JECRC™ UNIVERSITY

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School of Sciences

Course Structure and Syllabus

M.Sc. (Microbiology)
(2021-2023)

Academic Programme

July 2021`

The curriculum and syllabus for M.Sc. Program conforms to outcome based teaching learning process. In general, several outcomes have been identified and the curriculum and syllabus have been planned in such a way that each of the courses meets one or more of these outcomes. Program outcomes illustrate the students are expected to know and be able to do by the time of graduation. These relate to the skills, understanding, and behaviors that students acquire as they progress through the program. Further each course in the program brings out clear instructional objectives which are mapped to the student outcomes.

The student outcomes are:

1. An ability to apply profound understanding of science, zoology, botany and microbiology
2. An ability to design and perform experiments, as well as to analyze and interpret data
3. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
4. An ability to function on multidisciplinary teams
5. An ability to identify, formulate, and solve microbiological problems
6. An understanding of professional and ethical responsibility
7. An ability to communicate effectively
8. The broad education necessary to understand the impact of biological solutions in global, economic, environmental, and societal context
9. A recognition of the need for, and an ability to engage in life-long learning
10. A knowledge of contemporary issues
11. An ability to use the techniques, skills, and modern microbial tools necessary for microbiological practice.

PROGRAM OUTCOMES (POs)

PO1. To acquire recent technical knowledge in basic and applied biological sciences.

PO2. Understanding microbiology in medical, industrial, agriculture, food and environmental basis of life.

PO3. Demonstrate practical skills/competencies in the laboratory including ethical implication of microbial research and the use of good laboratory practices and biosafety.

PO4. To develop scientific communication, writing skills, problem solving, and innovative thinking in youth with respect to microbiology.

PO5. To apply the knowledge of microbiology in health, medicine, environment and sustainable development.

PO6. Competent in practical and project based skills for a career in research and entrepreneurship in fields of microbiology.

PO7. To gain knowledge of essential facts, concepts, principles and theories relating to the subject areas identified and to recognize, analyze problems and plan strategies for their solution.

JECRC UNIVERSITY
FACULTY OF SCIENCE
SESSION 2021-2022

Details of Scheme for M. Sc. Microbiology with various Courses & their credits with contact Hours

M.Sc. Microbiology Semester- I

Subject Code	Subject	Lecture (Hr.)	Tutorials (Hr.)	Practical (Hr.)	Credits			Total Credits	Paper Category
					L	T	P		
MMI 001A	Bacteriology	4	-	-	4			4	Core
MMI 002A	Instrumentation	4	-	-	4			4	Core
MMI 020A	Principles of Biochemistry	4	-	-	4			4	Core
	Any one from the following:								
MMI 004B	Virology, Mycology and Phycology / Swayam portal/ MOOCs	4	-	-	4			4	Elective
MMI027A	Plant – Pathogen Interaction	4	-	-	4			4	Elective
MMI 021A	Practical I	0	0	12	0	0	6	6	Compulsory Practical
	Total	12		2	12	0	6	22	
		12		2	12	0	6	22	

M.Sc. Microbiology Semester- II

Subject Code	Subject	Lecture (Hr.)	Tutorials (Hr.)	Practical (Hr.)	Credits			Total Credits	Paper Category
					L	T	P		
MMI 022A	Industrial Microbiology	4	-	-	4			4	Core
MMI 007A	Molecular Biology and Microbial Genetics	4	-	-	4			4	Core
MMI008A	Immunology	4	-	-	4			4	Core
	Any one from the following:								

MMI 014A	Applied Environmental Microbiology/Swayam portal/ MOOCs	4	-	-	4			4	Elective
MMI028A	Microbial Physiology and Metabolism	4	-	-	4			4	Elective
MMI 023A	Practical II	0	0	12	0	0	6	6	Compulsory Practical
		12		2	12	0	6	22	

M.Sc. Microbiology Semester- III

Subject Code	Subject	Lecture (Hr.)	Tutorials (Hr.)	Practical (Hr.)	Credits			Total Credits	Paper Category
					L	T	P		
MMI 011A	Medical Microbiology	4	-	-	4			4	Core
MMI 012A	Genetic Engineering	4	-	-	4			4	Core
MMI 024A	Food and Dairy Microbiology	4	-	-	4			4	Core
	Any one from the following:								
MMI025A	Biostatistics and Bioinformatics/ Swayam portal/ MOOCs	4	-	-	4			4	Elective
MMI029A	Microbial Ecology	4			4			4	Elective
MMI 026A	Practical III	0	0	12	0	0	6	6	Compulsory Practical
		12		2	12	0	6	22	

M.Sc. Microbiology Semester- IV

Subject Code	Subject	Lecture (Hr.)	Tutorials (Hr.)	Practical (Hr.)	Credits			Total Credits	Paper Category
					L	T	P		
MMI016A	Review Report/ Scientific writing	0	-	-	0			4	Core
MMI017A	Dissertation	0	-	-	0			16	Core
MMI018A	Seminar	0	-	-	0			2	Core

	Total	0	-	-	0			22	

Total Credits

Credits	I Sem	II Sem	III Sem	IV Sem	Total
	22	22	22	22	88

MMI 001A	Bacteriology	4-0-0 [4]

Course outcome

CO 1 Understand the classical and modern trends in classification with reference to Bergey's manual of systematic bacteriology

CO 2 Understand and apply the Ultra structure of bacteria, nutritional, bacterial endospores and sporulation.

CO 3 Apply and Understand general account of eubacteria (Gram + & -) and archaebacteria (methanotrophs, halophiles and sulphur bacteria).

CO 4 Understand and apply the Cultivation of Bacteria: growth curve and environmental factors affecting growth.

CO 5 Apply and Analyze account of oxygenic and anoxygenic photosynthesis and the different types pigments molecule involved in photosynthesis

UNIT 1	**Classification :** Classification of microorganisms- introduction, Haekel's three kingdom concept, Whittaker's five kingdom concept, three domain system of classification. Modern trends in classification (ribotyping, NA hybridization, RNA fingerprinting). Classification and salient features of bacteria according to Bergey's manual of systematic bacteriology(a brief outline) Morphological types of bacteria . Nutritional classification of bacteria.
UNIT 2	**Structure of bacteria :** Cell wall structure and synthesis, cell membrane,. Flagella and motility, chemotaxis Pili, Fimbriae, Cell inclusions like Glycogen granules, Volutin granules, Carboxysomes, magnatosomes, chlorosomes, gas vacoules, Slime sheet and capsule. Endospore structure and formation stages of sporulation, activation germination and outgrowth of bacterial endospores, poly-β-hydroxyl butyrate, nucleic acids
UNIT 3	**Eubacteria and Archaebacteria:** General characters and structure of Spirochetes, cyanobacteria, purple and green bacteria, rickettsia, Chlamydia, budding bacteria and sheathed bacteria. Gram positive bacteria- endospore forming bacteria, actinomycetes, mycobacteria. Archaebacteria-methanotrophs, halophiles and sulphur bacteria.
UNIT 4	**Microbial Growth :** The definition of growth, growth curve, measurement of growth and growth yields, Synchronous growth, Continuous, Batch and Fed Batch Culture; Growth as affected by environmental factors like temperature, acidity, alkalinity,

	water availability oxygen and pH, activity of water, radiations, osmotic pressure and gaseous environment, maintenance, preservation, Control of microorganisms: physical and chemical methods. Mode of action of antibiotics, Antimicrobial drug resistance - Mechanism and spread.
UNIT 5	**Microbial Physiology :** Photosynthesis: Oxygenic photosynthetic microbes and anoxygenic photosynthetic microbes. Brief account of photosynthetic and accessory pigments-chlorophyll and bacteriochlorophylls, rhodopsin, carotenoids, phycobiliproteins; oxygenic-anoxygenic photosynthesis.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	**Program Outcome**						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	2	1	1	1
CO2	2	2	1	2	2	2	1
CO3	3	2	3	2	3	1	1
CO4	2	2	2	3	2	3	2
CO5	3	2	2	3	1	2	2

