Bioremediation of environmental pollutants: Petroleum hydrocarbons and pesticides, use of biosensors for their detection. Microbial enhanced oil recovery, bioleaching of copper, gold and uranium, electronic waste management.

Unit-IV

Liquid and solid waste management: Treatment of sewage (primary, secondary and tertiary treatments), treatment of industrial effluents (distillery, textile, pulp and paper), methods to detect various pollutants (metals, sediments, toxin and organic matters). Solid waste types, composting, landfill development, incineration methods, composting and sustainable agriculture, biogas production, plastic degrading microorganisms as a tool for bioremediation, challenges in waste management.

Suggested Readings:

1. Atlas R.M., Bartha R. 3rd edition. Microbial Ecology Benjamin Cummings Publishing Co, USA.
2. Varnam A H, Evans M G. Environmental Microbiology .Manson Publishing Ltd.
3. Hurst CJ , Crawford RL, Garland JL, Lipson D A, Mills A L, Stetzenbach L D. 3rd edition.
4. Manual of Environmental Microbiology Blackwell Publishing. edited by R. Mitchell, J-D Gu. Wiley-Blackwell.
5. Maier R, Pepper I, Gerba C. 2nd edition. Environmental Microbiology .Academic Press.
6. Jjemba P K, Environmental Microbiology: Principles and Applications Science Publishing Inc.
7. Kuhad R C, Singh A . Lignocellulose Biotechnology: Future Prospects .I.K. International.
8. Okafor N. 1st edition, Environmental Microbiology of Aquatic & Waste systems Springer, New York.

Teaching learning process:

- **Lectures (online and offline mode):** Through white board, notes, power point presentation supported by smart class rooms and other online teaching platforms like Google meet and Google classroom. etc.
- **Doubt session :** once in a week
- **Assignments, seminars and different exercises**
- **Tests:** Learning level of the students will be tested through class tests, quizzes, surprise evaluation, assignments sessional exams and through interactive sessions.

CO-PO Mapping for MMB-204

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2.5	2.5	2.0	2.0	3.0	2.5
CO2	2.5	2.5	2.0	2.0	3.0	2.5
CO3	2.5	2.5	2.0	2.0	3.0	2.5
CO4	2.5	2.5	2.0	2.0	3.0	2.5
Average	2.5	2.5	2.0	2.0	3.0	2.5

CO-PSO Mapping for MMB-204

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2.5	2.5	2.0	2.0	3.0	2.5
CO2	2.5	2.5	2.0	2.0	3.0	2.5
CO3	2.5	2.5	2.0	2.0	3.0	2.5
CO4	2.5	2.5	2.0	2.0	3.0	2.5
Average	2.5	2.5	2.0	2.0	3.0	2.5

MMB-206: GENERAL MICROBIOLOGY (Open Elective)

Max.Marks:50
(Ext. 40+ Int. 10)

Credit : 2
Time: 3 hrs

Objective: The course is about the development and basic techniques used in the microbiology. The students will be covering the various physiological characteristics and classification of bacteria.

Course Outcomes: After completion of this course

- CO1. The students will be having the knowledge about various types of microscopy
- CO2. The students will know about various methods of staining and groups of bacteria
- CO3 The students will study about the various methods of cultivation of microbes.
- CO4. The students will study about the various methods of preservation of microorganisms

INSTRUCTIONS FOR THE PAPER- SETTERS AND CANDIDATES

- Nine questions of equal marks should be set.
- Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.
- Eight questions, four questions from each unit (I & II) should be set.
- Candidates will be required to attempt five questions in all, selecting at least two question from each unit (I & II) and the compulsory question 1.
- Each question will carry 8 marks.

Unit I

History, development, scope and applications of Microbiology. General methods of sterilization. Introduction to Microscopy: bright field microscopy, dark field microscopy, phase contrast microscopy, electron microscopy. Various methods of staining of bacteria (simple, negative and Gram) and fungus (mold and yeast). Whittaker system of classification. Brief introduction to Bergey's manual and groups of bacteria (gram positive and negative, spirochetes, endospore-forming bacteria, actinomycetes, archaea, mycoplasma)

Unit II

Morphology & fine structure of bacterial cell wall, cell membrane, flagella and capsules. Formation of spores. Bacterial growth curve and measurement. Nutritional requirements and nutritional types of bacteria. Pure culture techniques –pour plate, spread plate, streak plate and serial dilution agar plate method. Advantages and disadvantages of various techniques. Preservation of microbial culture-serial subculture, at very low temperature, overlaying culture with mineral oil, lyophilization or freeze drying, in liquid nitrogen.

Suggested Readings:

1. Stainier RY, Ingraham JL, Wheelis ML & Palmer PR. General Microbiology, MacMillan.
2. Tortora GJ, Funke BR & Case CL. Microbiology: An introduction with Mastering Microbiology, 10th ed. Benjamin Cummings.

3. Madigan MT, Martinko JM, Stahl DA & Clark DP. Brock Biology of Microorganisms, 13th ed., Benjamin Cummings
4. Willey JM, Sherwood LM & Woolverton CJ DA. Prescott, Harley and Klein's Microbiology, 7th ed., McGraw Hill International Edition, USA.

Teaching learning process:

- **Lectures (online and offline mode):** Through white board, notes, power point presentation supported by smart class rooms and other online teaching platforms like Google meet and Google classroom. etc.
- **Doubt session :** once in a week
- **Assignments, seminars and different exercises**
- **Tests:** Learning level of the students will be tested through class tests, quizzes, surprise evaluation, assignments sessional exams and through interactive sessions.

CO-PO Mapping for MMB-206

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2.5	2.5	2.0	2.0	3.0	2.5
CO2	2.5	2.5	2.0	2.0	3.0	2.5
CO3	2.5	2.5	2.0	2.0	3.0	2.5
CO4	2.5	2.5	2.0	2.0	3.0	2.5
Average	2.5	2.5	2.0	2.0	3.0	2.5

CO-PSO Mapping for MMB-206

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2.5	2.5	2.0	2.0	3.0	2.5
CO2	2.5	2.5	2.0	2.0	3.0	2.5
CO3	2.5	2.5	2.0	2.0	3.0	2.5
CO4	2.5	2.5	2.0	2.0	3.0	2.5
Average	2.5	2.5	2.0	2.0	3.0	2.5

MMB-207 LAB COURSE III

Max.Marks:100
(Ext. 80+ Int. 20)

Credit : 4
Time: 6 hrs

Objective: The student will be able to perform various techniques used in microbiology and molecular biology.

Course Outcomes: After completion of this course

CO1. The student will be able to isolate the genomic and plasmid DNA from bacteria and transformation study of bacterial cultures.

CO2. The student will be able to check purity of DNA, through agarose gel electrophoresis and PCR.

CO3. The student will be able to extract and analyse different proteins from bacteria through PAGE and SDS PAGE.

CO4. The student will learn different chromatographic techniques for the separation of compounds.

1. Isolation of plasmid DNA by using alkaline lysis
2. Transformation of plasmid DNA by using CaCl_2 .
3. Preparation of genomic DNA from bacteria.
4. Demonstration of agarose gel electrophoresis.
5. Demonstration of polymerase chain reaction.
6. Calorimetric estimation of DNA & RNA.
7. Isolation of proteins from bacterial culture by ammonium sulphate ppt. and NaCl extraction.
8. Demonstration of PAGE and SDS-PAGE.
9. To study principle and working of spectrophotometer.
10. Demonstration of thin layer chromatography.
11. Demonstration of paper chromatography.
12. Working of microscope.
13. Various types of Electroimmunodiffusion.
14. To study principle and working of spectrophotometer.

Suggested Reading:

1. Cappucino JG and Welsh CT. Microbiology: A laboratory manual. 11th edition. Pearson.
2. Thompson DA. Biochemistry Lab Manual. 3rd edition.
3. Segel IH. Biochemical calculations: how to solve mathematical problems in general biochemistry, Wiley, 2nd Edition.
4. Sambrook J & Russell D. Molecular Cloning: A laboratory manual. 4th edition. Cold Spring Harbor laboratory Press.
5. Collee JG, Fraser AG, Marmion BP & Simmons A (eds.). Mackie & McCartney Practical Medical Microbiology. Churchill Livingstone, Edinburgh.
6. Atlas RM, Parks LC & Brown AL. Laboratory Manual of Experimental Microbiology. MosbyYear Book, Inc., Missouri.

CO-PO Mapping for MMB-207

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2.5	2.5	2.0	2.0	3.0	2.5
CO2	2.5	2.5	2.0	2.0	3.0	2.5
CO3	2.5	2.5	2.0	2.0	3.0	2.5
CO4	2.5	2.5	2.0	2.0	3.0	2.5
Average	2.5	2.5	2.0	2.0	3.0	2.5

CO-PSO Mapping for MMB-207

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3.0	2.5	2.5	-	1.0	1.0
CO2	3.0	2.5	2.5	-	1.0	1.0
CO3	3.0	2.5	2.0	-	1.0	1.0
CO4	3.0	2.5	2.0	2.0	1.0	1.0
Average	3.0	2.5	2.25	0.25	1.0	1.0

MMB-208 LAB COURSE IV

Max.Marks:100
(Ext. 80+ Int. 20)

Credit : 4
Time: 6 hrs

Objective: The student will learn about the fecal contamination, potability of water and study of blood infections.

Course Outcomes: After completion of this course

CO1. The student will be able to check the fecal contamination, potability and various other properties of water.

CO2. The student will be able to learn common infections through blood sampling.

CO3. The student will be able to isolate the bacteria from various samples and will be able grow them on different media.

CO4. The student can identify the bacteria by using different biochemical tests.

