Telephone No: 2419208/2419315/2419219/2419361
Fax: 0821-2419363/2419301

e-mail : registrar@uni-mysore.ac.in
www.uni-mysore.ac.in

UNIVERSITY OF MYSORE

Established: 1916

Vishwavidyanilaya Karyasoudha,
Crawford Hall, Mysore-570 005.

No.AC.2(S)/378/2020-21

Dated: 19.08.2020

NOTIFICATION

Sub: Minor changes in the syllabus of M.Sc. Microbiology & Ph.D. program from the Academic Year 2020-21.

Ref: 1. Decision of Board of Studies in Microbiology (PG) meeting held on 20.12.2019.
2. Decision of the Faculty of Science & Technology Meeting held on 18.02.2020.
3. Decision of the Academic Council meeting held on 18.06.2020.

*****

The Board of Studies in Microbiology (PG) which met on 20.12.2019 has recommended to make minor changes in the existing syllabus of M.Sc. Microbiology program & Ph.D. program from the Academic Year 2020-21.

The Faculty of Science and Technology and Academic Council meeting held on 18.02.2020 and 18.06.2020 respectively have approved the above said proposal and the same is hereby notified.

The modified syllabus of M.Sc. Microbiology & Ph.D. program is annexed. The contents may be downloaded **from the University Website i.e., www.uni-mysore.ac.in**.

Draft approved by the Registrar

Deputy Registrar(Academic),
Deputy Registrar (Academic)
University of Mysore
Mysore-570 005

To:

1. The Registrar (Evaluation), University of Mysore, Mysore.
2. The Dean, Faculty of Science & Technology, DoS in Psychology, Manasagangotri, Mysore.
3. The Chairperson, BoS in Microbiology, DoS in Microbiology, Manasagangotri, Mysore.
4. The Chairperson, Department of Studies in Microbiology, Manasagangotri, Mysore.
5. The Director, College Development Council, Moulya Bhavan, Manasagangotri, Mysore.
6. The Deputy/Assistant Registrar/Superintendent, AB and EB, UOM, Mysore.
7. The P.A. to the Vice-Chancellor/Registrar/Registrar (Evaluation), UOM, Mysore.
8. Office file.

UNIVERSITY OFMYSORE

Program: M. Sc. Microbiology

Credit based Choice Based Continuous Evaluation Pattern System
(B.Sc. Honors and M. Sc. Microbiology)
76 credits course

Department of Studies in Microbiology
Manasagangotri
Mysuru – 570 006
2020 -21

Introduction

Microbiology is an important and wide-ranging discipline within the life sciences, covering a range of subjects relevant to human health, diseases, environmental studies and industrial and biotechnological application. Microbiology has vast scope in understanding the life through intervention of microorganism. There is an increase in demand for microbiologist globally. A microbiologist can innovate new diagnostic kits, teach, research, discover new drugs etc., it encompasses many disciplines of science like medicine, diary agriculture pharmacy nanotechnology etc.,

Knowledge and skills in Microbiology that will empower the students, through awareness of the significance of microorganisms in plant, animal and human health, environment, industry and general human welfare by a problem based and skill-oriented curriculum. The syllabus is highly oriented towards the complete knowledge of the subject, which includes the basic as well as contemporary applied aspects of Microbiology including molecular biology and genetic engineering.

Program Pedagogy:

The seminar presentation will improve the oration skills of students and group discussion will kindle their logical ability to analyze the problems**.** Assignments improvise students in gathering the information and enhancing their writing ability. In practical laboratory they will be enhancing their skills towards various techniques used in the laboratory. As a part of curriculum, students work on project, which will give a hands-on experience on different techniques and will be a platform for the students to work and interact with different scientists and research institutions. This will pave the way for the students to know about recent research works going on in the field and help the student in working in different amenities.

Program outcome:

- The students get to know about different beneficial and harmful microorganisms, which might be useful /pathogenic to humans, animals and plants.
- Microbiology is concerned with diversified forms of microorganism, classification, structure, reproduction, physiology, metabolism and most importantly their economic importance
- Industrial productions of organic acids, enzymesand pest control using microbes and improving soil quality and agricultural output and cleaning the environment through sustainable microbiological applications.
- To enable them to employ the acquired theoretical knowledge in the sector of Disease diagnosis, treatment and prevention.
- To enrich the post graduate students with fundamentals of microbiology and advanced technologies, which enables them use this knowledge in industry, hospitals, community and institutes or any other profession they would like to pursue.

Program specific outcome:

Understand the basic knowledge and concepts of microbiology and other related areas. Hands on skills in Industry and/or Institutes, for better placement in drug manufacturing companies, public health entities, blood service, industrial laboratories, cancer research institutes, R&D, educational institutes, environmental pollution control, agriculture and fisheries, food and dairy industry, forensic science, hospitals, public health laboratories, etc. There is requirement for microbiologist in quality control and safety sections of food, pharmaceuticals, health and beauty care, etc.

SCHEME OF THE STUDY

Credits to be earned	40 credits
Core papers	16 credits
Open elective paper	04 credits
Transborder /cross disciplinary/ Discipline centric elective papers	16 credits
Project work / term work	04 credits

For B.Sc. (Honors) in Microbiology

Credits to be earned	40 credits
Cumulative total of credits to be completed	40 (Honors)+ 36 (Masters) = 80 credits
Core papers	20 credits
Transborder /cross disciplinary/ Discipline centric elective papers	12 credits
Project work / term work	08 credits

For M. Sc. in Microbiology

Honors in Microbiology

Credit Based Choice Based Continuous Evaluation Pattern System

Proposed Semester-wise distribution of the course structure for the year 2020-2021

Semester-I Credits: 20

No	Paper Code	Title of The Course Paper	Credit Pattern in L:T:P	Credits
1	**MB 1.1 Hardcore**	Virology	3:1:0	4
2	**MB 1.2 Hardcore**	Bacteriology	3:1:0	4
3	**MB 1.3 Hardcore**	Mycology	3:1:0	4
		Select 3 among 4 papers		
4	**MB 1.4 Softcore**	Microbial Genetics	3:1:0	4
5	**MB 1.5 Softcore**	Microbial Ecology & Diversity	3:1:0	4
6	**MB 1.6 Softcore**	Practical I (Virology & Bacteriology)	0:0:2	2
7	**MB 1.7 Softcore**	Practical II (Mycology & Microbial Genetics)	0:0:2	2

HC= 03; SC=03; O.E=0.