3 = Highly Related; 2 = Medium; 1= Low

Suggested Readings

1. Atlas RM (1989) Basic and Practical Microbiology, Mac Millan Company New York.
2. Brock TD, Madigan MT, Martinko JM, Dunlap PV, Clark DP (2012) Biology of Microorganisms, Prentice Hall, USA.
3. Prescott ML, Klein AD, Harley JP (2008) Microbiology (7th Edition), Mc Graw Hill Companies
4. Atlas RM (1989) Microbiology Fundamentals and Applications (2edition), Maxwell Macmillan International edition
5. Cappuccino JG and Sherman N (2006) Microbiology-a Laboratory Manual (6th Edition), Addison Wesley, Pearson education, Inc.
6. Satynarayana T & Johri (2005) Microbial diversity: current perspectives and potential applications, B.N. I.K. International Pvt. Ltd.
7. Moat AG, Foster JW and Spector M (2002) Microbial Physiology (4th Edition), Wiley Liss publications
8. Brown AE (2005) Benson's Microbiological application: Laboratory Mannual in general th Mirobiology (9th Edition), Mc Graw Hill
9. Talaro KP and Talaro A (2002) Foundation in Microbiology (4th Edition), Mc Graw Hill

10. Stanier RY, Ingharam JL, Wheelies ML and Painter PR (1999) General Microbiology, Mac Millan Education Ltd
11. Alcamo IE, Jones and Barlett (2001) Labo ratory Fundamentals of Microbiology, publishers
12. Colwd D (1999) Microbial Diversity, Academic press
13. Pelczar MJ, Chan ECS, Kreig NR (2006) Microbiology (5th Edition), Tata Mc Graw Publication

MMI 002A	Instrumentation	4-0-0 [4]

CO 1 Understand the construction of principle and applications of microscopy and varius types of microscope and their use.

CO 2 Understand the Principle, sedimentation analysis & RCF of centrifugation and various type of centrifuges.

CO 3 Understand the Principle, techniques of chromatography and various types of chromatography techniques.

CO 4 Understand the Principle, factors affecting and types of electrophoresis.

CO 5 Understand the Spectroscopy technique and Radioisotopic Techniques.

UNIT 1	**Microscopy:** construction of a microscope, Principle and applications of light microscopy (bright field, dark field, phase-contrast, interference, fluorescence, polarization microscopy). Electron microscopy- TEM, SEM, Scanned probe microscopic techniques (STEM, AFM). Confocal, Steriomicroscope (Basic)
UNIT 2	**Centrifugation:** Principle, sedimentation analysis & RCF, ultracentrifugation, High speed centrifuge, Zonal & Isopycnic centrifuge: Preparative (differential and density gradient) and analytical centrifuges.
UNIT 3	**Chromatography:** Principle, techniques of chromatography (Paper chromatography, TLC, Column chromatography), types of chromatography (GC, HPLC, Fast performance liquid chromatography, Adsorption chromatography, Partition chromatography, Gel filtration, Ion-exchange chromatography and Affinity chromatography).
UNIT 4	**Electrophoresis:** Principle, factors affecting electrophoresis, types of electrophoresis - Agarose gel electrophoresis, PAGE, SDS-PAGE, 2-D electrophoresis, Pulsed field gel electrophoresis, isoelectric focussing, immuno electrophoresis, Isotechophoresis Immunodiffussion.
UNIT 5	**Spectroscopy:** Beer-Lambert law, UV-Vis spectroscopy, fluorescence spectroscopy, IR spectroscopy, Raman spectroscopy, Atomic absorption spectroscopy, NMR, ESR, Flame emission photometry, flow cytometry.**Radioisotopic Techniques:** Principle and applications of radiation techniques (Radioisotopes; nature of radioactivity, types of radioactive decay, unit of radioactivity), detection and measurement of radioactivity (Geiger-Muller counter, Solid and liquid scintillation counter, Propotional counter, Film batch pocket dosimetry, autoradiography).

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	**Program Outcome**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	1	3	1	1	3	3
CO2	2	0	2	1	1	2	2
CO3	3	0	3	0	1	2	2
CO4	2	1	2	0	1	3	2
CO5	3	1	3	1	1	3	1

3 = Highly Related; 2 = Medium; 1 = Low

Suggested Readings

1. Narayanan P (2000) Essentials of Biophysics, New Age Int. Pub. New Delhi
2. Ninfa AJ, Ballou DP (2009) Fundamental Laboratory Approaches for Biochemistry and Biotechnology (2nd Edition) Fitzgerald science press, Inc.
3. Venn RF, Taylor and Francis (2003) Principles and Practice of Bioanalysis (2nd Edition), CRC publisher
4. Wilson K and Walker J (2007) Principles and Techniques of Biochemistry and Molecular Biology (6th Edition), Cambridge University Press
5. Webster JG (2004) Bioinstrumentation, John Wiley & Sons Inc.
6. Notting B (2003) Methods in Modern Biophysics, Springer Verlag Berlin Heidelberg New York
7. Scopes R K (2004) Protein Purification Principles and Practice (3rd Edition), spring International
8. Hames GG (2005) Spectroscopy for the Biological Sciences, John Wiley & Sons Inc.

MMI020A	**Principles of Biochemistry**	4-0-0 [4]

Course Outcomes

CO 1 Describe the chemical foundations of biology with reference to pH, buffers, bioenergies and hierarchy of molecules.

CO 2 Describe a general account of types, structural and metabolic pathway of amino acids.

CO3 Explain general account of types, structural and metabolic pathway of carbohydrates.

CO 4 Describe the Classification, Structure, functions, catabolism and anabolism of saturated and unsaturated fatty acids.

CO 5 Describe the Enzyme Kinetics and the mechanism of enzyme catalysis and Factors affecting enzyme activity as well as enzyme inhibition

UNIT 1	**Chemical foundations of Biology:** pH, pK, acids, bases, buffers, weak bonds, chemical bonds, Bioenergetics: Principles of thermodynamics: free energy, important energy, rich molecules, standard free energy change, concept of redox reactions. Principles of self assembly, Hierarchy of molecular organization of living systems.
UNIT 2	**Amino acids and proteins:** Structure and chemistry of Amino acids, Classification, Chemical Reactions and Physical Properties, Proteins-purification and criteria for homogeneity, structural organization of proteins- primary, secondary, tertiary and quaternary structure. Ramachandran plot. Protein sequencing, Protein folding & stability, Levinthal's paradox, glyco and lipo protein structure and function. Degradation and reconstruction.
UNIT 3	**Carbohydrates:** Classification and reactions of aldehyde and ketone group, types, structural features(ring structure, tautomeric forms, mutarotation) of carbohydrates. Metabolism of carbohydrates, glycolysis, Krebs cycle, terminal oxidation/oxidative phosphorylation, reverse TCA cycle, gluconeogenesis, mechanism of ATP synthesis.
UNIT 4	**Lipids:** Classification, Structure and functions, Biosynthesis of saturated and unsaturated fatty acids, Metabolism of Lipid and fat bodies: Beta-oxidation and channeling of the products to ATP production: minor pathway of fatty acid oxidation, (alpha and omega oxidation), Biosynthesis of saturated and unsaturated fatty acids., denovo and salvage pathways, Degradation of Purines and pyrimidines pathways.
UNIT 5	**Enzymes & Enzyme Kintetics:** Rate of reactions, specific activity, molecular activity, Km, K, Michaelis Menten & Line weaver Burk plot and Bisubstrate Reaction, Eaidi-Hofstee plot & Hanes–Woolf plot, enzyme inhibition, mechanism of enzyme catalysis (acid-base electrostatic, metal ion, free radicals, transition state binding and covalent, proximity and orientation effects, Contribution of strain). Factors affecting enzyme activity, enzyme inhibition. Allosteric, Iso-, Co-enzymes, Immobelized ezymes & cells and their applications.