1. Detection of phenol coefficient of disinfectants.
2. Presumptive, confirmed and completed test for coliform bacteria
3. Water analysis for total bacterial population by standard plate count (SPC) and membrane filter method
4. Detection of dissolved oxygen of water
5. Determination of BOD/ COD of sewage water (treated and untreated)
6. Determination of total alkalinity and chlorine content of water.
7. To stain a tissue by immunohistochemical reaction.
8. To perform western blotting.
9. Preparation and storage of plasma and serum.
10. Study of human blood groups and Rh factor.
11. WIDAL test.
12. Detection of bacteremia and uremia.
13. General tests for identification of bacteria from clinical samples including IMViC test, Carbohydrate fermentation test, Nitrate reduction test, Triple sugar agar test, Urease test, Catalase test, Oxidase test
14. Preparation of different growth media.

Suggested Reading:

1. Cappucino JG and Welsh CT. Microbiology: A laboratory manual. 11th edition. Pearson.
2. Thompson DA. Biochemistry Lab Manual. 3rd edition.

3. Segel IH. Biochemical calculations: how to solve mathematical problems in general biochemistry, Wiley, 2nd Edition.
4. Sambrook J & Russell D. Molecular Cloning: A laboratory manual. 4th edition. Cold Spring Harbor laboratory Press.
5. Collee JG, Fraser AG, Marmion BP & Simmons A (eds.). Mackie & McCartney Practical Medical Microbiology. Churchill Livingstone, Edinburgh.
6. Atlas RM, Parks LC & Brown AL. Laboratory Manual of Experimental Microbiology. MosbyYear Book, Inc., Missouri.

CO-PO Mapping for MMB-208

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2.5	2.5	2.0	2.0	3.0	2.5
CO2	2.5	2.5	2.0	2.0	3.0	2.5
CO3	2.5	2.5	2.0	2.0	3.0	2.5
CO4	2.5	2.5	2.0	2.0	3.0	2.5
Average	2.5	2.5	2.0	2.0	3.0	2.5

CO-PSO Mapping for MMB-208

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3.0	2.5	2.5	-	1.0	1.0
CO2	3.0	2.5	2.5	-	1.0	1.0
CO3	3.0	2.5	2.0	-	1.0	1.0
CO4	3.0	2.5	2.0	2.0	1.0	1.0
Average	3.0	2.5	2.25	0.25	1.0	1.0

MMB-301 RECOMBINANT DNA TECHNOLOGY

Max.Marks:100
(Ext. 80+ Int. 20)

Credit : 4
Time: 3 hrs

Objectives: The objective of this course is to make the student familiar with the currently used techniques to manipulate/ analyze DNA, RNA and proteins. The student will be made familiar with the methods used to clone genes, make and screen libraries, and the various applications of the polymerase chain reaction.

Course Outcomes:

Upon successful completion of the course, the student:

CO1: Will be familiar with the use of various cloning vectors, and methods of DNA, RNA and protein analysis and various applications of PCR.

CO2. Will be able to understand the methods by which DNA is sequenced and will gain insights into how entire genomes of organisms are sequenced.

CO3. Will have learnt about promoter analyses, the many uses of the reporter genes, and methods to study the transcriptome along with overexpression of proteins.

CO4. Will have learnt about different methods to analyze protein-DNA and protein-protein interactions, protein engineering, and methods for proteome analyses. Will know about the creation of plant and animal transgenics.

INSTRUCTIONS FOR THE PAPER- SETTERS AND CANDIDATES

- Nine questions of equal marks should be set.
- Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.
- Eight questions, two questions from each unit (I, II, III, IV) should be set.
- Candidates will be required to attempt five questions in all, selecting one question from each unit (I, II, III, IV) and the compulsory question 1.
- All questions will carry equal marks

UNIT 1

Basics of DNA cloning, and methods of DNA and protein analysis: Simple cloning and cloning using linkers and adaptors. Cloning into various kinds of vectors – plasmids, phages lambda and M13, phagemids, cosmids, P1 phage, PACs, BACs and YACs. Selection and screening of clones.

Southern and Northern Blotting. Radiolabelling probes. Isolation and purification of DNA. RFLP analysis. DNA fingerprinting and its application in forensics, in disease diagnosis and in identification of strains. Western Blotting analysis.

Polymerase chain reaction and construction of cDNA and genomic DNA libraries:

Concept of PCR and various thermophilic enzymes used in PCR. Gradient PCR versus Touchdown PCR. Designing primers. Cloning PCR products. Long PCR, Inverse PCR, Vectorette PCR, RT-PCR, 5' and 3' RACE, Real Time PCR using SYBR Green, Scorpion primers and TaqMan probes, MOPAC, Multiplex PCR, Differential Display PCR, RAPD fingerprinting of micro-organisms, Ligation Chain Reaction, Overlap PCR, Rolling Circle Amplification Technology. Vectors used in the construction of cDNA versus genomic DNA

libraries. Steps in the construction of cDNA versus genomic DNA libraries. Screening libraries by colony hybridization and colony PCR. Screening expression libraries. Enriching for clones in cDNA libraries by positive selection and subtractive hybridization. Identifying genes in complex genomes by direct selection of cDNA and exon trapping.

UNIT II

Genome sequencing: DNA sequencing by Sanger's method – traditional and cycle sequencing. Physical mapping by restriction fragment fingerprinting of BAC clones and STS mapping. E-PCR. Whole genome shotgun sequencing. Clone-by-clone shotgun sequencing of genome – preparation of BAC/YAC library, selection of BACs, subclone library construction, random shotgun phase and finishing phase followed by sequence authentication. Next Generation sequencing methods.

UNIT III

Transcriptional analysis of gene expression and transcriptomics: Gene expression analysis by Northern Blotting, RT-PCR, EST analysis and the use of reporter genes. Enzymatic and bioluminescent reporters. Reporters used in protein localization and trafficking studies. Promoter analysis – deletion analysis and linker scanning analysis coupled to reporter assays, mapping transcriptional start sites by S1 nuclease mapping, primer extension studies or 5' RACE. Transcriptome analysis by DD-PCR and EST analysis, DNA microarrays (cDNA arrays and oligo arrays), Serial Analysis of Gene Expression (SAGE), RNA-seq.

Overexpression of recombinant proteins: Overexpression and tagging of recombinant proteins in *E.coli*, driven by lac, T7 and Tet-regulatable promoters, Expression in *B. subtilis*. Overexpression systems in *S.cerevisiae*, *P.pastoris*, *S.pombe* and *K.lactis*. Baculovirus overexpression system. Mammalian cell overexpression system.

Unit – IV

Analysis of protein-DNA and protein-protein interactions, protein engineering and proteome analysis: Gel retardation assay, DNA footprinting by DNase I and chemical methods, yeast one-hybrid assay, ChIP- chip, ChIP-seq. Yeast two hybrid, three-hybrid, split hybrids and reverse hybrid. Co-immunoprecipitation, pull-down, far-western. Use of GFP and its variants in FRET analysis, use of BiFC. Phage display. Insertional and deletion mutagenesis. Site directed mutagenesis by conventional and PCR-based methods. Proteome analysis by 2D gel electrophoresis coupled to mass spectrometric analysis. Principles and used of MALDI-TOF and LC-MS platforms. PMF versus MS/MS. Protein arrays and their applications.

Applications of recombinant DNA technology:

Human protein replacements – insulin, hGH and Factor VIII. Human therapies – TPA, interferon, antisense molecules. Vaccines – Hepatitis B, AIDS, and DNA vaccines. Creating transgenic animals and plants.

Suggested Readings:

1. Molecular Biology by D.P. Clarke, N. Pazdernik. 2nd edition. Academic Press.
2. Molecular Cloning: A laboratory manual by J. Sambrook, D. Russell. 4th edition. Cold Spring Harbor laboratory Press.
3. DNA Technology: The Awesome Skill by I. Edward Alcamo. Harcourt Academic Press.
4. Molecular Biology of the Gene by J. Watson, T. Baker, S. Bell, A. Gann, M. Levine, R. Losick. 7th edition. Pearson.

5. Gene Cloning and DNA Analysis: An Introduction by T.A. Brown. 7th edition. Wiley-Blackwell Publishers.
6. Old & Primrose. Principles of gene manipulation. Blackwell Scientific Publications.
7. Sambrook&Russel. Molecular Cloning, 3rd volume. CSH Press.
8. Genome Analysis. 4th volume. CSH Press.
9. Lewin B. Genes VIII, International Edition, Pearson Education
10. Alberts B, Johnson A, Lewis J, Raff M, Roberts K, & Walter P. Molecular Biology of the Cell, 5th ed., Garland Science Publishing
11. Fritsch J & Maniatis EF. Molecular cloning a laboratory Manual, Cold Spring Harbor Laboratory

Teaching learning process:

- **Lectures (online and offline mode):** Through white board, notes, power point presentation supported by smart class rooms and other online teaching platforms like Google meet and Google classroom. etc.
- **Doubt session :** once in a week
- **Assignments, seminars and different exercises**
- **Tests:** Learning level of the students will be tested through class tests, quizzes, surprise evaluation, assignments sessional exams and through interactive sessions.