Semester-II Credits: 20

No	Paper Code	Title of The Course Paper	Credit Pattern in L:T:P	Credits
1	**MB 2.1 Hardcore**	Microbial Physiology	3:1:0	4
2	**MB 2.2 Hardcore**	Immunology	3:1:0	4
		Select 3 among 4 papers		
3	**MB 2.3 Softcore**	Food Microbiology	3:1:0	
4	**MB 2.4 Softcore**	Soil Microbiology	3:1:0	4
5	**MB 2.5 Softcore**	Practical III (Microbial Physiology & Immunology)	0:0:2	2
6	**MB 2.6 Softcore**	Practical IV (Food Microbiology)	0:0:2	2
7	**MB 2.7 OE**	**Microbial Diversity**	**2:2:0**	4

HC= 02; SC=03; O.E=1.

M. Sc. Microbiology

Credit Based Choice Based Continuous Evaluation Pattern System
Proposed Semester-wise distribution of the course structure

Semester-III Credits: 20

No	Paper Code	Title of The Course Paper	Credit Pattern in L:T:P	Credits
1	**MB 3.1 Hardcore**	Molecular Biology	3:1:0	4
2	**MB 3.2 Hardcore**	Genetic Engineering	3:1:0	4
3	**MB 3.3 Hardcore**	Industrial Microbiology	3:1:0	4
		Select 3 among 4 papers		
4	**MB 3.4 Softcore**	Medical Microbiology	3:1:0	4
5	**MB 3.5 Softcore**	Clinical & Diagnostic	3:1:0	4
6	**MB 3.6 Softcore**	Practical V (Molecular Biology & Genetic Engineering)	0:0:2	2
7	**MB 3.7 Softcore**	Practical VI (Industrial Microbiology & Medical Microbiology)	0:0:2	2
8	**MB 3.8 OE**	**Techniques in Microbiology**	1:1:0	2

HC= 03; SC=03; O.E=01.

Semester-IV Credits: 16

No	Paper Code	Title of The Course Paper	Credit Pattern in L:T:P	Credits
1	**MB 4.1 Hardcore**	Agricultural Microbiology	3:1:0	4
		Select 2 among 3 papers		
2	**MB 4.2 Softcore**	Environmental Microbiology	2:0:0	2
3	**MB 4.3 Softcore**	Genomics & Proteomics	2:0:0	2
4	**MB 4.4 Softcore**	Practical VII (Agricultural Microbiology& Environmental Microbiology)	0:0:2	2
5	**MB 4.5 Hardcore**	Project Work	0:2:6	8

HC= 01; SC=02; PW=01

Grand Total Credits: 76

SEMESTER I
MB 1.1 Hardcore: VIROLOGY

Course Pedagogy:

- Knowledge on history, general characters of viruses and viral classification
- Understanding the replication strategies of viruses; Cultivation and detection of viruses.
- Comprehend evolutionary importance of viruses.
- Knowledge on some common plant and animal diseases caused by different viruses, viral transmission and control.

Course Outcome:

After the completion of the course students would be able

- To study the nature of viruses.
- Techniques employed for culturing and detection of plant and animal viruses
- To gain knowledge about newer emerging viral
- To unravel the mechanisms by which viruses infect cells and cause disease.
- Viruses used as cloning vectors for gene transfer, therapeutic agents.

THEORY **32hours**

UNITI **8 hours**

Viral Diversity: Classification – LHT, Baltimore & ICTV; and nomenclature of viruses.
Replication patterns of the following groups;
Group I – T2 Bacteriophage, Group II – Banana bunchy top virus, Group III – Reovirus, Group IV- TMV, Group V – Rhabdovirus, Group VI – HIV and Group VII – Hepatitis B virus.
Microbial viruses: General account on algal, fungal, protozoanviruses, Giant viruses and Bacteriophages.

UNITII **8hours**

Propagation, purification, characterization and identification of plant viruses: General methods of propagation of plant viruses; purification using centrifugation, chromatography and electrophoresis techniques. Methods employed in identification of plantviruses. Detection and diagnosis of Plant Viruses
Cultivation and detection of viruses: Animal Inoculation, Inoculation into embryonated egg and Cell Culture. **Direct methods of detection**- light microscopy (inclusion bodies), electron microscopy (SEM, TEM, AFM and Cryo EM) and fluorescence microscopy. **Immunodiagnosis:**hemagglutination and hemagglutination inhibition test, compliment fixation, neutralization, western blot, flow cytometry. **Nucleic acid based diagnosis:** nucleic acid hybridization, PCR, qRT, Microarray and nucleotide sequencing.
Infectivity assay for animal and bacterial viruses: Plaque assay, Transformation assay, Fluorescent focus assay, Infectious centre assay, end point dilution methods, $LD_{50,}$ ID_{50}, EID_{50}, $TCID_{50}$.

UNITIII **8hours**

Sub-viral particles: Discovery, Structure, Classification, replication and diseases caused by Satellite virus, Virusoids, Viroids andPrions.

Anti-viral strategies-prevention and control of viral diseases: Host specific and nonspecific defense mechanisms. Role of interferon in viral infections. Viral Chemotherapy: Nucleoside analogs, reverse transcriptase inhibitors, protease inhibitors. Conventional viral vaccines: killed and attenuated. Modern vaccines: subunit vaccines, peptide vaccines, edible vaccines, immunomodulators (cytokines) antiidiotype and DNA vaccines.

UNITIV **8hours**

Viral transformation and oncogenesis: Oncogenic viruses, viral transformation via cell cycle control pathways, activation of cellular signal pathways and other mechanisms

Viruses and the future: Promises and problems.Evolutionary importance ofviruses**:** Antigenic shift, antigenic drift. Newly emerging and life threatening diseases – Ebola, Marburg, Machupo viruses, sources and causes of emergent virusdiseases.The threat of bioterrorism, viruses as therapeutic agents, viruses for gene delivery, using viruses to destroy other viruses, viruses and nanotechnology.