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.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	**Program Outcome**						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	3	1	2	1	0
CO2	2	2	2	2	1	0	0
CO3	3	2	2	2	1	0	1
CO4	2	3	2	3	2	1	0
CO5	1	1	1	1	1	1	1

3= Highly Related; 2 = Medium; 1= Low

Suggested Readings

1. Voet D, Voet JG and Pratt CW (2004) Fundamentals of Biochemistry (3rd Edition) John Wiley and Sons, New York
2. Nelson DL and Cox MM (2004) Lehninger Principle of Biochemistry (4th Edition), Wiley publisher
3. Wilson K and Walker J (2007) Principles and Techniques in Biochemistry and Molecular Biology (6th Edition), Cambridge University Press
4. Elliot WH and Elliot DC (2005) Biochemistry and Molecular Biology (3 rd Edition), Oxford University Press
5. Rawn JD (2004) Biochemistry, 1st Indian Reprint, Panama Publishing Corporation

MMI 004B	**Virology, Mycology and Phycology**	4-0-0 [4]

Course outcome

CO 1 Understand the history, nomenclature, classification, morphology, ultra structure, cultivation and composition-viral genome and virus related agents (viroids, virusoids, prions).

CO 2 Analyze the viruses of plants, cyanobacteria, bacteriophage, algae and fungi their infection, transmission of plant virus with and without vectors.

CO 3 Understand the history, classification, nutrition, characteristic and classes of fungi.

CO 4 Evaluate the general feature and importance of families of algae.

CO 5 Describe economic importance of algae and lichen as well as their ecology.

UNIT 1	**Brief outline on discovery of viruses:** nomenclature and classification of viruses[LHT system, classification as per VII report of the international committee on taxonomy of viruses], distinctive properties of viruses; morphology & ultra structure; capsids & their arrangements; types of envelops and their composition-viral genome, their types and structure, virus related agents (viroids, virusoids, mycoplasma, prions) cultivation of viruses in embryonated eggs, experimental animals, cell cultures; Primary & secondary cell cultures; suspension cell cultures and monolayer cell cultures, cell certains, cell lines and transgenic systems.
UNIT 2	**Viruses:** Classification and nomenclature, different types and effects of viruses on plants and animals in contest of external appearance; histology, physiology and cytology; Viruses of cyanobacteria, algae and fungi. Transmission of plant virus with vectors (insects, nematodes, fungi) and without vectors (contact, seed and pollens), Prevention of crop loss due to virus infection- virus free planting material; vector control.Bacteriophage , lysogenic and lytic cycle of bacteriophage.
UNIT 3	**Mycology:** General characteristics of fungi, Classification of fungi, according to Ainsworth and Alexopolus and Mims with the general aspects of Major division of fungi. Type study of class oomycetes, zygomycetes, acsomycetes, basidiomycetes and deuteromycetes, Homothallism, Heterothallism, Heterokaryosis, Sex Hormones in Fungi. Fungi as insect symbiont. Mycotoxins and Mycotoxicoses. Economic importance of fungi.
UNIT 4	**Phycology:** General features and classification of algae. Occurrence, thallus organization and reproduction in Chlorophyceae, Euglenophyceae, Phaeophyceae, Rhodophyceae, Xanthophyceae, Pyrrophyceae and diatoms. Algal ecology & biotechnology. Economic importance of algae.
UNIT 5	**Lichens:** Lichen- ascolichen, basidiolichen, deuterolichen. Economic Importance of lichen.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	1	0	1	0
CO2	3	2	1	2	1	0	0
CO3	3	2	1	0	0	0	1
CO4	3	3	2	3	2	1	0
CO5	2	2	1	1	0	0	0

3= Highly Related; 2 = Medium; 1= Low

Suggested Readings

1. Dimmock, NJ, Easton AJ and Leppard KN (2001) Introduction to Modern Virology (5th Edition), Blackwell publishing, USA.
2. Levy JA, Owens OS and Conrat HF (1994) Virology (3rd Edition), PrenticeHall, Englewood cliff, New jersey
3. Mathews RE (1992) Functionals of plant virology, Academic press, San Diego
4. Topley and Wilson (1995) Text Book on principles of Bacteriology, virology and Immunology, Edward Arnold,London
5. Lennetter (1984) Diagnostic procedures for viral and Rickettsial diseases. American public Health association, NY
6. Hayes W (1985) The genetics of Bacteria and their viruses, Blackwell Scientific Publishers, London
7. Atlas RM (1985) Principles of microbiology, Mosby Year Book, Inc. Missouri 63146
8. Ayan RA and Paniker CCJ (2003) Textbook of Microbiology (6th Edition). Orient Longman Pvt Ltd
9. Mehrotra RS and Aneja KR (1990) An Introduction to Mycology, New Age International Publishers
10. Moore E, Kenneth L and Smith M (1999) Fundamentals of Fungi, Prentice Hall 11. Plant viruses, Universal Book Stall, New Delhi
12. Walkey DGA (1985) Applied Virology-International Books & Periodicals supply service, New Delhi
13. Alexopopulos CJ and Mims CW (1979) An Introduction to Mycology (3rd Edition), Wiley Eastern Ltd., New Delhi

MMI 027A	**Plant – Pathogen Interaction**	4-0-0 [4]

Course outcome

CO 1 Understand the physiology of plant diseases
CO 2 Analyze the important plant diseases and their etiology
CO 3 Understand the genetic basis of plant diseases.
CO 4 Evaluate the molecular approach of plant protection.

CO 5 Understand the diseases forecasting, diseases control in Indian farming.

UNIT 1	Concepts and physiology of plant diseases: What is a disease and what causes disease, pathogenesis, pathogenesis in relation to environment, effect of microbial infections on plant physiology, photosynthesis, respiration, transpiration, translocation. Biochemical basis of plant diseases: Enzymes and toxins in plant diseases, phytoalexins.
UNIT 2	Some important plant diseases and their etiological studies: Crown gall, symptoms of viral diseases and their control, diseases of some important cereals, vegetables and crops.
UNIT 3	Genetical basis of plant diseases: Genetics of host-pathogen interactions, resistance genes, resistance mechanism in plants. Disease control: Principles of plant disease control, physical and chemical methods of disease control, biocontrol, biocontrol agents - concepts and practices, fungal agents, Trichoderma as biocontrol agent, biocontrol agents – uses and practical constraints.
UNIT 4	Molecular approach: Molecular diagnosis, transgenic approach for plant protection, futuristic vision of molecular diagnosis, applications and constraints.
UNIT 5	Disease forecasting: History and important milestones in disease control, disease forecasting and its relevance in Indian farming.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	**Program Outcome**						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	2	1	2	2	1	1
CO2	2	3	2	2	1	2	2
CO3	3	2	3	3	2	2	1
CO4	3	1	1	2	2	1	2
CO5	2	2	1	2	1	2	2

3 = Highly Related; 2 = Medium; 1= Low

Suggested Readings

1. Plant pathology by George N. Agrios: 4th ed., Academic press, New York, 1969.
2. Plant pathology by R.S. Mehrotra: Tata McGraw –Hill publishing company limited. New Delhi.
3. Bacterial plant pathology, cell and molecular aspects by David C. Sigee, Cambridge University Press, 1993.
4. Molecular plant pathology by M. Dickinson: BIOS Scientific Publishers, London, 2003.
5. The essentials of Viruses, Vectors and Plant diseases by A.N. Basu & B.K. Giri: Wiley Eastern Limited, 1993.