CO-PO Mapping for MMB-301

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2.2	2.5	2.4	1.5	2.5	2.3
CO2	2.5	2.4	2.1	1.2	2.6	2.6
CO3	2.7	2.4	2.1	1.2	2.6	2.6
CO4	2.6	2.7	2.2	1.1	2.7	2.5
Average	2.5	2.5	2.2	1.25	2.6	2.5

CO-PSO Mapping for MMB-301

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2.0	2.1	2.6	2.4	2.8	2.3
CO2	2.2	2.2	2.7	2.5	2.9	2.4
CO3	2.1	2.3	2.8	2.5	2.9	2.5
CO4	2.1	2.2	2.7	2.6	2.8	2.6
Average	2.1	2.2	2.7	2.5	2.85	2.45

MMB-302 MICROBIAL BIOTECHNOLOGY AND INDUSTRIAL MICROBIOLOGY

Max.Marks:100
(Ext. 80+ Int. 20)

Credit : 4
Time: 3 hrs

Objectives: To familiarize students about microbial processes/systems/activities for the development of industrially important products/processes. Students will be aware about industrially important microorganisms and different aspects of microbial fermentation and production. .

Course Outcomes: After completion of this course

CO1 The student will gain insight on industrially important microbes and their preservation, inoculum development and techniques involved in the development of industrially relevant strains including recombinant DNA technology.

CO2. Student will be able to differentiate between batch, fed-batch and continuous cultivation systems and their optimization strategies through RSM.

CO3. Will be able to differentiate between the design of a laboratory and industrial scale fermenter as well the different types of fermenters and instrumentations associated with it. Will learn the importance and principles of sterilization, mathematical modelling of sterilization processes and the effect of sterilization on media quality and yield coefficients.

CO4. Student will learn about various downstream processing techniques; process optimization involved in the development of recombinant biopharmaceuticals, industrial enzymes, therapeutic proteins etc.

INSTRUCTIONS FOR THE PAPER- SETTERS AND CANDIDATES

- Nine questions of equal marks should be set.
- Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.
- Eight questions, two questions from each unit (I, II, III, IV) should be set.
- Candidates will be required to attempt five questions in all, selecting one question from each unit (I, II, III, IV) and the compulsory question 1.
- All questions will carry equal marks

UNIT 1

Introduction to industrial microbiology: Introduction to microbial products and fermentation processes, sources of industrially important microorganisms, Industrially important microorganisms, criteria of industrially important microorganisms, Biology of industrially important microorganisms, preservation techniques for microbial cultures, inoculum development, microbial strain improvement, high throughput screening methods, recombinant DNA technology in strain improvement, oxidation-reduction principle in fermentation, recent developments in fermentation technology.

UNIT II

Fermentation systems:

Batch cultivation, continuous cultivation, multistage chemostat, feedback systems, types of fed-batch cultures, open and closed systems, Monod kinetics of microbial growth, growth and non-growth associated product formation, product formation kinetics and mathematical modeling, bioprocess optimization strategies.

Media Optimization : Substrates for industrial fermentation, media optimization strategies like Plackett–Burman design, response surface methodology. Immobilized cell reactor, solid state fermentation.

UNIT III

Design and types of fermenters: Basic components of a fermenter, fermenter construction materials, designing of laboratory and industrial scale fermenters, types of impellers, mechanical seal, types of baffle and spargers, sampler design, foam controller, types of fermenter like stirred tank, bubble column, airlift, hollow fibers chambers, packed beds, fluidized beds, perfusion cultures, photo-bioreactors and animal cell culture bioreactor. Different types of sterilization strategies, sterilization of large scale bioreactors.

Bioprocess instrumentation and control parameters: Measurement of various control parameters in bioreactor like pH, dissolved oxygen, temperature, antifoam, principles of feed-back control, PID control, respiratory quotient, effect of dissolved oxygen on microbial production processes, effect of foam and anti-foam on oxygen transfer, oxygen mass transfer coefficient, measurement of KLa values using sulfite oxidation techniques, gassing-out techniques, fluid rheology, newtonian and non-newtonian fluids, bingham plastic, pseudo plastic, power number, Reynolds number.

Unit – IV

Downstream processing: Downstream processing for filtration (DSP) cell disruption, liquid-liquid extraction, solvent recovery, supercritical fluid extraction, various chromatography techniques in product recovery, diafiltration, ultrafiltration and reverse osmosis, drying (lyophilization and spray drying), whole broth processing and crystallization, upstream processing and product recovery.

Applications of bioprocessing: Production of Biofertilizers, Biopesticides, Edible Mushroom, Single Cell Protein (SCP), steroid conversion and biotransformation.

Biotechnological applications of microbes in the commercial production of the following:

Alcoholic beverages: Beer, Whisky

Organic acids: Citric, lactic and acetic acid.

Microbial enzymes: Cellulases, amylases, proteases and lipases.

Antibiotics: penicillin, tetracycline

Amino acids: Glutamic acid, lysine.

Suggested Readings:

1. Principles of Fermentation Technology by P. Stanbury, A. Whitaker, S. Hall. 3rd edition. Butterworth-Heinemann.
2. Bioprocess Engineering: Basic Concepts by M. L. Shuler, F. Kargi, 2nd edition. Pearson Education India.
3. Modern Industrial Microbiology & Biotechnology by N. Okafor. 1st edition. CRC Press, USA.
4. Fermentation Microbiology and Biotechnology edited by E.M.T. El-Mansi, C.F. Bryce, A.L. Demain, A.R. Allman. 3rd edition. CRC Press.
5. Microbial Biotechnology: Fundamentals of Applied Microbiology by A.N. Glazer, H. Nikaido. 2nd edition. Cambridge University Press.
6. Pharmaceutical Biotechnology: Concepts and Applications by G. Walsh. John Wiley & Sons Ltd.

7. Pharmaceutical Biotechnology: Fundamentals and Applications by J.A.D. Crommelin, R.D. Sindelar, B. Meibohm. 4th Edition. Springer.
8. Reed G. Industrial Microbiology CBS Publisher.
9. Cruger & Cruger. Microbial Biotechnology, Panima Press
10. Moo-Young M, Cooney CL & Humphery AE. Comprehensive Biotechnology-The Principles, Applications & Regulations of Biotechnology in Industry, Agriculture & Medicine, Pergamon Press

Teaching learning process:

- **Lectures (online and offline mode):** Through white board, notes, power point presentation supported by smart class rooms and other online teaching platforms like Google meet and Google classroom. etc.
- **Doubt session :** once in a week
- **Assignments, seminars and different exercises**
- **Tests:** Learning level of the students will be tested through class tests, quizzes, surprise evaluation, assignments sessional exams and through interactive sessions.

CO-PO Mapping for MMB-302

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2.2	2.5	2.4	1.5	2.4	2.3
CO2	2.6	2.6	2.2	1.2	2.6	2.7
CO3	2.7	2.6	2.1	1.0	2.7	2.6
CO4	2.8	2.7	2.3	1.1	2.7	2.4
Average	2.57	2.6	2.25	1.2	2.6	2.5

CO-PSO Mapping for MMB-302

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2.4	2.6	2.5	2.7	2.5	1.7
CO2	2.6	2.5	2.6	2.8	2.6	1.2
CO3	2.7	2.7	2.7	2.8	2.5	1.4
CO4	2.3	2.6	2.6	2.5	2.4	1.7
Average	2.5	2.6	2.6	2.7	2.5	1.5

MMB-303: MICROBIAL PATHOGENICITY

Max.Marks:100

(Ext. 80+ Int. 20)

Credit : 4

Time: 3 hrs

Objectives: Students will be able to understand the mechanisms of microbial pathogenesis, spread of infection and recovery from it.

Course Outcomes: After completion of this course

CO1. Student will be able to understand the basics of classical and molecular microbial pathogenicity.

CO2. Student will be able to understand the spread of microbes through body, their strategies and mechanism to cause the damage.

CO3 Students will understand the emergence of new infections as well as various methods of molecular microbial epidemiology.

CO4. Students will be able to understand the various mechanisms of antimicrobial resistance and new rapid diagnostic principles.

UNIT-I

Classical view of microbial pathogenicity: Define pathogenicity and virulence; Quantitative measures of pathogenicity: minimal lethal dose (MLD), LD50, ID50, TCID50. Virulence determinants: colonization, toxins, enzymes and invasiveness. Facultative / obligate intracellular pathogens.

Molecular microbial pathogenicity: Molecular Koch's postulates, multiplicity of virulence determinants, coordinated regulation of virulence genes, and environmental regulation of virulence determinants by two component signal transduction systems, antigenic variation; clonal and panmictic nature of microbial pathogens, type three secretion system (TTSS, T3SS), Role of biofilms and quorum sensing in microbial pathogenicity.

UNIT-II

The spread of microbes through the body: direct and indirect spread, microbial factor promoting spread, spread via lymphatic, blood and via other pathways.

Microbial strategies in relation to immune responses: Immune tolerance immune suppression, molecular mimicry, induction of ineffective antibodies antibody mopping, antigenic variation, avoidance of immune responses and interference to immune response induction.

Mechanisms of tissue injury in relation to bacterial infection: infection with no cell or tissue damages, direct damage by micro-organisms, microbial toxins, extra cellular enzymes, indirect damage via inflammation, immune responses.

UNIT-III

Emerging and re-emerging pathogens: Illustrate emerging and re-emerging pathogens using *V. cholerae* 0139, *X-MDR M. tuberculosis*, *Helicobacter pylori*, *Enterohaemorrhagic E. coli* (EHEC), *Cryptosporidium parvum*, Bird/swine flu, AIDS and Dengue Hemorrhagic Fever, opportunistic fungal pathogens. Mechanisms of emergence of new pathogens: horizontal gene transfer (HGT) and pathogenicity islands (PAI).

Molecular microbial epidemiology: Objectives of microbial epidemiology. Biochemical and Immunological tools - biotyping, serotyping, phage typing, multilocus enzyme electrophoresis (MLEE); Molecular typing: RAPD, rep (REP, ERIC, BOX)-PCR, IS based typing, PFGE, AFLP, MLST, VNTR and whole genome sequence; Use of geographical information system (GIS) for microbial epidemiology.