References:

1. Alan J. Cann (2011) Principles of Molecular Virology, 5th edition, Elsevier
2. Clokie, Martha R. J., Kropinski, Andrew (2009) Bacteriophages, Methods and Protocols, Volume 1: Isolation, Characterization, and Interactions, Humana Press
3. Edward K. Wagner, Martinez J. Hewlett, David C. Bloom , David Camerini (2007), Basic Virology, 3rd Edition, John Wiley &Sons.
4. Hunter-Fujita, Frances R., Philip F. Entwistle, Hugh F. Evans, and Norman E. Crook. Insect viruses and pest management. John Wiley & Sons Ltd 1998.
5. Jane S. Flint , Lynn W Enquist, Anna Marie Shalka (2004) Principles of Virology: Molecular Biology, Pathogenesis, and Control of Animal Viruses, American Society for Microbiology
6. John Carter, Venetia A. Saunders,(2007),Virology: Principles and Applications, John Wiley & Sons, west Susscex ,England.
7. Lobocka, Malgorzata, and Waclaw T. Szybalski, eds. (2012) Bacteriophages. Part 2 , Academic Press
8. Marc H.V. van Regenmortel, Brian W.J. Mahy (2009) Desk Encyclopedia of General Virology, I edition, Academic Press.
9. Matthews, Richard Ellis Ford, and Roger Hull. (2002) Matthews' plant virology. 4th edition, Gulf Professional Publishing.
10. Moulay Mustapha Ennaji (2020), Emerging and Reemerging Viral Pathogens: Volume 1: Fundamental and Basic Virology Aspects of Human, Animal and Plant Pathogens 1st Edition. Academic Press.
11. Nigel Dimmock, Andrew Easton, Keith Leppard, (2009), Introduction to Modern Virology, 6thEdition,Wiley-Blackwell.

MB 1.2 Hardcore: BACTERIOLOGY

Course Pedagogy:

- To study the scope, history, economic importance, cell structure, growth, cultivation and control of bacteria.
- Working principles of microscopy and staining.

Course Outcome:

After the completion of the course students would be able:

- To know bacterial classification, nutrition, cultivation, preservation of microbial culture.
- To describe the morphological features, cell arrangement and structural components of bacterial cell.
- To enlist the characteristics of archaea.
- To use different microscopes for studying bacterial morphology.
- To work in medical laboratories, pharmacological, food and fermentation industries.

THEORY **32 hours**

UNITI **8hours**

Introduction: Important events in development of bacteriology, Scope and relevance of bacteriology. Economic importance of bacteria.

Cell Structure: An overview of bacterial size, shape and arrangement, structure, chemical composition of cell wall of Archaebacteria, gram-negative bacteria, gram-positive bacteria and acid fast bacteria, cell wall deficient organisms including L-form structure, composition and function of cell membrane, capsule, flagella, pili, Inclusion bodies, ribosomes, mesosomes, reserve food materials , magnetosomes and phycobilisomes, endospores, bacterial nucleic acids – chromosome, plasmid, transposons, integrons and antibiotic resistance cassettes.

Microscopy: Working Principles of bright field microscope, fluorescent microscope, dark field microscope, phase contrast microscope, stereo microscope, confocal microscopy and electron microscope. Preparation of sample for electron microscopic studies.Application and importance of above microscopes.Measurement of microscopicobjects.

UNIT II **8 hours**

Bacterial classification and taxonomy: Criteria for the classification of bacteria. Phenetic, Phylogenetic, Genotypic, Numerical taxonomy. Techniques for determining microbial taxonomy and Phylogeny.ICNBrules. Classification systems of major categories and groups of bacteria according to Bergey are manual of Systematic Bacteriology and Determinative Bacteriology. Non-culturable methods for the identification of pathogenic microorganisms.

UNIT III **8 hours**

Growth, Cultivation and control of Bacteria: Nutrient requirements, nutritional types of bacteria, culture media, classification of media.Growth:Nutritional uptake, Growth kinetics, generation time, growth curve, factors affecting growth. Methods for measurement of microbial growth – direct microscopy, viable count estimates, turbidometry, and biomass. Aerobic, anaerobic, batch, continuous and synchronous cultures.Methods of pure culture isolation, Enrichment culturing techniques, single cell isolation, and pure culture development. Preservation and Maintenance of Microbial cultures: Repeated sub culturing, preservation at low temperature, sterile soil preservation, mineral oil preservation, deep freezing and liquid nitrogen preservation, lyophilization. IUBS – International Union of Biological Sciences.World federation for culture collections – guidelines, statuets and by laws.

Control of microorganisms: Antimicrobial agents, physical and chemical methods. Principles, functioning and types of Biosafety cabinets.

UNIT IV **8 hours**

Characteristics and Salient features of major groups of Bacteria: Archaebacteria: general characteristics and classification; extremophiles, halophiles, thermophiles and barophiles; General characteristics, classification, diversity and distribution, economic importance of **Actinomycetes, Cyanobacteria**. **Bioluminescent bacteria;** characteristics and examples, mechanism of bioluminescence. General characteristics, life cycle, growth, multiplication and significance of **Mycoplasma, Rickettsiae and Chlamydia**

References:

1. Alfred Brown (2011) Benson's Microbiological Applications Short Version (Brown, Microbioligical Applications), 12th edition, McGraw-Hill Science/Engineering/Math.
2. Jacquelyn G. Black (2012) Microbiology: Principles and Explorations,8th edition, Wiley.
3. Jeffrey C. Pommerville (2010) Alcamo's Fundamentals of Microbiology, 9th Revised edition, Jones and Bartlett Publishers, Inc
4. Jeffrey C. Pommerville (2010) Alcamo's Laboratory Fundamentals of Microbiology, Jones and Bartlett Publishers, Inc.
5. Jerome J. Perry, James Staley, Stephen Lory (2002), Microbial Life, Sinauer Associates.
6. Mara, Duncan, and Nigel J. Horan, (2003) . Handbook of water and wastewater Microbiology, Academic Press.
7. Michael J. Leboffe, Burton E. Pierce , David Ferguson (2012) Microbiology Laboratory Theory & Application, Brief, 2nd Edition, Morton Publishing Company
8. Michael T. Madigan, David P. Clark, David Stahl, John M. Martinko, 2012, Brock Biology of Microorganisms 13th Edition, Benjamin Cummings
9. Sherwood, and Woolverton Willey (2007), Prescott, Harley, and Klein's Microbiology (7th International Edition),McGraw-Hill
10. Stuart Hogg (2013) Essential Microbiology, 2nd Edition, Wiley-Blackwell

MB 1.3 Hardcore: MYCOLOGY

Course Pedagogy:

- It includes the study of taxonomic classification, fungi as symbionts.
- Fungi in production of food supplements like SCP, vitamins, enzymes, organic acids and production of secondary metabolites like antibiotics.
- In practical classes they mount the fungi, learn microscopic views and the key characteristics to identify different species of fungi.