6. Biocontrol of Plant Diseases (Vol. I) by K.G. Mukerji & K.L. Garg: CRC Press, Inc., Boca Raton, Florida, 1988.
7. Molecular Biology of Filamentous Fungi by U. Stahl & P. Tudzyski: VCH Verlagsgesellschaft mbH, D6940 Weinheim (Federal Republic of Germany), 1992.

MMI021 Practical I **Credits: 12**

1. Instrumentation and general lab introduction
2. To determine the acid value of the given oil sample.
3. To prepare biologically important buffers (phosphate and acetate).
4. To separate and identify amino acids by using TLC.
5. To separate and identify carbohydrates using TLC.
6. To find out the concentration of amino-acids in the given sample using ninhydrin.
7. To estimate the presence of carbohydrates.
8. To estimate the presence of Amino acids.
9. To identify of various Algal members.
10. To prepare potato dextrose Agar medium.
11. To check Oligodynamic effect (effect of heavy metals) on the given bacterial sample.
12. To check the given bacterial culture for amylase (starch hydrolysis) activity.
13. To check the given bacterial culture for protease (protein hydrolysis) activity.
14. To check the given bacterial culture for cellulase (carboxymethyl cellulose hydrolysis) activity.
15. To determine effect of U.V. rays on bacteria.
16. To classify and identify various fungal members.
17. To examine symptoms produced in plants due to virus infection.
18. To examine viral diseases of plants/animals/human (Specimen/photographs)
19. To prepare models of different type of viruses (Photographs/sketches).
20. To stain Endospore.
21. To perform the Gram's staining of bacteria.
22. To check the given bacterial culture for its tryptophan utilizing activity.
23. To estimate the total proteins present in the given sample using lowry's method.
24. To Isolate and identify airflora.

25. To Isolate and identify fungi from sewage water.
26. To Isolate and identify soil flora by sprinkle method & serial dilution method.
27. To perform the pure culture isolation methods.
28. To evaluate alcohol as disinfectant.
29. To find out the size of the given spore.
30. To estimate the carbohydrate present in the given sample using Anthrone reagent.
31. To find out the thermal death time of the given bacterial samples.
32. To study the effect of pH on microbial growth
33. To determine the bacterial growth in liquid medium by growth curve.
34. To perform simple bacterial staining.
35. To perform the capsule staining of given bacterial samples.
36. To check the given bacterial culture for its Citrate utilizing activity.
37. To check the given bacterial culture for its MRVP activity.
38. To study the effect of osmotic pressure on microbial growth.

MMI022A	**Industrial Microbiology**	4-0-0 [4]

Course outcome

CO 1 Understand the Introduction to microbial products and fermentation processes.
CO 2 Understand and apply the Fermentation system and Media optimization; Batch cultivation, continuous cultivation, multistage chemostat, feedback systems, types of fed-batch cultures, open and closed systems
CO 3 Apply and Understand general account of eubacteria (Gram + & -) and archaebacteria (methanotrophs, halophiles and sulphur bacteria).

CO 4 Understand and apply the Downstream processing: Downstream processing for filtration (DSP) cell disruption, liquid-liquid extraction, solvent recovery, supercritical fluid extraction, various chromatography techniques in product recovery
CO 5 Apply and Analyze Biotechnological applications of microbes in the commercial production of various products

UNIT 1	**Introduction to industrial microbiology:** Introduction to microbial products and fermentation processes, sources of industrially important microorganisms, Industrially important microorganisms, preservation techniques for microbial cultures, inoculum development, microbial strain improvement, high throughput screening methods,

	recombinant DNA technology in strain improvement.
UNIT 2	**Fermentation systems:** Batch cultivation, continuous cultivation, multistage chemostat, feedback systems, types of fed-batch cultures, open and closed systems. **Media Optimization:** Substrates for industrial fermentation, media optimization strategies like Plackett–Burman design, response surface methodology. Immobilized cell reactor, solid state fermentation.
UNIT 3	**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.
UNIT 4	**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.
UNIT 5	**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. .

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	**Program Outcome**						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	3	2	2	2	1
CO2	2	2	2	2	2	2	2
CO3	3	2	2	3	1	1	1
CO4	3	3	3	3	1	1	1
CO5	2	1	1	1	3	3	1

3 = Highly Related; 2 = Medium; 1 = Low

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. 4thEdition. Springer.
8. Reed G. Industrial Microbiology CBS Publisher.
9. Cruger & Cruger. Microbial Biotechnology, Panima Press

MMI007A	MOLECULAR BIOLOGY AND MICROBIAL GENETICS	4-0-0 [4]

Course outcome

CO1 Understand the prokaryotic and eukaryotic gene structure and function.
CO2 Undersatnd mechanism of prokaryotic and eukaryotic transcription.
CO3 Understand the different tools and mechanisms of transcriptional regulation.
CO4 Understand the Bacterial genetics in reference to molecular mapping, gene transfer mechanisms i.e. transformation, transduction.
CO5 Undersatnd general account of Bacteriophages eg. Lytic phages, Lysogenic phages and their uses in microbial genetics.

UNIT 1	**Prokaryotic and Eukaryotic gene structure and function:** Structure and properties of nucleic acids, Central dogma of molecular biology, Prokaryotic genome and its organization, Eukaryotic genome structure and chromosome organization Replication in Prokaryotes and Eukaryotes. Enzymes and accessory proteins involved in DNA Replication.
UNIT 2	**Prokaryotic & Eukaryotic transcription:** (Initiation, Elongation & Termination), general apparatus of transcription, RNA,Polymerase, General & Specific Transcription Factors, Regulatory elements & mechanism of transcription regulation, Post transcriptional gene silencing (PTGS), Modifications in RNA.
UNIT 3	**Prokaryotic and Eukaryotic Translation:** the translation machinery, Mechanism of initiation, elongation, termination, Regulation of translation, Co & post translational modification of proteins, Localization of proteins, synthesis of secretory & membrane proteins, protein targeting and trafficking in mitochondria,

	chloroplast & peroxisomes.
UNIT 4	**Bacterial genetics:** Molecular mapping of genome, genetic and physical mapping, map based cloning. Gene transfer mechanisms-Transformation- molecular mechanism, mapping and other uses of transformation, Transduction- generalized transduction, co-transduction and linkage, mapping by cotransduction, specialized transduction, specialized transducing phage as a cloning vehicle. Congugation- molecular mechanism
UNIT 5	**Bacteriophages:** , Lytic phages-T7 and T4.Lysogenic phages Lambda phage, and P1, M13 and F, Ø X174 life cycles, Phage MU and their uses in microbial genetics. Role of microbial genetics in vaccine designing. Microbial genetics and design of vaccines. BCG and design of vaccine for TB and leprosy. DNA vaccines, design and advantages.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	**Program Outcome**						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	3	2	3	3	2	1
CO2	1	2	1	2	3	2	2
CO3	0	3	1	3	3	2	1
CO4	0	2	1	2	2	3	1
CO5	1	2	1	2	2	3	2