UNIT-IV

Antimicrobial resistance (AMR) : Recent concepts – Multidrug efflux pumps, extended spectrum beta-lactamases (ESBL), X-MDR *M. tuberculosis*, Methacillin-resistant *S. aureus* (MRSA), Role of integrons.

Rapid diagnostic principles: Nucleic acid probes in diagnostic microbiology, nucleic acid amplification methods, Real-time PCR, Lateral flow assays, diagnostic sequencing and mutation detection, automated instruments for detection / diagnosis of infectious agents (BACTAC and Vitek-2, GeneExpert).

Suggested readings:

1. Carroll KC, Hobdon JA, Miller S, Morse SA, Mietzner TA. 27th edition. Jawetz, Melnick, & Adelberg's Medical Microbiology Lange Publication.
2. Edward DJ and Holt KE. Beginner's guide to comparative genome analysis using next generation sequence data. Microbial Informatics and Experimentation, 3:2, <https://doi.org/10.1186/2042-5783-3-2>.
3. Wilson BA, Salyers AA, Whitt DD and Winkler ME. Bacterial Pathogenesis: A molecular approach. 3rd edition. American Society for Microbiology Press, Washington, DC USA.
4. Locht C and Simonet M. Bacterial Pathogenesis: Molecular and Cellular Mechanisms. Caister Academic Press.
5. Persing DH, Tenover FC, Hayden R, Leven M, Miller MB, Nolte FS, Tang YW, Belkum AAV. Molecular Microbiology: Diagnostic Principles and Practice. 3rd edition. Washington, American Society for Microbiology Press.
6. Nelson KE and Williams CM. Infectious Disease Epidemiology: Theory and Practice. 4th edition. Jones and Bartlett.

Teaching learning process:

- **Lectures (online and offline mode):** Through white board, notes, power point presentation supported by smart class rooms and other online teaching platforms like Google meet and Google classroom. etc.
- **Doubt session :** once in a week
- **Assignments, seminars and different exercises**
- **Tests:** Learning level of the students will be tested through class tests, quizzes, surprise evaluation, assignments sessional exams and through interactive sessions.

CO-PO Mapping for MMB-303

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2.2	2.5	2.4	1.5	2.4	2.3
CO2	2.6	2.6	2.2	1.2	2.6	2.7
CO3	2.7	2.6	2.1	1.0	2.7	2.6
CO4	2.8	2.7	2.3	1.1	2.7	2.4
Average	2.57	2.6	2.25	1.2	2.6	2.5

CO-PSO Mapping for MMB-303

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2.4	2.6	2.5	2.7	2.5	1.7
CO2	2.6	2.5	2.6	2.8	2.6	1.2
CO3	2.7	2.7	2.7	2.8	2.5	1.4
CO4	2.3	2.6	2.6	2.5	2.4	1.7
Average	2.5	2.6	2.6	2.7	2.5	1.5

MMB-304A AGRICULTURE MICROBIOLOGY

Max.Marks:100
(Ext. 80+ Int. 20)

Credit : 4
Time: 3 hrs

Objectives: Objective of this course is to teach students regarding basics of microbiology related to soil including biogeochemical cycles, plant growth promoting rhizobacteria, microbial interactions in soil and use of biofertilizers and biocontrol agents for maintaining soil health.

Course Outcomes: After learning this course students will be able to

CO1: understand different MO present in soil ecosystem and their role and different interactions for sustainable agriculture alongwith beneficial attributes of PGPR.

CO2: Understand the concept of plant nutrition by microbial inoculants through biological nitrogen fixation and mycorrhiza and other biofertilizers.

CO3: understand role of microorganisms in different biotransformation and biodegradation strategies of different organic matter, organic polymers, and pesticides. They will gain basic idea of biogas, composting, vermicomposting.

CO4: Understand mechanism of common plant diseases of cereals, vegetables and crops and will learn different biocontrol and transgenic approaches for protection of plant from diseases.

INSTRUCTIONS FOR THE PAPER- SETTERS AND CANDIDATES

- Nine questions of equal marks should be set.
- Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.
- Eight questions, two questions from each unit (I, II, III, IV) should be set.
- Candidates will be required to attempt five questions in all, selecting one question from each unit (I, II, III, IV) and the compulsory question 1.
- All questions will carry equal marks

UNIT I

Soil microbial ecology: Soil biota, types of organisms in different soils; Soil microbial biomass; Factors influencing the soil microflora. Different Agriculturally important beneficial microorganisms – free living, symbiotic (rhizobial, mycorrhizal, actinorhizal), associative and endophytic nitrogen fixers including cyanobacteria .

Microbial interactions: Different interfaces of interactions - Plant-microbe, microbe-microbe, soil-microbe, soil-plant-microbe interactions leading to symbiotic, associative, endophytic and pathogenic interactions ,unculturable soil biota. Plant growth promoting rhizobacteria (PGPR). Mechanism of plant growth promotion by PGPR.

UNIT II

Introduction to biofertilizers- definition, types of biofertilizers; Characteristic features of the following biofertilizer organisms: *Azospirillum*, *Azotobacter*, *Bacillus*, *Pseudomonas*, *Rhizobium*, *Frankia*, *Anabaena* and *Nostoc* . Mechanisms of action of different bio-inoculants for plant growth. Significance of biofertilizers. Mass scale production and quality control of bio-inoculants. Biofertilizer inoculation and microbial communities in the soil.

Biological nitrogen fixation- Biochemistry of N₂fixation, nif operon ,mechanism of nitrogen fixation. Symbiotic nitrogen fixation: Rhizobium-Legume association, Actinorhizal associations, contribution of symbiotic nitrogen fixation. Denitrification. Phosphate solubilization and

mobilization. Mycorrhizae- Ecto and endomycorrhizae, VAM and their importance in agriculture.

UNIT III

Microbial transformations of nitrogen, phosphorus, sulphur, iron and manganese in soil. Biochemical composition and biodegradation of soil organic matter and crop residues. Biodegradation of pesticides, Organic wastes and their use for production of biogas and manures.

Microbial degradation of polymers: lignin, cellulose, hemicelluloses. Factors affecting the degradation of organic matter.

Organic manures: Preparation, properties, and use in crop production, nutrient enriched compost, green manure; Composting, vermicomposting

UNIT IV

Some important plant diseases and their etiological studies: diseases of some important cereals, vegetables and crops. Genetical basis of plant diseases: Genetics of host-pathogen interactions, resistance genes, resistance mechanism in plants, transgenic approach for plant protection.

Biocontrol – Concept, types, mode of action, uses and practical constraints & applications of biocontrol agents. Biocontrol agent for sustainable agriculture. Different types of biocontrol agents. Biopesticides and bioherbicides, Biopesticides- classification, advantages. Major biopesticides based on bacteria, viruses & fungi (*Bacillus thuringiensis* (Bt) toxin, Boverin, DeVine, Collego).

Suggested Readings:

1. Paul EA. Soil Microbiology, Ecology and Biochemistry. 3rd Ed. Academic Press.
2. Varnam AH & Evans MG. Environmental Microbiology, Manson Publishing Ltd.
3. Christon J.Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills. Manual of Environmental Microbiology, ASM Press
4. Spencer JFT, Alicia L & Ragout de Spencer. Environmental Microbiology: Methods and Protocols. Springer,
6. Burlage R.S., Atlas R., Stahl D., Geesey G. & Sayler G. Techniques in Microbial Ecology. Oxford University press, Inc.
- 7 Gaur A.C. Handbook of organic farming and biofertilizer, Ambika book agency, Jaipur
8. Alexander M. Soil Microbiology. John Wiley
9. Kosuge T and Nester EW. Plant-Microbe Interactions: Molecular and Genetic perspectives. vols I-IV, McGraw Hill
10. Pradhan S. Soil health improvement by biofertilizer, biotech book, Ansari road New Delhi
11. Pand H. and Hota D. Biofertilizer and organic farming, Gene tech book Ansari road New Delhi
12. Sharma A.K. Biofertilizer for sustainable agriculture, Agrobios, Jaipur
- 13 Bergerson FJ. *Methods for Evaluating Biological Nitrogen Fixation*. John Wiley & Sons.
- 14 Kannaiyan S, Kumar K & Govindarajan K. *Biofertilizers Technology*. Saujanya Books.
- 15 Mahendra Rai. *Handbook of Microbial Biofertilizer*. Ist Ed. Springer.
- 16 Sylvia DM, Fuhrmann JJ, Hartlly PT & Zuberer D. *Principles and Applications of Soil Microbiology*. 2nd Ed. Pearson Prentice Hall Edu.
- 17 Van Elsas JD, Trevors JT & Wellington EMH. *Modern Soil Microbiology*. CRC Press.

Teaching learning process:

- **Lectures (online and offline mode):** Through white board, notes, power point presentation supported by smart class rooms and other online teaching platforms like Google meet and Google classroom. etc.
- **Doubt session :** once in a week
- **Assignments, seminars and different exercises**
- **Tests:** Learning level of the students will be tested through class tests, quizzes, surprise evaluation, assignments sessional exams and through interactive sessions.