Course outcome:

After the completion of the course students would be able

- To understand the general characteristics and reproduction in fungi and lichens.
- To understand the economic and pathological importance of fungi.
- To identify common fungal plant diseases and device control measures and work as plant doctor.

THEORY **32 hours**

UNIT I **8hours**

Introduction: History and Development of Mycology, scope of mycology. Recent developments in Mycology.

Fungal taxonomy: Taxonomic problems associated with variation in fungi, Classification of fungi (Alexopoulos andMims).

UNIT II **8hours**

General characteristics of fungi and reproduction: Morphology and somatic structures: The thallus, organization, fungal cell, nuclear components, specialized somatic structures; Aggregation of hyphae, tissues, mycangia, General aspects of fungal nutrition and reproduction (Asexual, Sexual reproduction, Heterothalism and Parasexuality)

UNIT III **8 hours**

Salient features of fungal major groups: Chytridiomycota, Zygomycota ,Basidiomycota, Ascomycota, Deuteromycota, Oomycota, Hypochytriomycota, Labyrinthulomycota, Plasmodiophoromycota and Myxomycota. Symbiotic fungi- Lichens.

UNIT IV **8 hours**

Economic importance of fungi: Fungi as biocontrol agent, Economic importance of Fungi in Agriculture, Industry and medicine. Fungi as SCP, Fungi as parasites of human and plants.Role of fungi in bio-deterioration of wood and paper.Mycorrhiza – ectomycorrhiza, endomycorrhiza, vesicular arbuscularmycorrhiza. Fungi as insect symbionts.

Important metabolites of Fungi – aflatoxin, Ochratoxin, Ergot alkaloids, T-2 toxin, DON, Fumonisin.Impact of mycotoxins on human health.Importance of secondary metabolites of fungi as nephrotoxins, neurotoxins, hapatotoxins, mutagens/carcinogens.

Reference:

1. Alexopoulas C J and Mims C W, 1979 Introductory Mycology 3rd edn, Wiley Eastern.,NewDelhi.
2. David Moore, Geoffrey D. Robson, Anthony P. J. Trinci (2011) 21st Century Guidebook to Fungi. Cambridge University Press.
3. Deacon, J W, 1997- Modern Mycology 3rd Edition, Blackwell Science publishers, London.
4. Kevin Kavanagh (2011) Fungi: Biology and Applications. John Wiley & Sons, Sussex,U.K.
5. Mehrotra, RS &Aneja, K R, 1998. An Introduction to Mycology. New Age International Pvt. Ltd. New Delhi.
6. Mercedes S. Foster& Gerald F. Bills (2011) Biodiversity of Fungi: Inventory and Monitoring Methods. Academic Press
7. Michael John Carlile, Sarah C. Watkinson, G. W. Gooday (2007) The fungi. Academic Press. London, U. K
8. Odum, E.P. 1971. Fundamentals of Ecology; Third Edition. Toppan Co. Ltd. Tokyo,

Japan.

MB 1.4 Softcore: MICROBIAL GENETICS

Course Pedagogy:

- Describe the fundamental molecular principles of genetics.
- Understand the relationship between phenotype and genotype.
- Describe the basics of genetic mapping.
- Understand how gene expression is regulated

Course Outcome:

After the completion of the course students would be able

- To Understand the Genetic constituent's of bacteria with special emphasis on inheritance.
- To extend the knowledge on molecular basis of mutation at microbial level.
- To focus on gene regulation and expression mechanisms.
- To understand the principles role of plasmids and gene transfer methods and mapping.

THEORY **32 hours**

UNITI **8hours**

Concepts in Microbial Genetics: History and developments of Microbial genetics. Essentials of microbial genetics: Microbes as Genetic Tools for Basic and Applied Genetic studies. Advantages and disadvantages of Microbes, Generalized reproductive cycles of microbes- *Neurospora*, *Saccharomyces*, *Chlamydomonas*and*Acetabularia.*

UNIT II **8 hours**

Viral Genetics: Lytic and Lysogenic cycles, Phage Phenotypes, Phenotypic Mixing, Recombination in viruses: Mutations, Recombination and Mapping (rII loci)

Bacterial Genetics: Bacterial Transformation: Types of transformation mechanisms found in prokaryotes, Bacterial Conjugation: properties of the F plasmid, F+ x F - mating, F' x F- conjugation, Hfr conjugation, gene mapping in bacteria. Transduction: Generalized and specialized transduction, Transposable elements.

UNIT III **8 hours**

Fungal Genetics: *Neurospora*- Tetrad analysis and linkage detection - 2 point and 3 point crosses, chromatid and chiasma interference, Mitotic recombination in *Neurospora*and *Aspergillus*.

Algal Genetics: *Chlamydomonas*- unordered tetrad analysis - Recombination and Mapping, Nucleocytoplasmic interactions and gene expression in *Acetabularia*. Extra nuclear (Cytoplasmic) inheritance.

UNIT IV **8 hours**

Mutation and mutagenesis: Nature, type and effects of mutations. Mutagenesis – physical and chemical mutagens, base and nucleoside analog, alkylating agents, interrelating agents, ionizing radiation. Induction and detection of mutation in microorganisms. Site directed mutagenesis and its applications.

References:

1. D. Peter Snustad, Michael J. Simmons (2011) Principles of Genetics, 6th Edition; Wiley
2. Dr. Evelyn J. Biluk (2012)Microbiology Study Guide: Microbial Genetics, Controlling Microbial Growth, and Antimicrobial Agents; Create Space Independent Publishing Platform
3. James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick (2013) Molecular Biology of the Gene, 7 edition; Benjamin Cummings
4. Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick (2012) Lewin's GENES XI, 11 edition; Jones & Bartlett Learning
5. John R. S. Fincham (1996) Microbial and Molecular Genetics; Hodder Arnold
6. Larry Snyder, Joseph E. Peters, Tina M. Henkin, Wendy Champness (2013) Molecular Genetics of Bacteria, 4th Edition; ASM Press
7. Nancy Jo Trun, J. E. Trempy (2003) Fundamental Bacterial Genetics; Wiley-Blackwell
8. Royston C. Clowes, William Hayes (1968) Experiments in Microbial Genetics; Blackwell Science Ltd
9. Sriram Sridhar (2005) Genetics and Microbial Biotechnology; Dominant Publishers &Distributors
10. Stanley R. Maloy, Jhon E. Cronan, Jr. David Freifelder (1994) Microbial Genetics (Jones and Bartlett Series in Biology),2nd edition; Jones and Bartlett Publishers
11. Uldis N. Streips, Ronald E. Yasbin (2002) Modern Microbial Genetics, 2nd edition; Wiley-Liss
12. Venetia A. Saunders (1987) Microbial genetics applied to biotechnology :principles and techniques of gene transfer and manipulation; Springer

MB 1.5 Softcore: MICROBIAL ECOLOGY AND DIVERSITY

Course Pedagogy:

- To understand the ubiquitous nature of microbes.
- To give basic knowledge on extremophiles.
- To provide knowledge on characteristics of Microbes.