3 = Highly Related; 2 = Medium; 1 = Low

Suggested Readings

1. Maloy RS, Cronan JE and Freifelder D (1994) Microbial Genetics (2nd Edition, Jones and Barlett Publishers
2. Snyder L and Champness W (2003) Molecular Genetics of Bacteria, ASM Press, Washington, D.C.
3. Malacinski GM and Freifelder D (2005) Essentials of Molecular Biology (3rd Edition) Jones and Bartlett Publishers
4. Sambrook J, Fritsch EF and Maniatis I (2001) Molecular Cloning: a Laboratory Manual (3rd Edition), Cold Spring harbor Laboratory Press, New York
5. Dabre PD (1988) Introduction to Practical Molecular Biology, John Wiley & Sons Ltd.,Yourk
6. Brown TA (1999) Genomes, John Wiley and sons (ASIA) PTE Ltd
7. Alberts B, Bray DJ, Raff M and Roberts K(1994) Watson Molecular Biology of the Cell (2nd Edition), Garland publishing. Inc., New York
8. Baker W, Gann B and Losick L (2003) Molecular Biology of the Gene (5th Edition), Pearson Education
9. Darnell J, Lodish H and Baltimore D (1994) Molecular Cell biology (2nd Edition), Scientific American Books,USA
10. Malacinski GM and Freifelder D (1998) Essentials of Molecular Biology, Jones & Bartlett Publishers Inc.

11. Winnacker (2003) From Genes to Clones, Panima Publishing Corporation, New Delhi/Bangalore,
12. Russell and Peter J (2003) Genectics – A molecular approach, Pearson publisher
13. Lewin B (2007) Gene IX (9th Edition), Ox ford University Press. U.K.
14. Walker JM and Rapley R (2007) Molecular Biology and biotechnology (4th Rev.).A comprehensive desk reference, VCH Publishers, Inc., New York

MMI008A	Immunology	4-0-0 [4]

Course outcome

CO 1 Understand the immune system comprising innat & adaptive immunity also organization and structure of lymphoid organs.
CO 2 Understand the cellular and molecular aspect of immune system.
CO 3 Analyze the antigen- antibody interactions and the advanced concepts in Immunology.
CO 4 Understand the organ and systemic specific autoimmune disease.
CO 5 Understand the autoimmunity and different models of auto immune disease treatment of autoimmune disorders.

UNIT 1	**Introduction to immune system:** Phylogeny of immune system, Innate and acquired immunity, Clonal nature of immune response. Cells of the Immune system: Hematopoiesis and differentiation, Lymphocyte trafficking, B-lymphocytes, T-lymphocytes, Macrophages, Dendritic cells, NK and Lymphokine activated killer cells, Eosinophils, Neutrophils and Mast Cells. Organization and structure of lymphoid organs
UNIT 2	**Cellular and molecular aspects:** Nature and biology of antigens and super antigens. Immunoglobulin: structure, types and their function, Major histocompatibility complex, B-Cell Receptor and T-Cell Receptor, generation and diversity, Complement system. Immune response & its regulation Antigen processing and presentation, generation of Humoral and Cell mediated immune responses, B- and T- cell maturation, activation and differentiation, Cytokines and their role in immune regulation, T-cell regulation, MHC restriction
UNIT 3	**Antigen- antibody interactions:** Precipitation, Immunodiffusion, Immunoelectrophoresis, Agglutination, RIA, ELISA, Immunofluorescence. Advanced concepts in Immunology:Hypersensivity, Autoimmunity, Immunity of infectious agents (intracellular parasites, helminthes and viruses), Hybridoma Technology and Monoclonal antibodies and their applications.
UNIT 4	**Transplantation:** organ specific autoimmune disease, systemic autoimmune diseases, graft rejection, evidence and mechanism of graft rejection, prevention of graft rejection, Vaccine development and immunization programme, AIDS and other immunodeficiencies
UNIT 5	**Autoimmunity:** immunosuppressive drugs, HLA and disease, mechanism of immunity to tumor antigen, Autoantibodies in human pathogenic mechanism, experimental models of autoimmune disease treatment of autoimmune disorders.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	**Program Outcome**						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	1	3	2	3	2	1
CO2	3	2	3	1	2	1	1
CO3	2	2	2	2	2	2	1
CO4	2	2	2	2	1	2	1
CO5	2	2	1	1	1	1	1

3 = Highly Related; 2 = Medium; 1 = Low

Suggested Readings

1. Thomas J and Barbara KA (2006) Kuby's Immunology (4th Edition), -R.A. Goldsby, Osbarne, (Freeman) & Co. New York
2. Roitt IM and Peter J. Delves (2001) Roitt's Essential Immunology (10th Edition), Blackwell Science, 2001
3. Lydyard P, and Fanger M (2003) Instant Notes on Immunology (2nd Edition), Viva Books Pvt. Ltd.
4. Abbas AK, Litchman AH (2005) Cellular and Molecular Immunology (5rd edition), Saunders
5. Wise D J and Carter GR (2001) Immunology: A Comprehensive Review, Iowa State University Press
6. Levinson W and Jawetz E (2002) Medical Microbiology and Immunology (7th Edition), Mc Graw Hill

MMI014A	**Applied Environmental Microbiology**	4-0-0 [4]

Course outcome

CO1 Understand the aerobic treatment of industrial effluents and municipal waste through microorganisms

CO2 Understand and analyze the anaerobic processes i.e. composting, vermiculture and methanogenesis.

CO3 Understand the Biodegradation of natural compounds as well as xenobiotics ex situ and in-situ bioaccumulation and biomagnifications.

CO4 Understand the biodeterioration and bioleaching of paper, wood, paint and other metals.

CO5 Understand the concept of biofertilizers, Biopesticides and Bioplastics.

UNIT 1	**Waste management:** Treatment of industrial effluents and municipal waste through micro-or ganisms. Aerobic Processes: Oxidation pools, Rotating Biological Discs, Rotating Drums, Trickling filter, Activated sludge process
UNIT 2	**Anaerobic Processes:** Anaerobic digestion, Anaerobic filter, upflow an aerobic sludge blanket reactors. Indicator microorganisms. Solid wastes: Sources and management composting, vermiculture and Methane Production.
UNIT 3	**Biodegradation of natural compounds:** (cellulose, hemicelluloses, lignin, chitin,). Biodegradation of xenobiotics in environment – Organisms involved in degradation of chlorinated hydrocarbons, substituted simple aromatic compounds, polyaromatic hydrocarbons, pesticides, synthetic polymers, detergents and hydrocarbons Bioremediation- *ex situ* and *in situ*. bioaccumulation, biomagnifications.
UNIT 4	**Biodeterioration and Bioleaching:** Definition, biodetorioration of paper, wood, paint, textiles, leather, metals (corrosion).Control of biodetorioration. Microorganisms and metal pollutants- metal bioavalibility in environment, mechanism of microbial metal resistance and detoxification, metal- microbe interaction, Bioleaching of metals, Microbial enhanced oil recovery. **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.
UNIT 5	**Biofertilizers:** Definition and types of biofertilizers, Mass cultivation and methods of inoculation of microbial inoculants – (Rhizobium, Azotobacter, &Asospirillium.) Cyanobacteria –Azolla– Anabaena association and its role in rice cultivationQuality control and ISI specifications for Rhizobium cultures. Mycorrhizal Relationship, Biopesticides and Bioplastics