CO-PO Mapping for MMB-304A

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2.0	2.2	2.2	1.0	2.2	2.3
CO2	2.2	2.2	2.2	1.0	2.4	2.7
CO3	2.1	2.4	2.2	1.0	2.7	2.6
CO4	2.1	2.4	2.2	1.0	2.7	2.4
Average	2.1	2.3	2.2	1.0	2.5	2.5

CO-PSO Mapping for MMB-304A

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2.4	2.0	2.6	2.4	2.4	2.2
CO2	2.2	2.1	2.3	2.5	2.2	2.1
CO3	2.2	2.1	2.5	2.5	2.2	2.0
CO4	2.4	2.8	2.6	2.4	2.4	2.1
Average	2.3	2.5	2.5	2.45	2.3	2.1

MMB 304B: BASICS OF BIOINFORMATICS

Max.Marks:100

(Ext. 80+ Int. 20)

Credit : 4

Time: 3 hrs

Objectives:

- Students will be able to understand the bioinformatics tools and techniques used in microbiology.
- How to use various online tools and data bases for analysis of proteins and other biomolecules.

Course Outcomes: after completion of course

- CO1. Student is able to understand the basics of bioinformatics like file formats, databases, etc.
- CO2. Student is able to understand the basic alignments tools like BLAST, PAM, etc
- CO3 Students will gets familiar with different types multiple sequence alignment tools for analysis and will get to know about the basics of genome and transcriptome.
- CO4. Students will be able to understand the various methods of phylogenetic analysis.

Unit I

Introduction, overview and needs of bioinformatics technology. Biological databases – nucleic acid, genome, protein sequence and structure, gene expression databases, Database of metabolic pathways, SNP, chemical, metabolic pathways, signalling pathways, general human genetics, cancer gene.

Mode of data storage - File formats - FASTA, Genbank and Uniprot, Data submission & retrieval from NCBI, EMBL, DDBJ, Uniprot, PDB.

Unit II

Introduction to sequence alignment and its applications. Pair wise sequence alignment: Concept of global and local alignment, Dot Plot, algorithm for pair wise sequence alignment (Needleman Wunsch, Smith-watterman methods).

Introduction to BLAST: types of BLAST, algorithm of BLAST and interpretation of its result. Substitution matrices: Introduction to substitution matrices: PAM and BLOSUM matrices, concept of log odd ratio.

Unit III

Multiple sequence alignment: Methods of multiple sequence alignment, Tools of MSA– ClustalW, Tcoffee; Position specific scoring matrices, introduction to consensus sequences, motifs and profiles.

Significance of alignments: E value, Scores Diversity of Genomes: Viral, prokaryotic & eukaryotic genomes. Basic concepts of Genome, transcriptome, proteome.

Unit IV

Phylogenetic Analysis: Introduction to phylogenetic analysis and its application. Types of phylogenetic trees, Different approaches of phylogenetic tree construction - UPGMA, Neighbour joining, Maximum Parsimony, Maximum likelihood.

Genome Annotation: Concept of genome annotation, methods of gene identification. Tools of gene identification: GenScan, Grail, GeneID and Glimmer.

Suggested readings:

1. Baxevanis AD, Ouellette BFF. Bioinformatics: A practical guide to the analysis of genes and proteins (John Wiley and Sons).

2. Rastogi S.C., Mendiratta N. and Rastogi P. Bioinformatics: methods and applications, genomics, proteomics and drug discovery, 2nd ed. Prentice Hall India Publication
3. Lesk M.A. Introduction to Bioinformatics. Oxford Publication, 3rd International Student Edition
4. Primrose and Twyman. Principles of Genome Analysis & Genomics. Blackwell
5. Attwood TK & Parry-Smith DJ. Introduction to Bioinformatics. Pearson Edu.

Teaching learning process:

- **Lectures (online and offline mode):** Through white board, notes, power point presentation supported by smart class rooms and other online teaching platforms like Google meet and Google classroom. etc.
- **Doubt session :** once in a week
- **Assignments, seminars and different exercises**
- **Tests:** Learning level of the students will be tested through class tests, quizzes, surprise evaluation, assignments sessional exams and through interactive sessions.

CO-PO Mapping for MMB-304B

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2.5	2.5	2.0	2.0	3.0	2.5
CO2	2.5	2.5	2.0	2.0	3.0	2.5
CO3	2.5	2.5	2.0	2.0	3.0	2.5
CO4	2.5	2.5	2.0	2.0	3.0	2.5
Average	2.5	2.5	2.0	2.0	3.0	2.5

CO-PSO Mapping for MMB-304B

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3.0	2.5	2.5	-	1.0	1.0
CO2	3.0	2.5	2.5	-	1.0	1.0
CO3	3.0	2.5	2	-	1.0	1.0
CO4	3.0	2.5	2	2	1.0	1.0
Average	3.0	2.5	2.25	0.25	1.0	1.0

MMB-306: APPLIED MICROBIOLOGY (Open Elective)

Max.Marks:50
(Ext. 40+ Int. 10)

Credit : 2
Time: 3 hrs

Objective: The course is about the applications of microbiology in various fields.

Course Outcome: after completion of the course student will know about

CO1. Applications of microbes in soil ecosystem and agriculture

CO2. Modes of transmission of diseases via different routes

CO3. Food borne infections and their control

CO4. Use of Genetically Engineered Micro-organisms for production of various compounds

INSTRUCTIONS FOR THE PAPER- SETTERS AND CANDIDATES

- Nine questions of equal marks should be set.
- Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.
- Eight questions, four questions from each unit (I& II) should be set.
- Candidates will be required to attempt five questions in all, selecting at least two question from each unit (I & II) and the compulsory question 1.
- Each question will carry 8 marks.

Unit I

Rhizosphere & Rhizoplane micro-organisms and its significance. Biofertilizers and its examples. Nitrogen fixing bacteria: Symbiotic & non-symbiotic; Phosphorous solubilizing bacteria; plant growth promoting rhizobacteria; mycorrhiza.

Methods of determination of Antimicrobial activity – well diffusion method and MIC

Modes of transmission of disease: air, water, soil, contact, animals. Coliforms as the biological indicators of water safety and their assessment

Unit II

Food borne diseases: Staphylococcal food poisoning, Salmonellosis. Food spoilage: spoilage of various food products meat, milk, canned food, fruit and vegetables.

Microbes as food: SCP, mushroom. Ethanol fermentation by yeast: beer and wine

Control of microbes in food by physical methods: temperature, irradiation, filtration, osmotic pressure.

Use of Genetically Engineered Micro-organisms (GEMs)

(a) Production of antibiotics: Penicillin

(b) Biopesticides: Bt toxin, Boverin, DeVine

(c) Control of pollution: degradation of xenobiotic compound

Suggested Reading:

1. Stainier RY, Ingraham JL, Wheelis ML & Palmer PR. General Microbiology, MacMillan.
2. Tortora GJ, Funke BR & Case CL. Microbiology: An introduction with Mastering Microbiology, 10th ed. Benjamin Cummings.
3. Madigan MT, Martinko JM, Stahl DA & Clark DP. Brock Biology of Microorganisms, 13th ed., Benjamin Cummings
4. Willey JM, Sherwood LM & Woolverton CJ DA. Prescott, Harley and Klein's Microbiology, 7th ed., McGraw Hill International Edition, USA.

Teaching learning process:

- **Lectures (online and offline mode):** Through white board, notes, power point presentation supported by smart class rooms and other online teaching platforms like Google meet and Google classroom. etc.
- **Doubt session :** once in a week
- **Assignments, seminars and different exercises**
- **Tests:** Learning level of the students will be tested through class tests, quizzes, surprise evaluation, assignments sessional exams and through interactive sessions.

CO-PO Mapping for MMB-306

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2.5	2.5	2.0	2.0	3.0	2.5
CO2	2.5	2.5	2.0	2.0	3.0	2.5
CO3	2.5	2.5	2.0	2.0	3.0	2.5
CO4	2.5	2.5	2.0	2.0	3.0	2.5
Average	2.5	2.5	2.0	2.0	3.0	2.5

CO-PSO Mapping for MMB-306

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2.5	2.5	2.0	2.0	3.0	2.5
CO2	2.5	2.5	2.0	2.0	3.0	2.5
CO3	2.5	2.5	2.0	2.0	3.0	2.5
CO4	2.5	2.5	2.0	2.0	3.0	2.5
Average	2.5	2.5	2.0	2.0	3.0	2.5

MMB-307 LAB COURSE V

Max.Marks:100
(Ext. 80+ Int. 20)

Credit : 4
Time: 6 hrs

Objective: Student will learn about the applications of microbes in microbial biotechnology and molecular biology.

Course Outcomes: After completion of this course, student:

CO1. Will be able to perform different experiments related to lactose, calcium, phosphatase activity in milk and other milk products.

CO2. Will be able to establish fermentative production of different metabolites under different cultural conditions

CO3. will be well versed with fermentative production of wine, vinegar, bioethanol.

CO4. will learn protocol about isolation of chromosomal and plasmid DNA.

1. Isolation of amylase producing bacteria from soil
2. Preparation of standard curve of reducing sugars by DNS method
3. Quantitative estimation of amylolytic potential of isolated bacterial culture
4. To perform an experiment to show the Ethanol fermentation by yeast.
5. Quantitative estimation of ethanol by distillation method
6. Demonstration of surface fermentation/ submerged fermentation/ solid state fermentation
7. Whole cell immobilization of bacterial cell using calcium alginate
8. To isolate plasmid DNA from a given culture.
9. To prepare agrose gel and to run the plasmid DNA samples
10. Isolation of chromosomal DNA
11. To test the given sample for purity of DNA content.
12. Isolation of lipolytic microorganisms from butter
13. Determination of lactose /calcium/magnesium/phosphorus in milk
14. Demonstration of vinegar production in laboratory
15. Demonstration of wine production by using grape juice
16. Determination of phosphatase activity in milk/butter/whey/milk powder

Suggested Reading:

1. Cappucino JG and Welsh CT. Microbiology: A laboratory manual. 11th edition. Pearson.
2. Thompson DA. Biochemistry Lab Manual. 3rd edition.
3. Segel IH. Biochemical calculations: how to solve mathematical problems in general biochemistry, Wiley, 2nd Edition.