Course Outcome:

After the completion of the course students would be able

- Students able to differentiate various groups of Microbes.
- Get knowledge on adaptability of extremophiles.
- Knowledge about microbial taxonomy.

THEORY **32 hours**

UNITI **8hours**

Introduction to microbial ecology: Structure of microbial communities. Interaction among microbial populations.Interaction between microorganisms and plants.Biotransformation, biodegradation, bioremediation and phytoremediation. Ecological and Evolutionary diversity (Genetic diversity) of microbial world

Development of Microbial communities: Dynamics of community, ecological succession, structure, dispersion, microbial communities in nature and ecosystem models

UNIT II **8 hours**

Physiological Ecology of microorganisms: Adaptation to environmental conditions - abiotic limitations to microbial growth.

Viral Diversity: Group I – T2 Bacteriophage, Group II – Banana bunchy top virus, Group III – Reovirus, Group IV- TMV, Group V – Rhabdovirus, Group VI – HIV, Group VII – Hepatitis virus.

Sub-viral particles: Discovery, Structure, Classification, replication and diseases caused by Satellite, Satellites virus, Virusoids, Viroids and Prions.

UNIT III **8 hours**

Bacterial Diversity: Archaebacteria, Photosynthetic Eubacteria, Chemoautotrophic and Methophilic Eubacteria, Gliding Eubacteria, Spirochetes, Rickettsiae and Chlamydiae, Actinomycetes, Mollicutes, Protists

Fungal Diversity: salient features of the following group: Zygomycota (*Rhizopus*), Ascomycota *Neurospora*), Basidiomycota (*Agaricus*), Deuteromycota (*Penicillium*), Chytridiomycota (*Allomyces*) Myxomycota and Yeast.

UNIT IV **8 hours**

Importance and Conservation of Microbial Diversity: Importance of microbial diversity in environment, pharmaceuticals & human health. Metagenomics.Importance of conservation.*In situ* conservation and *Ex situ* conservation. Role of culture collection centers in conservation.

References

1. Atlas, Ronald M., Bartha, Richard (1997) Microbial Ecology Fundamentals and Applications; Addison-Wesley
2. Colwell, R. R., Simidu, Usio, Ohwada, Kouicki (1996) Microbial Diversity in Time and Space; Springer
3. David L. Kirchman (2008) Microbial Ecology of the Oceans; Wiley-Liss
4. David L. Kirchman (2012) Processes in Microbial Ecology; Oxford University Press
5. James W. Brown (2014) Principles of Microbial Diversity; ASM Press
6. McArthur, J. Vaun (2006) Microbial Ecology An Evolutionary Approach; Academic Press
7. Nelson, Karen E. (1997) Advances in Microbial Ecology; Springer
8. OladeleOgunseitan (2004) Microbial Diversity: Form and Function in Prokaryotes; Wiley-Blackwell
9. OladeleOgunseitan (2008) Microbial Diversity: Form and Function in Prokaryotes; Wiley-Blackwell
10. Osborn, A. M., Smith, Cindy (2005) Molecular Microbial Ecology; Taylor & Francis

Group
11. Pierre Davet (2004)Microbial Ecology of the Soil and Plant Growth; Science Pub Inc
12. Ronald M. Atlas, Richard Bartha (1997) Microbial Ecology: Fundamentals and Applications (4th Edition); Benjamin Cummings
13. Satyanarayana, T., Johri, B. N. (2005) Microbial Diversity: Current Perspectives and Potential Applications; I.K. International Publishing House Pvt., Limited

MB 1.6 Softcore: Practical I (Virology and Bacteriology)

1. Laboratory safety rules
2. Microscopic measurement of microorganisms by micrometry
3. Culturing and maintenance of bacterial cultures
4. Isolation and enumeration of bacteria from soil
5. Isolation and enumeration of bacteria from water
6. Cultural characteristics of bacteria
7. Staining techniques – simple (positive and negative), differential (Grams and acid fast), structural (endospore and capsule)
8. Motility test (hanging drop method and soft agar method)
9. Biochemical tests for the identification of bacteria – catalase, oxidase, IMViC, Urease, TSIA, Nitrate reduction, gelatine, starch, casein, chitin and esculin hydrolysis.
10. Determination of growth curve in *E.coli*.
11. Diauxic growth curve in *E.coli*
12. Isolation of coliphages from sewage
13. Study of morphological changes due to viral infection in plants

MB 1.7 Softcore: Practical II (Mycology and Microbial Genetics)

1. Isolation of slime molds.
2. Isolation of aquatic fungi.
3. Isolation of soil fungi.
4. Isolation of fungi from air.
5. Isolation of fungi from cereals and cereal based products.
6. Study of the following representative genera: *Aspergillus, Penicillium, Fusarium, Neurospora, Saccharomyces, Erysiphae, Polyporus, Agaricus, Puccinia, Ustilago, Alternaria, Drechslera, Saprolegnia, Rhizopus, Trichoderma*and symbiotic fungi-Lichens.
7. Measurement of concentration of fungal conidia by Haemocytometer.
8. Measurement of fungal cells by Micrometer.
9. Replica plating technique for transfer of bacterial colonies.
10. Ultra-violet killing curve and determination of mutant types in *Saccharomyces cerevisiae.*
11. Induction of mutation
12. Isolation of streptomycin resistant strain of *E .coli* by gradient plate method.
13. Ames test
14. Isolation of genomic DNA from bacteria by heat lysis method.
15. Isolation of genomic DNA from yeast by DNA spooning method.

16. Extraction of mycotoxins and detection by TLC.

SEMESTER II

MB 2.1 Hardcore: MICROBIAL PHYSIOLOGY

Course Pedagogy:

- To develop understanding about microbial metabolism, growth and energy generation.
- Gain knowledge of various fermentation pathways, microbial communication and energetics.
- To acquire knowledge on microbial stress response.