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	**Program Outcome**						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	1	3	2	3	2	1
CO2	3	2	3	1	2	3	2
CO3	3	2	3	2	3	2	3
CO4	3	2	2	2	2	2	1
CO5	2	2	1	2	1	2	2

3 = Highly Related; 2 = Medium; 1 = Low

Suggested Readings

1. Thakur IS (2006) Environmental Biotechnology – Basic concepts and applications. I K International publications
2. Maier RM, Pepper IL and Gerba CP (2000) Environmental Microbiology, Academic Press. (2000)
3. Michel R (1999) Introduction of Environmental Microbiology, Prentice-Hall
4. Atlas RM, Bartha R (2005) Microbial Ecology- Fundamentals & Applications, (4th Edition), Pearsrson Publication
5. Ignacimuthu S, SEN A (2001) Microbials in Integrated Pest Management, (special Indian edition), Oxford and IBH Publishing Co. Pv. Ltd.
6. Allsopp D and Seal KJ, Gaylarde C (2003) Introduction to Biodeterioration (2nd Edition), Cambridge University Press
7. Rao S (1988) Biofertilizers in Agriculture (2nd Edition), Oxford & IBH Pub. Co
8. John AM (1977) Introduction to soil microbiology Wiley & Sons. Inc., New York
9. Deshmukh AM (1988) Biofertilizers and Biopesticides, Technosciences Publications

MMI 028A	Microbial Physiology and Metabolism	4-0-0 [4]

Course outcome

CO1 Understand the cell growth and solute transportation
CO2 Understand the central metabolic pathway and regulation.
CO3 Understand the nitrogen and lipid metabolism
CO4 Understand the nucleotide metabolism and function.
CO5 Understand the physiological adaptation and intercellular signaling

UNIT 1	Growth and cell division: Measurement of growth, growth physiology, cell division, growth yields, growth kinetics, steady state growth and continuous growth. Solute Transport: Primary and Secondary transport: Introduction, Kinetics, ABC transporters, Phosphotransferase system, Drug export systems, amino acid transport.
UNIT 2	Central Metabolic Pathways and Regulation: Glycolysis, PPP, ED pathway, Citric acid cycle: Branched TCA and Reverse TCA, glyoxylate cycle. Utilization of sugars other than glucose and complex polysaccharides
UNIT 3	Nitrogen metabolism: Metabolism of amino acids: Amino acid biosynthesis and utilisation, lysine and glutamine overproduction, stringent response, polyamine biosynthesis and regulation. Metabolism of lipids and hydrocarbons: Lipid composition of microorganisms, biosynthesis and degradation of lipids, lipid accumulation in yeasts, hydrocarbon utilization, PHA synthesis and degradation.
UNIT 4	Metabolism of nucleotides: Purine and pyrimidine biosynthesis, regulation of purine and pyrimidine biosynthesis, inhibitors of nucleotide synthesis.
UNIT 5	Physiological Adaptations and Intercellular signaling: Introduction to two component system, regulatory systems during aerobic- anaerobic shifts: Arc, Fnr, Nar, FhlA regulon, response to phosphate supply: The Pho regulon Quorum sensing: A and C signaling

system, sporulation in Bacillus subtilis, control of competence in *Bacillus subtilis*. Heat-Shock responses pH homeostasis, osmotic homeostasis.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	**Program Outcome**						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	2	1	2
CO2	3	2	1	2	2	2	2
CO3	3	1	3	2	2	2	2
CO4	3	2	2	3	2	3	2
CO5	2	1	1	2	2	1	1

3 = Highly Related; 2 = Medium; 1= Low

Suggested Readings:

1. Biochemistry by Geoffrey L. Zubay. Fourth Edition, Addison-Wesley educational publishers Inc., 2008
2. Lehninger Principles of Biochemistry by David L. Nelson and Michael M. Cox. Fifth Edition, W.H. Freeman and Company; 2008.
3. Microbial lipids edited by C. Ratledge and SG Wilkinson, second edition, Academic Press; 1988.
4. Microbial Physiology by Albert G. Moat and John W. Foster. Third edition, John Wiley and Sons; 2002 5. The Physiology and Biochemistry of Prokaryotes by David White. Second Edition, Oxford University Press; 2000.

MMI023A Practical II **Credits: 12**

1. To isolate plasmid DNA.
2. To perform Ouchterlony double diffusion
3. To determine antibody concentration using ELISA
4. To determine antigen concentration using Sandwich ELISA
5. To examine restriction digestion of DNA
6. To isolate rhizospheric microflora.
7. To determine R : S ratio of soil.

8. To isolate microorganisms from soil, water and air
9. To detect MPN coliforms for determination of the purity of potable water.
10. To determine biological oxygen demand (BOD) of sewage sample.
11. To determine chemical oxygen demand (COD) of sewage sample.
12. To isolate and identify common microorganisms spoiling food (Fungi and bacteria).
13. To prepare fermented foods (Sauerkraut).
14. To isolate and identify Rhizobium from root nodules of leguminous plants.
15. To isolate and identify Azotobacter from soil.
16. To detect ammonification by bacteria.
17. To isolate the microorganism from extreme condition (salt or chemical influent).
18. Isolation and identification of coli forms from Water by Presumptive, Confirmed & Completed test
19. Detection of siderophore production by microorganisms.
20. To check the presence of coliform bacteria using LBCP broth.
21. To check the presence of coliform bacteria (E.coli) using EMB agar (confirmatory test).
22. To study DNA profile of the given sample by using Agarose gel electrophoresis.
23. Water analysis for total bacterial population by standard plate count (SPC) method.
24. Isolation of phosphate solubilising microorganisms from soil.
25. Isolation of an antibiotic producer microorganism from soil.
26. Determination of total dissolved solids of water.
27. To perform the fermentation of carbohydrates by microorganisms.
28. To perform Radial Immunodiffusion (RID) by Mancini's technique.
29. To isolate Genomic DNA of bacteria
30. To perform the electrophoresis of bacterial genomic DNA.
31. PCR: Amplification of 16S rRNA gene from E.coli by domain specific primers
32. Isolation of bacterial protein by SDS PAGE.
33. Widal test using tube agglutination reaction
34. Agglutination reaction with reference to blood grouping.

35. Pregnancy testing by using immunological methods.

MMI011A	Medical Microbiology	4-0-0 [4]

Course outcome

CO 1 Understand the Classification of medically important micro organisms and Normal microbial flora of human body

CO 2 Apply the knowledge for diagnostic of important bacterial diseases including their pathogenecity.

CO 3 Understand the Pathogenic fungi-*Candida albicans* Protozoan diseases – Malaria, Amoebiasis

CO 4 Understand the general detail of Epidemiology, life cycle, pathogenicity, diagnosis, prevention and treatment of RNA viruses and DNA animal viruses.

CO 5 Brief account of available vaccines, Antifungal drugs, antiviral drugs and their mode of action.