4. Sambrook J & Russell D. Molecular Cloning: A laboratory manual. 4th edition. Cold Spring Harbor laboratory Press.
5. Collee JG, Fraser AG, Marmion BP & Simmons A (eds.). Mackie & McCartney Practical Medical Microbiology. Churchill Livingstone, Edinburgh.
6. Atlas RM, Parks LC & Brown AL. Laboratory Manual of Experimental Microbiology. MosbyYear Book, Inc., Missouri.

CO-PO Mapping for MMB-307

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2.5	2.5	2.0	2.0	3.0	2.5
CO2	2.5	2.5	2.0	2.0	3.0	2.5
CO3	2.5	2.5	2.0	2.0	3.0	2.5
CO4	2.5	2.5	2.0	2.0	3.0	2.5
Average	2.5	2.5	2.0	2.0	3.0	2.5

CO-PSO Mapping for MMB-307

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3.0	2.5	2.5	-	1.0	1.0
CO2	3.0	2.5	2.5	-	1.0	1.0
CO3	3.0	2.5	2	-	1.0	1.0
CO4	3.0	2.5	2	2	1.0	1.0
Average	3.0	2.5	2.25	0.25	1.0	1.0

MMB-308 LAB COURSE VI

Max.Marks:100
(Ext. 80+ Int. 20)

Credit : 4
Time: 6 hrs

Objective: The objective of this course is to identify various pathogenic microorganisms, role of PGPR in soil ecosystems and various tools of bioinformatics.

Course Outcomes:

CO1. The student will be able to perform sterility testing of a sample and is acquainted with the resident microflora of skin and oral cavity.

CO2. The student will be able to identify human pathogenic microorganisms on selective/differential media following biosafety norms.

CO3. Student will be able to isolate rhizospheric and non rhizospheric microorganism for different PGPR attributes.

CO4. The student will be able to isolate the microorganism for cellulose degradation and will be able to identify pathogenic fungi from plants

OR

CO3. Student will learn about different protein database and protein modeling tools.

CO4. Student will be able to do sequence alignments using BLAST and able to construct phylogenetic tree.

1. To study cultural characteristics of pathogenic bacteria on following selective/differential media: TCBS agar; Hektoen Enteric agar; XLD agar; Endo agar; Salmonella-Shigella agar; Deoxycholate citrate agar
2. To study pathogenicity of *Staphylococcus aureus* by coagulase test
3. To demonstrate the liberation of ammonia from nitrogenous organic compound (ammonification).
4. To perform sterility testing of a sample.
5. To study resident microflora of skin.
6. To study resident microflora of oral cavity
7. To demonstrate the reduction of nitrates to nitrogen gas (denitrification).
8. Isolation of rhizosphere and nonrhizosphere microflora.
9. Isolation of cellulose degrading microorganisms from soil.
10. Identification of pathogenic fungi:
 - (a) *Puccinia*(b) *Colletotrichum*(c)*Phytophthora*
11. Isolation of Rhizobium from root nodules.

12. Isolation of antibiotic producing bacteria from soil.
13. Isolation of phosphate solubilising microorganism from soil
14. Detection of siderophores produced by a given microorganisms
15. Demonstration of Indole acetic acid production by soil microorganisms.

OR

10. Introduction to various protein databases.
11. To perform protein modeling using SWISS-MODEL.
12. Visualization of 3D structures of proteins.
13. Sequence retrieval using BLAST.
14. Sequence alignment & phylogenetic analysis using clustal omega & phylip.
15. To analyze the given 16srRNA sequences by using BLAST and construct a phylogenetic tree based on the comparison results

Suggested Reading:

1. Cappucino JG and Welsh CT. Microbiology: A laboratory manual. 11th edition. Pearson.
2. Thompson DA. Biochemistry Lab Manual. 3rd edition.
3. Segel IH. Biochemical calculations: how to solve mathematical problems in general biochemistry, Wiley, 2nd Edition.
4. Sambrook J & Russell D. Molecular Cloning: A laboratory manual. 4th edition. Cold Spring Harbor laboratory Press.
5. Collee JG, Fraser AG, Marmion BP & Simmons A (eds.). Mackie & McCartney Practical Medical Microbiology. Churchill Livingstone, Edinburgh.
6. Atlas RM, Parks LC & Brown AL. Laboratory Manual of Experimental Microbiology. MosbyYear Book, Inc., Missouri.

CO-PO Mapping for MMB-308

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2.5	2.5	2.0	2.0	3.0	2.5
CO2	2.5	2.5	2.0	2.0	3.0	2.5
CO3	2.5	2.5	2.0	2.0	3.0	2.5
CO4	2.5	2.5	2.0	2.0	3.0	2.5
Average	2.5	2.5	2.0	2.0	3.0	2.5

CO-PSO Mapping for MMB-308

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3.0	2.5	2.5	-	1.0	1.0
CO2	3.0	2.5	2.5	-	1.0	1.0
CO3	3.0	2.5	2	-	1.0	1.0
CO4	3.0	2.5	2	2	1.0	1.0
Average	3.0	2.5	2.25	0.25	1.0	1.0

MMB-401: BIOSTATISTICS & COMPUTERS

Max.Marks:100

(Ext. 80+ Int. 20)

Credit : 4

Time: 3 hrs

Objectives:

- Students will be able to know the basics of computers and MS office.
- Student gets familiar with basics of Biostatistics and they will do hands on training to various statistical methods to analyze their experimental data.

Course Outcomes: After completion of this course

- CO1. The students will know the basics of computer, its functioning and various devices attached to computer.
- CO2. The student will be familiar with MS office basics as well as basics of operating system and networking
- CO3. The student will be well versed with different statistical methods: Principles of statistical analysis of biological data. Measures of central tendency, dispersion, skewness and kurtosis.
- CO4. Student will understand Large Sample Test based on Normal Distribution, Confidence Interval; Application of Chisquare test; Small sample test based on t-test and F test..

Unit I

Introduction to computer: Classification of computers –computer generation-low, medium and high level languages. Block Diagram of a computer; Description of each block in detail; concept of input-output devices; compilers and interpreters, mini, main frame and super computer, their characteristics and applications. BIT, BYTE.

Concept of Memory: Types of Memory; Concept of Central processing Unit (CPU), Control Unit (CU), and Arithmetic Logic Unit (ALU).

Data representation and storage –binary codes, binary systems and its relationship to Boolean Operations. Different numbers systems and conversions. Secondary storage media.

Unit II

Word Basics : – Formatting Text and Documents : Auto format, Line spacing, Margins, Borders and Shading, etc.

Microsoft excel: Data entry, graphs, aggregate functions- formulations and functions (students are expected to be familiar with all operations).

Operating system basics : Overview, The purpose of operating systems, Types of operating systems, Providing a user interface, Running programs, Managing hardware, Enhancing an OS utility software.

Networking Basics : Overview, Sharing data anywhere, anytime, The uses of a network, Common types of networks, Hybrid networks, How networks are structured, Network topologies and protocols, Network media, Network hardware. Internet: How internet works? Significance.

Unit III

Biostatistics: Statistics, its meaning and objectives .Population samples, frequency tables and their graphs, measures of central tendency (mean, mode, median) and their dispersion. Concepts of moments, Skewness and kurtosis. Intuitive definition of random variables, probability mass function and probability density function, expectation and variance.

Standard distribution; binomial, Poisson and normal distribution with their important properties and significance.

Unit IV

Fitting of main distributions and testing of goodness –of – the –fit with special reference to χ^2 - test, t –test, Z-test. Fitting of trends; linear and quadratic with least square method. Lines of regression, coefficient of correlation, coefficient of variation and their significance.

Analysis of variance; one way and two way classification. Brief exposure of three basic principles of design of experiments, treatment, plot and block.

Text and Reference Books:

1. Rosne B. Fundamentals of Biostatistics, Cengage Learning.
2. Zar JH. Biostatistical Analysis, Pearson Education 5th ed.
3. Campbell RC .Statistics for Biologists, Cambridge university press.
4. Daniel WW. Biostatistics: A Foundation for Analysis in Health Science, 6th ed., John Wiley
5. Snedecar GW & Cochram WG. Statistical Methods, Oxford Press.
6. White Ron .How Computers Work? Techmedia.

Teaching learning process:

- **Lectures (online and offline mode):** Through white board, notes, power point presentation supported by smart class rooms and other online teaching platforms like Google meet and Google classroom. etc.
- **Doubt session :** once in a week
- **Assignments, seminars and different exercises**
- **Tests:** Learning level of the students will be tested through class tests, quizzes, surprise evaluation, assignments sessional exams and through interactive sessions.

CO-PO Mapping for MMB-401

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2.5	2.0	3.0	1.0	2.0	1.0
CO2	2.5	2.0	3.0	1.0	2.0	1.0
CO3	2.5	3.0	2.0	1.0	2.0	2.0
CO4	2.5	2.0	2.0	1.0	2.0	1.0
Average	2.5	2.0	2.5	1.0	2.0	1.5

CO-PSO Mapping for MMB-401

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2.5	2.5	2.5	1.0	3.0	1.0
CO2	2.5	2.5	2.5	1.0	3.0	1.0
CO3	2.5	2.5	2.5	1.0	3.0	1.0
CO4	2.5	2.5	2.5	1.0	3.0	1.0
Average	2.5	2.5	2.5	1.0	3.0	1.0

MMB-402 FOOD & DAIRY MICROBIOLOGY

Max.Marks:100
(Ext. 80+ Int. 20)

Credit : 4
Time: 3 hrs

Objectives: To impart knowledge regarding the biochemical aspects of various nutrients and their interactions in foods during processing, storage and deterioration.