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Course Outcomes:

After the completion of the course students would be able.

- To acquaint with basics of metabolism and growth under normal and stressed conditions.
- To understand major fermentation, aerobic and anaerobic pathways for energy generation in microbial cells.
- To know the concepts of microbial cross-talk.

THEORY **32 hours**

UNITI **8hours**

Microbial bioenergetics: The role of ATP in metabolism. Microbial enzymes and mechanism of Enzyme actions.Inhibition and regulation – allosteric, feedback, competitive, non-competitive.

Metabolism of Carbohydrate: Glycolysis, Citric acid Cycle and different types of Phosphorylation, Fates of pyruvate, Fermentation. Utilization of sugars other than glucose: Lactose, Galactose, Maltose, Mannitol. Degradation of cellulose, Starch and Glycogen.

UNITII **8 hours**

Lipid metabolism: β-oxidation, Biosynthesis of fatty acids, degradation of fatty acids.

Nitrogen metabolism: Nitrogen metabolism, Biological nitrogen fixation process, symbiotic and non-symbiotic nitrogen fixation. Degradation and biosynthesis of essential and non-essential amino acids.**Nucleic acid metabolism**: Biosynthesis and degradation of purines and pyrimidines.

UNIT III **8 hours**

Microbial Photosynthesis: Photosynthetic Pigments and apparatus in bacteria. Oxygenic and Anoxygenic.Photosynthesis.Autotropic CO2 fixation and mechanism of Photosythesis.Utilizationof light energy by Halobacteria.

Autotrophic Mechanisms in bacteria: Hydrogen bacteria, Nitrifying bacteria, Purple sulphur bacteria, Non-sulfur bacteria, Green sulfur bacteria, Iron bacteria, Methylotrophs.

UNIT IV **8 hours**

Microbial Signaling and Stress response: Two Component signal transduction in prokaryotes: Chemotaxis, Quorum sensing, biofilms, response to anti microbials, sporulation inducing signals and events in sporulation; Dormancy, osmolarityporin regulation in *E. coli* (*Omp* system), phosphate assimilation in *E. coli* (Pho systems), Nitrogen fixation in *Klebsiella* and *Rhizobium* (Ntr system). Oxidative stress, Thermal stress, Starvation stress, Aerobic to anaerobic transitions.

References:

1. Albert G. Moat,Michael P. Spector John W. Foster (2009) Microbial Physiology,;BWSTM
2. Albert G. Moat,Michael P. Spector John W. Foster (2009) Microbial Physiology;BWSTM
3. Byung Hong Kim,Geoffrey Michael Gadd (2008) Bacterial Physiology and Metabolism; Cambridge UniversityPress
4. Daniel R.Caldwell (1999) Microbial Physiology and metabolism ; Star PubCo
5. Daniel R.Caldwell (1999) Microbial Physiology and metabolism,; Star PubCo
6. David White, James Drummond , Clay Fuqua (2011)The Physiology and Biochemistry of Prokaryotes, Oxford UniversityPress
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8. Robert K. Poole (2014) Advances in Microbial Systems Biology, Volume 64 (Advances in Microbial Physiology); AcademicPress
9. Rose, Anthony H. ()Advances in Microbial Physiology, Vol. 9; Elsevier Science & Technology Book
10. Rose, Anthony H. (1976) Chemical Microbiology An Introduction to Microbial Physiology; Basic Books

MB 2.2 Hardcore: Immunology

Course Pedagogy:

- To provide overview of immune system, antigen, antibody structure and interactions.
- Understanding of innate and adaptive immunity along with major cells and molecules involved.
- To integrate immunology with health and enrich the knowledge for autoimmune disorders, hypersensitivity reaction.

Course Outcomes:

After the completion of the course students would be able

- To gain knowledge of immune system, cells involved along with complement system and autoimmunity.
- To evaluate the usefulness of immunology in different pharmaceutical companies
- To understand immune system, antigen antibody interactions.

- To gain theoretical knowledge of various diseased conditions generated due to interplay of immune system components

THEORY **32 hours**

UNIT I **8hours**

Introduction to Immunology: An overview of immune system, Phagocytes, Natural killer cells, mast cells, basophils, Dendritic cells and other cells of the inmate immune system. Immunity**:** Types- Innate immunity: (nonspecific) physical, biochemical and genetic factors involved in governing innate immunity, molecules of inmate immunity – complement, acute phase proteins and interferons; Chemokines and Cytokines . Acquired immunity: (specific) natural, artificial, passive immunity, humoral or antibody mediated immunity, cell mediated immunity.

Antigens and Antibodies: Antigen processing and presentation, properties of antigen, Super antigen, Hapten; Haptens and the study of antigenicity Microbes as antigen Antigen recognition and MHC molecules. Antibodies (Immunooglobulins) – structure and function, clonal selection, monoclonal antibodies and its clinical applications, Antibody engineering (Construction of monoclonal antibodies Lymphoma and other diseases by genetically engineered antibodies).

UNITII **8 hours**

Hypersensititivity: Hypersensitivity reactions, Types and their roles in Immunopathological processes.

Autoimmune processes: Immunologic tolerance, genetic predisposition to the development of autoimmune processes. Autoimmune disorders- Immunopathogenesis of celiac disease, myasthenia gravis, sclerosis multiplex, psoriasis vulgaris**,** Rheumatoid arthritis) Immunodeficiency diseases, Hormones and environmental factors in induction of autoimmune processes.

UNITIII **8hours**

Transplantation of tissues and organs: Nomenclature of transplantations. Recognition of self and non-self Transplantation reactions HvG and GvH. Exception from rejections.Kidney and bone marrow transplantations.

Tumours and immune system: Etiology of malignant transformations of cells (physical, chemical and biological factors involved in). Immunological surveillance. Escape mechanisms of tumor cells from immunological surveillance. Metastatic processes. Immunodiagnosis and Immunotherapy.

UNITIV **8 hours**

Vaccines and Vaccination: Vaccines – definition, types, Antigens used as Vaccines, effectiveness of vaccines, Vaccine safety, current vaccines, adjuvants, active immunization and passive immunization. National vaccination schedule.

Manipulation of immune mechanisms: Immunoprevention, Immunoprophylaxis, Immunostimulatory and Immunosuppressive drugs.