UNIT 1	**Normal micro flora and factors responsible for pathogenesis:** Classification of medically important micro organisms; Normal microbial flora of human body; role of the resident flora. Entry of pathogens into the host; colonization and mechanism of bacterial adhesion establishment, spreading, tissue damage and anti-phagocytic factors; factors predisposing to infections, types of toxins and their structure; mode of action.
UNIT 2	**Pathogenic bacteria I:** Diagnostic features of important diseases including their pathogenecity and control. Pyogenic cocci-*Staphylococci, Streptococci, Neisseria meningitides, N. gonococcus* Gram positive cocci-*Clostridium tetani,* Mycobacteria-*M. tuberculosis, M. leprae*
UNIT 3	**Fungi and Protozoan:** Diagnostic features of important diseases including their pathogenecity and control. Enteric Gram negative bacteria-*Salmonella, Shigella, Vibrio cholera, E. coli Spirochaetes- Treponema palladium*Chlamydiae- Trachoma, Rickettesial diseases, Diseases caused by Mycoplasma,Pathogenic fungi-*Candida albicans* Protozoan diseases – Malaria, Amoebiasis
UNIT 4	**Animal viruses:** Epidemiology, life cycle, pathogenicity, diagnosis, prevention and treatment of RNA viruses- Picorna virus family-Poliomyelitis, influenza, Mumps, Measles, DNA viruses; Pox virus-Variola and Vaccina, Herpes virus- Varicella Zoster virus, Hepatitis viruses, Arthropod borne (arbo) Viral disease- Dengu, Swine flu.
UNIT 5	**Chemotherapy and Antimicrobial agents:** Mode of action of penicillin, Sulfa drugs, streptomycin, tetracycline and other broad spectrum antibiotics. Antifungal drugs, antiviral drugs. Brief account on available vaccines

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES :

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	3	2	3	3	1	2
CO2	0	2	1	2	2	1	2
CO3	0	3	1	2	2	0	1
CO4	1	3	1	1	3	1	3
CO5	1	2	2	1	3	1	1

3 = Highly Related; 2 = Medium; 1 = Low

Suggested Readings

1. Salyers AA and Whitt DD (2002) Bacterial Pathogenesis-A Molecular Approach (2nd Edition), ASM Press
2. Irving W, Boswell T and Aldeen AD (2005) Instant Notes Medical Microbiology, Taylor and Francis group,
3. Timbury MC (1971) Notes of Medical virology (3rd Edition) Churchill Livingstone, London
4. Roberts JR, Evan C and Nester MT (2011) Microbiology A Human Perspective (7th Edition), Brown Publishers
5. Ananthnarayanan R and Paniker CKJ (2006) Text book of Microbiology, Orient Longman
6. Levinson W and Jawetz E (2008) Medical Microbiology and Immunology: Examination and Board Review (10th Edition), Mc Graw Hill
7. Kayser FH and Beniz KA (2005) Medical Microbiology vol. 1 Microbial infection, vol. 2, Thieme
8. Mackie T J (1996) Practical Medical microbiology (14th Edition), Churchill Livingstone
9. Agrios G N (2005) Plant Pathology (5th Edition), Academic Press
10. Smith KM (2012) Plant viruses (3rd Edition), Elsevier

MMI012A	**Genetic Engineering**	4-0-0 [4]

Course outcome

CO 1 Understand the of scope and milestone in genetic engineering as well as Basic tools & techniques used in recombinant DNA technology as well as different vectors and their expression.

CO 2 Understand and apply the Principle and uses of nucleic acid hybridization.

CO 3 Apply and Analyze the sequencing gene DNA and genomic library.

CO 4 Describe the molecular mapping and physical mapping of genome as well as RAPD, RFLP, AFLP and other molecular marker techniques.

CO 5 Understand and apply strategies of gene delivery and classify the target gene replacement and the gene expression.

UNIT 1	**Tools of genetic engineering:** Scope and milestones in genetic engineering, Basic tools and techniques used in recombinant DNA technology: Restriction endonuclease, DNA modifying enzymes, cloning vectors: plasmids, bacteriophage, cosmid, phagemids, *in vitro* construction of vectors, expression vectors, Different Blotting techniques,
UNIT 2	**Principle and uses of nucleic acid hybridization:** Principle and applications of polymerase chain reaction. Patenting of cloned life forms. Site directed mutagenesis and protein engineering, *in vitro* DNA synthesis, *in vitro* transcription and translation.
UNIT 3	**Sequencing of genes DNA and genomic library:** : m- RNA enrichment, reverse transcription, Linkers, Adaptors,Screening of cDNA and genomic library, Sequencing and mapping: Sequencing vector,fluorescent tagging, Automated DNA sequencing, Pyrosequencing. Restriction mapping and map construction, Application of sequence information for identification of defective genes.
UNIT 4	**Molecular Mapping of Genome:** Genetic and physical mapping, Genome sequencing: genome size, organelle genome, YAC, BAC libraries, strategies of genome sequencing, Analysis of genetic variations: RAPD, RFLP, AFLP and other molecular marker techniques, application of RFLP in forensic studies, disease prognosis, genetic counselling, pedigree analysis etc.
UNIT 5	**Strategies of gene delivery:** Agrobacterium mediated transformation, electoporation, particle bombardment, microinjection, Gene therapy: Target gene replacement, gene knockout technique, computer aided drug designing. Gene expression DNA and protein microarray technology, RNase protection assay, Reporter gene assay, northern blotting and S1 nuclease assay, Heterologous gene expression in bacteria, yeasts, insects, mammals and plants. codon optimization.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	**Program Outcome**						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	2	2	2	2
CO2	2	2	3	1	1	2	1
CO3	2	3	2	2	2	1	1
CO4	1	2	2	1	2	2	2
CO5	1	1	3	2	1	1	2

3 = Highly Related; 2 = Medium; 1= Low

Suggested Readings

1. Sambrook J, Fritsch EF (2000) Maniatis Molecular Cloning: a Laboratory Manual, Cold Spring Harbor Laborator y Press, New York
2. Glover DM and Hames BD (1995) DNA Cloning: a practical Approach, IRL Press Oxford
3. Cseke LJ, Kirakosyam A, Kaufman PB and Westfall MV (2011) Molecular and Cellular Methods in Biology and Medicine (3rd Edition) , CRC Press.Florida
4. Desmond ST and Nicholl (2002) An Introduction to Genetic Engineering, Cambridge University Press
5. Carson S and Robertson D (2005) Manipulation and Expression of Recombinant DNA (2nd Edition) Academic Press
6. Primrose B and Twyman R (2007) Principles of Gene Manipulation and Genomics (7th Edition), Blackwell Publishers
7. Fire A and Nirenberg M (2005) RNA interference Technology- From basic science to drug development, Cambridge Press
8. Berger SL and Kimmel AR (1998) Methods in Enzymology Vol.152, Guide to Molecular Cloning Techniques, Academic press. Inc.
9. Mickloss DA and Greyer GA (1990) DNA Science- A First Course in Recombinant Technology, Cold Spring Harbor Laboratory Press, New York
10. Primorse SB (1194) Molecular Biotechnology (2nd Edition), Blackwell Scientific Publishers, Oxford

MMI024A	Food and Dairy Microbiology	4-0-0 [4]

Course outcome

CO1 Understand the role of microorganism in food microbiology

CO2 Understand the spoilage of food and food preservatives.

CO3 Analyze the fermentated products of food.

CO4 Understand the food beverages and enzymes

CO5 Understand the Food-borne diseases and poisoning.

UNIT 1	**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. **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 2	**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 3	**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.
UNIT 4	**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 5	**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.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	**Program Outcome**						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	1	2	2	3	2	1
CO2	2	2	1	3	1	3	1
CO3	2	2	1	1	2	3	2
CO4	2	3	2	2	1	2	1
CO5	2	2	1	2	2	2	1

3 = Highly Related; 2 = Medium; 1= Low

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

MMI025A	BIOSTATISTICS AND BIOINFORMATICS	4-0-0 [4]

Course outcome

CO 1 Evaluate the classification and tabulation of data, measures of central tendency, different methods of dispersion.

CO2 Evaluate the Tests of significance- Chi-square test, t-test, F-test, ANOVA, correlation and regression.

CO3 Evaluate the types and theorems of probability.