To familiarize the students with food microbiology including fermented food, dairy, food preservation, spoilage and detection of food borne diseases, their control measures.

Course Outcomes:

Upon successful completion of the course, the student will:

CO1: Knows the important microbes associated with different food products and various factors affecting microbial growth.

CO2. Can recognize the types and causes of spoilage of different food products and principles of food preservation, various classical physical, chemical, and biological methods of preservation.

CO3. Knows how to produce different fermented food products and various bioactive compounds in fermented food material.

CO4. Can identify food borne infections including bacterial, viral and fungal infections based on their symptoms. Knows about the various types and causes of food intoxication. Is aware how to prevent microbial food infections.

INSTRUCTIONS FOR THE PAPER- SETTERS AND CANDIDATES

- Nine questions of equal marks should be set.
- Question 1 consisting of number of short answer type questions (having no internal choice) spread over the whole syllabus should be compulsory.
- Eight questions, two questions from each unit (I, II, III, IV) should be set.
- Candidates will be required to attempt five questions in all, selecting one question from each unit (I, II, III, IV) and the compulsory question 1.
- All questions will carry equal marks

UNIT I

Microorganisms important in food microbiology: Taxonomical classification of microbes associated with food products, their phenotypic and biochemical identification. Food associated molds, yeasts, yeast-like fungi and bacteria. General microbiome of food material.

Intrinsic and extrinsic factors affecting microbial growth in foods: Intrinsic factors (Nutrient contents, pH, moisture contents/water activity, antimicrobial barriers, Antimicrobial substances), Extrinsic factors (relative humidity, temperature, gaseous atmosphere).

Microbiology of foods: Microbial habitat of specific food materials, adaptations and changes in microbiome of vegetables, fruits, milk, fermented and non-fermented milk products, fresh meats, poultry and non-dairy fermented foods.

UNIT II

Microbial spoilage of foods: Types and causes of spoilage of cereals and cereals products, spoilage of vegetables and fruits, juices, spoilage of meat and meat products, spoilage of fish and other sea foods, spoilage of eggs and other poultry products, spoilage of milk and milk products.

Study of microorganisms responsible for spoilage and microbial succession during spoilage. Brief insights into chemical and physical spoilage of foods.

Food preservation: General principles of food preservation, various classical physical, chemical, and biological methods of preservation. New developments in food preservation techniques. Analysis of practical implementation of such techniques. HACCP technology.

UNIT III

Fermentation processes: Production of fermented milk and milk products, plant-based products, pickles, fish products, and meat products, bread, baker's yeast, Edible mushroom (*Agaricus*, *Volverella*, *Pluerotus*). Manufacture of starter cultures from lab to pilot scale. Batch submerged and solid-state fermentation of foods.

Food beverages and enzymes: Concept of human microbiome, probiotics and prebiotics. Insight into health benefits of fermented milk products. Understanding benefits of tradition and non-traditional fermented foods. Introduction to the concept of bioactive compounds and brief study of such compounds from fermented foods including malt beverages, wines, distilled liquors and vinegar.

UNIT IV

Food-borne diseases: Food borne infections including bacterial, viral and fungal infections. Study of infections due to food borne parasites. In depth study of various types and causes of food intoxication. Botulism, Staphylococcal food poisoning, Clostridium perfringens food poisoning, *Bacillus cereus* gastroenteritis, Salmonellosis, *Escherichia coli* diarrhea, and colitis, *Vibrio cholera*.

Fungal poisoning: *Aspergillus*, *Penicillium*, *Claviceps*, *Fusarium*. Summary of prevention of microbial food infections. Identification and first aid for specific types of food infections.

Suggested Readings:

1. Frazier WC, Westoff DC and Vanitha KN. Food Microbiology. 5th edition. McGraw Hill Education.
2. Jay JM, Loessner MJ, Golden DA. Modern Food Microbiology. 7th edition. Springer.
3. Ray B and Bhunia A. Fundamental Food Microbiology. 5th edition. CRC press.
4. Adams MR, Moss MO and McClure P. Food Microbiology. 4th edition Royal Society of Chemistry.
5. Doyle MP and Beuchat LR. Food Microbiology: Fundamentals and Frontiers. 3rd edition. ASM press.
6. Montville T, Matthews K and Kniel K. Food Microbiology: An Introduction 4th edition. ASM press.
7. Robinson R K. Dairy Microbiology Handbook, 3rd ed., John Wiley & Sons

Teaching learning process:

- **Lectures (online and offline mode):** Through white board, notes, power point presentation supported by smart class rooms and other online teaching platforms like Google meet and Google classroom. etc.
- **Doubt session :** once in a week
- **Assignments, seminars and different exercises**
- **Tests:** Learning level of the students will be tested through class tests, quizzes, surprise evaluation, assignments sessional exams and through interactive sessions.

CO-PO Mapping for MMB-402

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1.8	1.8	1.3	1.0	2.0	1.7
CO2	1.7	1.8	1.4	0.6	2.1	1.7
CO3	1.6	1.6	1.5	0.8	2.1	1.6
CO4	1.7	1.6	1.4	0.8	2.2	1.4
Average	1.7	1.7	1.4	0.8	2.1	1.6

CO-PSO Mapping for MMB-402

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2.6	2.2	2.5	2.5	1.5	1.8
CO2	2.6	2.2	2.5	1.7	1.7	2.0
CO3	2.6	2.4	2.5	2.6	2.2	2.0
CO4	2.6	2.6	2.5	1.6	2.2	1.8
Average	2.6	2.35	2.5	2.1	1.9	1.9

MMB-403 SEMINAR BASED ON PROJECT REPORT**Max.Marks:50****Credit: 2**

MMB-404A: INTELLECTUAL PROPERTY RIGHTS & ENTREPRENEURSHIP

Max.Marks:100

Credit : 4

(Ext. 80+ Int. 20)

Time: 3 hrs

Objectives:

- Students will be able to know fundamental aspects of Intellectual property Rights.
- Student gets familiar with all aspects of the IPR Act and basics of entrepreneurship.

Course Outcomes:

- CO1. Will have learnt the concepts of IPR and its protection.
- CO2. Will have gathered understanding of protection of IP through Patents, Copyright and related rights, Trademarks, Geographical indications, Industrial designs and New Plant Varieties
- CO3 Will get acquainted with Agreements, Treaties and Acts in relation to IP protection .
- CO4. Will understand the licensing agreements and infringements of IPR Act and basics of entrepreneurship.

Unit I

Introduction to Intellectual Property: importance of IPR – patentable and non patentables. Trade secrets and know-how agreements. Utility models: Differences between a utility model and a patent. Types of inventions protected by a patent. Need for a patent.

Grant of Patent and Patenting Authorities: Claims. Searching a patent, Drafting of a patent, Filing of a patent, Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures;

Unit II

Copyrights: Definition, need, coverage and duration. Related rights. Distinction between related rights and copyright. Rights covered by copyright.

Trademarks: Definition. Rights of trademark, signs that can be used as trademarks, types of trademark. Protection and registration a trademark. Duration of protection. Well-known trademarks.

Geographical indications: Definition. Need for Protection. Examples.

Industrial design: Overview, kind, duration and need for protection provided by industrial designs.

New Plant Varieties: Requirements, Rights of breeder, Extent and Duration, Examples. Biotechnology Research and Intellectual Property Rights Management,

Unit III

Agreements and Treaties: GATT, TRIPS Agreements; Role of Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; UPOV & Brene conventions.

Patenting life – legal protection of biotechnological inventions – World Intellectual Property Rights Organization (WIPO). Patent Co-operation Treaty (PCT).

Indian Patent Act 1970 & recent amendments.

Unit IV

Patent licensing and agreement: Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner. Commercializing Biotechnology Invention, Case studies of Biotechnology.

Entrepreneurship: Selection of a product, line design and development processes, economics on material and energy requirement, stock the product and release the same for making etc.

The basic regulations of excise: Demand for a given product, feasibility of its production under given constraints of raw material, energy input, financial situations export potential etc.

Suggested Reading:

1. Wooley DP and Byers KB. Biological Safety: Principles and Practices. 5th edition. ASM press, USA.
2. Ramakrishna B. and Anil Kumar H.S. Fundamentals of Intellectual Property Rights: For Students, Industrialist and Patent Lawyers. 1st edition. Notion Press, India.
3. Singh KK. Biotechnology and Intellectual Property Rights: Legal and Social Implications Springer, India.
4. Goel D. and Parashar S. IPR, Biosafety and Bioethic. 1st edition. Pearson Education, India.
5. Kankanala C. Genetic Patent Law and Strategy. 1st edition. Manupatra Information Solution Pvt. Ltd., India.
6. Wadehra B.L. Law Relating to Patents, Trade Marks, Copyright, Designs and Geographical Indications. Universal Law Publishing, India.
7. Murray TM and Mehlman MJ. Encyclopedia of Ethical, Legal and Policy issues in Biotechnology. John Wiley and Sons, UK.

Teaching learning process:

- **Lectures (online and offline mode):** Through white board, notes, power point presentation supported by smart class rooms and other online teaching platforms like Google meet and Google classroom. etc.
- **Doubt session :** once in a week
- **Assignments, seminars and different exercises**
- **Tests:** Learning level of the students will be tested through class tests, quizzes, surprise evaluation, assignments sessional exams and through interactive sessions.