Immunotechniques and Immunodiagnosis: Antigens and Antibody reactions *in vitro;* Agglutination, complement fixation, ELISA, Immunodiffusion, Immunoelectrophoresis, Immunoflourescence, Immunoprecipitation, Radioimmunoassay and serotyping.

References:

1. Abul K. Abbas (2014)Cellular and Molecular Immunology, ;Saunders
2. Abul K. Abbas , Andrew H. H. Lichtman , Shiv Pillai (2011)Cellular and Molecular Immunology; Saunders
3. Abul K. Abbas , Andrew H. H. Lichtman , Shiv Pillai (2012)Basic Immunology: Functions and Disorders of the Immune System, ;Saunders
4. Delves, Peter J., Martin, Seamus J., Burton, Dennis R.(2011)Roitt's Essential Immunology; Wiley& Sons, Incorporated, John.
5. George Pinchuk (2001) Schaum's Outline of Immunology; McGraw-Hill
6. Helen Chapel , ManselHaeney, SirajMisbah, Neil Snowden (2014) Essentials of Clinical Immunology; Wiley-Blackwell
7. Judy Owen , Jenni Punt, Sharon Stranford (2013) Kuby Immunology; W. H. Freeman
8. Louise Hawley, Benjamin Clarke, Richard J. Ziegler (2013) Microbiology and Immunology; LWW
9. Peter Parham (2009)The Immune System, 3rd Edition; Garland Science
10. William E. Paul (2012) Fundamental Immunology; LWW

MB 2.3: Softcore: FOOD MICROBIOLOGY

Course Pedagogy:

- The course aims to provide instruction in the general principles of food microbiology.
- The course covers the biology and epidemiology of food borne microorganisms of public health significance, including bacteria, yeasts, fungi, protozoa and viruses.
- Understand food spoilage microorganisms; the microbiology of food preservation and food commodities; fermented and microbial foods; principles and methods for the microbiological examination of foods; micro biological quality control, and quality schemes.
- To supplement the academic input of students by way of seminars, conferences, guest lectures and industry oriented projects/ visits.

Course Outcome:

After the completion of the course students would be able

- To understand the principles of microorganisms during various food-processing and preservation steps.
- To comprehend the interactions between microorganisms and the food environment, and factors influencing their growth and survival.
- To understand the significance and activities of microorganisms in food.
- To recognize the characteristics of food-borne and spoilage microorganisms, and methods for their isolation, detection and identification.
- To analyze the importance of microbiological quality control programme's in food production.
- To describe the rationale for the use of standard methods and procedures for the microbiological analysis of food.

THEORY **32 hours**

UNITI **8hours**

Introduction to food microbiology: Definition, concepts and scope. Food as substrate for microbes.Factors influencing microbial growth in food-Extrinsic and intrinsic factors.Principles of food preservation- Chemical preservatives and Food additives Asepsis-Removal of microorganisms, (anaerobic conditions, high temperatures, low temperatures, drying).Canning, processing for Heat treatment.

UNIT II 8 hours

Contamination and food spoilage: Cereals, sugar products, vegetables, fruits, meat and meat products, Fish and sea foods- poultry- spoilage of canned foods.

Dairy Microbiology: Microbiology of raw milk, Milk as a vehicle of pathogens, Prevention of contamination of raw milk, Microbiology of processed milk, Spoilage and defects fermented milk and milk products, Microbiological standards for milk and milk products. Cream and butter bacteriology.

UNIT III 8 hours

Food poisoning and intoxication: Significance of food borne diseases, Food poisoning and intoxication: Botulism, Listeriosis, *Bacillus cereus* food poisoning, Food borne Gastroenteritis by *Salmonella*, *Shigella*, *Vibrio, Campylobacter* and *Yersinia*, Staphylococcus and Staphylococcal enterotoxins, fungal spoilage and Mycotoxins. **Introduction to biowarfare**: Food and water as media to transmit food borne threat to health; policies and practices.

Food produced by Microbes: Microbial cells as food – single cell proteins, sea weed (algae), mushroom cultivation. Bioconversions- production of alcohol-fermented beverages- beer and wine.Genetically modified foods.

UNITIV **8 hours**

Detection of food-borne microorganisms: Culture, Microscopic and Sampling methods. Chemical: Thermostable nuclease *Limulus* Lysate for Endotoxins, Nucleic Acid (DNA) probes, DNA Amplification (PCR), Adenosine- Triphosphate Measurement, Radiometry, Fluoro-and Chromogenic substrates. Immunologic Methods: Fluorescent Antibody, Enrichment Serology, Salmonella 1-2. Test, Radioimmunoassay,ELISA.

Microbial indicators of food safety and quality control: Principles of quality control and microbiological criteria, Indicators of product quality and microbiological safety of foods, Hazard analysis, critical control points (HACCP), Good manufacturing process (GMP) Microbiological standards Codex Alimentarius and Food legislation with respect to FSSAI, NABL and ISO

References:

1. Adams M. R. and Moss M. O. 2007. Food Microbiology 3rd Edition. Royal Society of Chemistry.UK.
2. Ahmed E.Y. and Carlstrom C. 2003 Food Microbiology: A Laboratory Manual, John Wiley and Sons, Inc. NewJeresy.
3. Bibek Ray, ArunBhunia. 2013. Fundamental Food Microbiology, Fifth Edition. CRCPress
4. C Blackburn.2006. Food Spoilage Microorganisms. WoodheadPublishing.
5. Dongyou Liu. 2009. Molecular Detection of Foodborne Pathogens. CRCPress.
6. Elmer H. Marth, James Steele. 2001. Applied Dairy Microbiology, Second Edition. CRCPress.

7. Frazier W.C. and Westhoff C.D. 2008 Food Microbiology. Tata McGraw Hill Publishing Company Limited, New Delhi. IndianEdition.
8. Jay, James M., Loessner, Martin J., Golden, David A. 2004.Modern Food Microbiology. 7th ed. Springer
9. Marshall, Richard J. (Ed.). 2007. Food Safety.Springer.
10. Pina M. Fratamico, Arun K. Bhunia, and James L. Smith. 2008. Foodborne Pathogens: Microbiology and Molecular Biology. CaisterAcademicPress.
11. Pitt, John I., Hocking, Ailsa D. 2009. Fungi and Food Spoilage 3rd Edition.Springer.
12. Sperber, William H., Doyle, Michael P. (Eds.). 2010. Compendium of the Microbiological Spoilage of Foods and Beverages.Springer.
13. Stephen J. Forsythe. 2010. The Microbiology of Safe Food, 2nd Edition.Wiley-Blackwell.