CO4 Understand the basic of elementary idea of Bioinformatics

CO5 Evaluate the bioinformatics and their tools use to study genomics.

UNIT 1	Introduction, Scope and application of Biostatistics. Classification and tabulation and graphical presentation of data: frequency distribution. .Measure of central tendency- Mean, median and mode, Measures of dispersion - range, mean deviation ,standard deviation, coefficient of variation, Skewness and kurtosis.
UNIT 2	Tests of significance**:** Hypothesis testing, Nulls hypothesis and alternative hypothesis, level of significance. Chi-square test, t-test, F-test, ANOVA-one way and two way classifications. Simple correlation and simple regression.
UNIT 3	Probability: addition and multiplication theorem of probability. A brief idea of normal, Poisson and binomial distribution.
UNIT 4	Elementary idea of Bioinformatics, Biological databases-Overview, modes of database search, mode of data storage (file format), formats of GenBank, EMBL, DDBJ, PDB;
UNIT 5	**Phylogenetic Analysis:** Introduction to phylogenetic analysis and its application.Types of phylogenetic trees, Different approaches of phylogenetic tree construction - UPGMA, Neighbour joining, Maximum Parsomony, Maximum likelihood.

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

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	**Program Outcome**						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	3	2	3	2	3
CO2	2	3	3	3	2	2	2
CO3	2	2	2	2	2	2	2
CO4	3	3	3	2	2	1	2
CO5	3	1	2	3	1	2	2

3 = Highly Related; 2 = Medium; 1= Low

Suggested Readings

1. Daniel WW (2014) Biostatistics: A Foundation for Analysis in Health Sciences (10th Edition), John Wiley and Sons Inc.
4. Bailey NTJ (1995) Statistical Methods in Biology, Cambridge University Press
5. Campbell RC (1989) Statistics for Biologist, Cambridge University Press
6. Rosner B (2010) Fundamentals of Biostatistics (7th Edition), Publishing Corporation
7. Wardlaw AC (2000) Practical Statistics for Experimental Biologists, John Wiley and sons Inc.
8. Baxevanis A.D. and Ouellette (2005) Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins , Third Edition. John Wileyand Son Inc.
9. Mount D.W (2004) Bioinformatics Sequence and Genome Analysis, CSHL Press.
10. Tramontano A (2007) Introduction to Bioinformatics, Chapman & Hall/CRC.
11. Zvelebil, M.and Baum (2008) Understanding Bioinformatics, Chapman & Hall/CRC.

MMI029A	**Microbial Ecology**	**4-0-0 [4]**

Course outcome (CO)

CO 1 Understand the basic concepts within the field of microbial ecology and environmental microbiology.

CO 2 Understand and Interpret the various ecological and evolutionary principles that impact microbes.

CO 3 Analyze and design experimental approaches used in the field of microbial ecology.

CO 4 Understand functional ubiquity and diversity observed among different microbes.

CO 5 Apply the arguments that researchers in microbial ecology make based on evidence.

UNIT 1	Origin of life: A brief history of the physical origin of the Earth, Chemical and Cellular evolution; Microbial Diversification: Consequences for Earth's Biosphere; Endosymbiotic origin of eukaryotes.
UNIT 2	Microbial Ecology vs. Macroecology, Basic concept of Ecosystem and Biosphere, Concept of habitat and niche, Concept of population growth and community dynamics in microbe, Basic concept of food chain-food web and energy flow.
UNIT 3	Physiological ecology of microorganisms: Adaptation to environmental condition, Abiotic growth limiting factors-Leibig's law of minimum, Shelford law of tolerance. Microbial community succession-biofilm communities.
UNIT 4	Quantitative Ecology: Microbial diversity, OTU, Diversity indices (Shannon, Shimpson), Alpha and beta diversity, Richness and evenness, Samples and samplings, Concept of culturability, Significance of Biogeochemical cycles-Carbon, Nitrogen, Phosphorous, Sulphur.
UNIT 5	Development of microbial communities: r and k strategies. Determination of total and viable microbial number, Molecular analysis of function and diversity of microbial community, Metagenomics and microbiomics.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	**Program Outcome**						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	2	3	2	3	2	2
CO2	2	3	3	3	2	2	1
CO3	2	2	2	3	2	2	1
CO4	2	3	3	3	1	2	1
CO5	2	2	1	2	2	2	1

3 = Highly Related; 2 = Medium; 1= Low

Suggested readings:

1. Environmental Microbiology and Biotechnology by Singh and Dwivedi. New Age Int. Sci. Publication.

2. Environmental Microbiology by Riana.
3. Microbiology by Prescott, Harley and Klein. TMH Publication.
4. Brock Biology of Microorganisms. Prentice Hall Publication.
5. General Microbiology by Stanier. MacMillan Education Ltd.
6. Environmental Microbiology: Principles and Applications. Patrick K. Jjemba.
7. Encyclopedia of Environmental Microbiology, 6 Vol. Set. Willey Publication.
8. Microbial Ecology by Alexander. Willey Publication

MMI026A Practical III **Credits:12**

1. To isolate antibiotic resistant microorganisms by replica plating.
2. To isolate antibiotic resistant microorganisms by Gradient plate technique.
3. To enumerate the following in blood sample a. RBC b. WBC
4. To prepare blood smear and determine differential WBC count.
5. To detect Antibiotic sensitivity of a given sample by disc method.
6. To determine MIC of antibiotics
7. To immobilize cell using alginate.
8. To isolate *Lactobacillus* species from curd.
9. To test quality of milk by MBRT.
10. Demonstration of fungal human pathogens (dermatophytes) from skin.
11. Isolation of bacterial flora from the skin.
12. Isolation of microbial flora of the mouth teeth cervices.
13. Isolation of microorganisms of the upper respiratory tract (throat).
14. Demonstration of streaking plates using toothpick.
15. Visit and report formation of STP unit/ vermicomposting unit/Biogas plant unit.
16. Construction of exclusive and inclusive frequency tables.
17. Demonstration and exercises on mean, median and mode.
18. Demonstration and exercises on deviation.
19. Demonstration and exercises on probability.
20. Demonstration and exercises on the testing of hypothesis using student t test.
21. Demonstration and exercises on the testing of hypothesis using Chi-square test.

22. Demonstration and exercise on ANOVA.
23. Demonstration and exercise on correlation.
24. Demonstration and exercise on regression.
25. Introduction to bioinformatics databases i.e. NCBI, EMBL, PDB, DDBJ, Uniprot, KEGG.
26. Exploring the integrated database system at NCBI server and querying the PUBMED and GenBank databases.
27. Exploring the integrated database system at EBI server and searching the EMBL Nucleotide database using the SRS search engine.
28. Sequence alignment by using alignment tool BLAST.
29. Sequence alignment by using alignment tool FASTA.

SEMESTER IV

MMI016A Review Report **Credits: 04**

The review report of M.Sc. IV semester will be based on a detailed review of any one of the topics listed in syllabus in about 100 pages. This review will be evaluated by a supervisor, Head of the Department and any other person appointed by the Dean, SSC.

MMI017A Dissertation **Credits: 16**

The dissertation work will involve practical work on a problem suggested by the supervisor of the candidate. The student will submit the dissertation report at the end of IV semester. This dissertation report will be examined by the supervisor of the student, Head of the Department and any other person appointed by Dean, SSC.

MMI018A Seminar **Credits: 2**

The seminar will be based on a detailed report of any one of the topic listed in syllabus. This report is handwritten. The assessment of the seminar based on report as well as presentation in form of power point or Prezi. This seminar report will be examined by the supervisor of the student, Head of the Department and any other person appointed by Dean, SSC.