CO-PO Mapping for MMB-404A

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2.5	2.0	3.0	1.0	2.0	1.0
CO2	2.5	2.0	3.0	1.0	2.0	1.0
CO3	2.5	3.0	2.0	1.0	3.0	2.0
CO4	2.5	2.0	2.0	1.0	2.0	1.0
Average	2.5	2.25	2.5	1.0	2.25	1.5

CO-PSO Mapping for MMB-404A

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2.5	2.5	2.5	1.0	3.0	1.0
CO2	2.5	2.5	2.5	1.0	3.0	1.0
CO3	2.5	2.5	2.5	1.0	3.0	1.0
CO4	2.5	2.5	2.5	1.0	3.0	1.0
Average	2.5	2.5	2.5	1.0	3.0	1.0

MMB-404B: COMPUTATIONAL BIOLOGY

Max.Marks:100

(Ext. 80+ Int. 20)

Credit : 4

Time: 3 hrs

Objectives:

- Students will be able to know the various tools available for comparing multiple structures simultaneously
- Student gets familiar with different algorithms available for structure comparison in proteins.

Course Outcomes: After completion of course the student

- CO1. Will have gathered understanding of diversity of viral, prokaryotic, eukaryotic genomes and their organization, sequencing strategies, also the knowledge of current techniques in genomic and interactomics along with current concepts in gene organization, challenges in gene prediction, primer designing.
- CO2. Will be familiar with various (online as well as standalone) tools available for protein structure visualization.
- CO3 Students will understand the basis of protein classification in databases like CATH and SCOP.
- CO4. Will understand the details of primary, secondary and tertiary structure of proteins, knowledge of domains, motifs and folds, strategies on protein structure prediction, Protein modeling approaches and rational drug designing and discovery.

UNIT-I

Genomics and Gene Annotation: Organization and structure of prokaryotic and eukaryotic genomes; Genome annotation and databases; Automated in-silico methods of finding gene and relevant features; Genome Sequencing using first and seconding generation sequencing methods; Advantages of genome sequencing projects in modern biological research.

Genomics Analysis: Diversity and features of completed genomes: Viral, prokaryotic (*E .coli*) and eukaryotic genomes (*Arabidopsis*, Human). Codon bias and optimization. Primer designing. Gene prediction methods. Techniques used in genomics and transcriptomics: NGS, Microarray, RNAseq.

UNIT-II

Protein structure and proteomics: Hierarchy and features of protein structure: primary, secondary, tertiary and quaternary structures. Structural classes, motifs, folds and domains. Modelling of tertiary structure of protein in presence and absence of template. Energy minimizations and evaluation by Ramachandran plot.

Proteome, interactome, 2-D gel electrophoresis, MALDI-TOF spectrometry, STRING, MMDB. Computer aided drug discovery.

UNIT-III

Protein Structure Databases: Different databases of macro-molecular biomolecules; Accessing and mining protein structure classification databases such as SCOP, CATH; Tools for viewing and interpreting macromolecular structures.

Protein Structure Comparison: Various algorithms and programs for superimposition of structures; RMSD calculations, multiple structure alignment methods such as DALI and VAST.

UNIT-IV

Protein Structure Prediction &Molecular Modeling: Principles of secondary and tertiary structure predictions; *Ab-initio* and homology based methods of secondary and tertiary structure predictions; Homology modeling; Threading and *ab-initio* protein structure prediction.

Inferring Function from Protein Sequence &Structure: Using evolutionary information; Gene neighborhood; Phylogenetic profiles; Gene fusion; Catalytic templates; Prediction and analysis of binding cavities for function prediction.

Suggested Readings:

1. Haubold & Wiele. Introduction to Computational Biology: An Evolutionary Approach. 1st edition. Springer International.
2. Lesk A. Introduction to Bioinformatics.. 3rd edition. OUP India.
3. Ewens W and Grant GR. Statistical methods in Bioinformatics: An introduction. 2nd Edition. Springer-Verlag.
4. Mount D. Bioinformatics: Sequence and genome analysis. 2nd edition. Cold Spring Harbor Lab Press.
5. Baxevanis and Outlette. Bioinformatics: A practical guide to the analysis of genes & proteins. 2nd edition. John Wiley and Sons.
6. Zimmermann KH. An Introduction to Protein Informatics. 1st edition, Springer International.
7. Krane .Fundamental Concepts of Bioinformatics. 1st edition. Pearson Education.
8. Burkowski FJ. Structural bioinformatics: an algorithmic approach. 1st edition, Chapman & Hall/CRC.

Teaching learning process:

- **Lectures (online and offline mode):** Through white board, notes, power point presentation supported by smart class rooms and other online teaching platforms like Google meet and Google classroom. etc.
- **Doubt session :** once in a week
- **Assignments, seminars and different exercises**
- **Tests:** Learning level of the students will be tested through class tests, quizzes, surprise evaluation, assignments sessional exams and through interactive sessions.

CO-PO Mapping for MMB-404B

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2.5	2.0	3.0	1.0	2.0	1.0
CO2	2.5	2.0	3.0	1.0	2.0	1.0
CO3	2.5	3.0	2.0	1.0	3.0	2.0
CO4	2.5	2.0	2.0	1.0	2.0	1.0
Average	2.5	2.0	2.5	1.1	2.0	1.5

CO-PSO Mapping for MMB-404B

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2.5	2.5	2.5	1.0	3.0	1.0
CO2	2.5	2.5	2.5	1.0	3.0	1.0
CO3	2.5	2.5	2.5	1.0	3.0	1.0
CO4	2.5	2.5	2.5	1.0	3.0	1.0
Average	2.5	2.5	2.5	1.0	3.0	1.0

MMB-405 LAB COURSE VII

Max.Marks:100
(Ext. 80+ Int. 20)

Credit : 4
Time: 6 hrs

Objective: The student will be able to isolate microorganisms from various food sources and they will be able to learn various tools of statistics and computers for analysis of data .

Course Outcomes:

CO1. The student will be able to learn measures of central tendency, dispersion, skewness and kurtosis. Student will learn about discrete and continuous random variable, correlation and regression. Emphasis with examples on how descriptive statistics helps in analysing biological sciences data.

CO2. The student Will obtain information on IPR, its main components, various types of application for filing the patent .

CO3. Will be acquainted with bioinformatics and its relation with molecular biology, genetics and genomics, various modes of data transfer and simultaneously learning the advantages of encrypted data transfer, gained an in-depth knowledge of primary, secondary and composite databases, organization of diverse types of biological databases.

CO4. Will understand the details of domains, motifs and folds, homology modelling for protein structure prediction, proteomics, computer aided drug designing and discovery.

1. Isolation and Identification of microorganisms from spoiled foods.

- (a) Bread (b) Fruits
- (c) Meat (d) Cake

2. Enumeration of bacteria in milk and presumptive test for coliforms.

3. To study Litmus milk reactions.

4. To perform methylene blue reduction test of raw and pasteurized milk.

5. Isolation of Lactobacilli and Streptococci from curd.

6. Isolation of important bacteria involved in food spoilage (*Bacillus*, *Escherchia*, *Staphylococcus*).

7. Identification of common molds involved in food spoilage (*Aspergillus*, *Penicillium*, *Cladosporium*, *Fusarium*, *Rhizopus*, *Mucor*).

8. Handling of data using measures of central tendency.

9. Handling of data using measures of dispersion.

10. Problems based on skewness and kurtosis.

11. Finding Karl Pearson's correlation coefficient and interpretation of result.

12 Application of Chi-Square Distribution and interpretation of result on given data set

- a. Chi-square test of proportions.
- b. Chi-square tests of association.
- c. Chi-square test of goodness-of-fit

13. Study of steps of a patenting process and different forms of filing the patent.

14. Design a suitable strategy to protect a genetically modified organism.

15. Case studies related to patenting of biological materials

OR

13. Picking out a given gene from genomes using Genscan or other software's (promoter region identification, repeat in genome, ORF prediction).

14. Gene finding tools (Glimmer, GENSCAN), Primer designing, Genscan/Genetool.

15. Virtual screening of drugs.

Suggested Reading:

1. Danniell WW. Biostatistics: A Foundation for Analysis in the Health Sciences by. John Wiley,
2. Goon AM, Gupta MK and Dasgupta B. Fundamentals of Statistics Vol. I & II. 8th edition. The World Press, India.
3. Ramakrishna B and Anil HSK. Fundamentals of Intellectual Property Rights: For Students, Industrialist and Patent Lawyers. 1st edition. Notion Press, India.
4. Wadehra BL. Law Relating to Patents, Trade Marks, Copyright, Designs and Geographical Indications by. Universal Law Publishing, India.
5. Selzer PM, Marhöfer RJ and Koch O. Applied Bioinformatics: An Introduction. 2nd edition. Springer, USA.
6. Rastogi SC, Mendiratta N and Rastogi P. Bioinformatics: methods and applications, genomics, proteomics and drug discovery. 4th edition. Prentice Hall India Publication.

CO-PO Mapping for MMB-405

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2.5	2.5	2.0	2.0	3.0	2.5
CO2	2.5	2.5	2.0	2.0	3.0	2.5
CO3	2.5	2.5	2.0	2.0	3.0	2.5
CO4	2.5	2.5	2.0	2.0	3.0	2.5
Average	2.5	2.5	2.0	2.0	3.0	2.5

CO-PSO Mapping for MMB-405

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3.0	2.5	2.5	-	1.0	1.0
CO2	3.0	2.5	2.5	-	1.0	1.0
CO3	3.0	2.5	2	-	1.0	1.0
CO4	3.0	2.5	2	2	1.0	1.0
Average	3.0	2.5	2.25	0.25	1.0	1.0