MB 2.4: Softcore: SOIL MICROBIOLOGY

Course Pedagogy:

- Lectures are held with the help of slides, the laboratory lessons will be performed in a laboratory designed and equipped for microbiological practices.
- The laboratory practices will be performed in groups of students. The e-learning site will be used to provide teaching material and to communicate with the students.
- The interaction between teacher and students take place through tutorials, seminars and Intermediate written tests.

Course Outcome:

After the completion of the course students would be able

- To have knowledge about soil as an excellent habitat for multitude of microorganisms balancing the soil ecosystem.
- To be employable in the field of Agronomy/Soil Science
- To acquire skills and knowledge on the importance of microorganisms in biogeochemical cycles biological fertility of soil.

THEORY **32 hours**

UNIT I **8hours**

Soil Microbiology: Historical accounts and the "Golden Age" of soil microbiology and significant contributions of pioneer soil microbiologists.

Soil Microbial diversity: Soil as habitat for microbes; soil pH, temperature and soil atmosphere. Diversity and abundance of dominant soil microorganisms, Methods of isolation of soil microflora, soil organic matter decomposition,

UNIT II 8 hours

Biogeochemical cycles: Organic matter decomposition, humification.Carbon, sulphur, nitrogen and iron cycles in soil.

Soil microbe interaction - Antagonism, commensalism, mutualism, symbiosis, predators and parasite relationship and competition.Interaction of soil microflora with vascular plants - Rhizosphere, rhizoplane microorganisms, *Rhizobium, Azatobacter, Azospirillum, Cyanobacteria* and *Azolla*.

UNIT III 8 hours

Techniques to study soil organisms: Microbial biomass estimation**;** fumigation-incubation technique, fumigation-extraction method, substrate-induced respiration method and Using ATP or enzyme activity

Applied soil microbiology: soil microbial inoculants, Manipulations of soil microorganisms for agriculture, Soil environmental contaminants and Bioremediation, Microbial products- Plant growth promoting Hormones, Antibiotics, Toxins and Enzymes

UNIT IV 8 hours

Soil-Borne Diseases and Human Health: *Clostridium tetani*(tetanus), Toxoplasmosis, Aspergillosis, Actinomycosis.

Soil microorganisms in agro ecosystems: Types of microbial communities; soil microbial diversity: significance and conservation; effect of agricultural practices on soil organisms. Biological nitrogen-fixation: The range of nitrogen fixing organisms; mechanism of nitrogen fixation (biochemistry of nitrogenase); genetics of nitrogen-fixation; *Rhizobium*-Legume Association; Sym plasmids, N2 fixation by non-leguminous plants.

References:

1. Agrios, G. N. 2000. Plant pathology. Harcourt Asia Pvt.Ltd.
2. Bergersen, F.J. and Postgate, J.R. 1987. A Century of Nitrogen Fixation Research Present Status and Future Prospects. The Royal Soc.,London.
3. Buchanan, B.B., Gruissem, W. and Jones, R.L. 2000. Biochemistry and Molecular Biology ofPlants.
4. Burges, H.D. 1981. Microbial control of insect pests, Mites and plant diseases. Academic,London.
5. Dixon, R.O.D. and Wheeler, C.T. 1986. Nitrogen Fixation in plants. Blackie USA, Chapman and Hall, NewYork.
   I.K. International Pvt. Ltd.
6. Kannaiyan, S. 1999. Bioresources Technology for sustainable agriculture. Assoc. Pub. Co. New Delhi.
7. Mehrotra, R.S. 2000. Plant pathology. Tata McGraw-Hill Publishing CompanyLimited.
9. Metcalf, R.L. and Luckmann, W.H. 1994. Introduction to insect pest management 3ed edn. John Willey and Sons,Inc.
10. Motsara, I.M.R., Bhattacharyya, P. and Srivastava, B. 1995. Biofertilizer Technology, Marketing and usage-A source Book-cum- glossary- FDCO, New Delhi.
11. Somasegaran,PandH.J.Hoben,1994.HandbookforRhizobia;methodsinlegume*Rhizobium*Technology. Springer-Verlan, New York.

MB 2.5 Softcore: PRACTICAL III (Microbial Physiology and Immunology)

1. Population growth of yeast – *S. cerevisiae*.
2. Population growth of bacteria – *E. coli*.
3. Sugar fermentation tests.
4. Catalase activity.
5. Hydrolytic rancidity.
6. Casein hydrolysis.
7. Carbohydrate catabolism by microbes

8. Study of acid and pH stress tolerance by microbes.
9. Effect of molecular oxygen on microbial growth.
10. Effect of osmotic pressure on microbial growth.
11. Effect of relative humidity on microbial growth.
12. Effect of different wavelengths of light on microbial growth.
13. Immunological Methods used for organism detection – production of antibodies for use in laboratory testing.
14. Serological Diagnosis of Infectious diseases – Serologic test Methods.
15. Precipitin test, ELISA, OuchterlonyImmunodifusion test, Immuno electrophoresis, Complement fixation test.
16. Isolation of Antigens and raising antibodies from animals (from different Models),
17. Development of polyclonal antibodies, purification of antibodies.
18. WIDAL Test.
19. VDRL Test (RPR).
20. HBs Ag Test.
21. HCG test (Agglutination inhibition test).
22. Detection of RA factor.
23. CRP test.
24. ASO Test (Anti streptolysin 'O' Test).

MB 2.6 Softcore: PRACTICAL IV (FOOD MICROBIOLOGY)

1. Bacterial examination of drinking water by membrane filters technique.
2. Study of important microbes in the degradation of wastes.
3. Determination of TDT.
4. Determination of TDP.
5. Detection and quantification of AflatoxinB1.
6. Detection of food-borne bacteria by immunoassays.
7. Detection and enumeration of Microorganisms present in Utensils.
8. Isolation and identification of pathogenic microorganisms from canned food (ISO method).
9. Enumeration of bacteria in raw and pasteurized milk by SPC method (ISO method).
10. Determination of quality of a milk sample by MBRT.
11. Detection of number of bacteria in milk by breed-count method
12. Litmus milk test.
13. Microbial quality of milk products.
14. Microbiological examination of Ice-cream and Dairy products
15. Soil microbes interaction *In vitro* by dual culture method
16. Isolation, identification and enumeration of Rhizosphere and Rhizoplane microorganism
17. Isolation of *Rhizobium* from roots of leguminous plant.

MB 2.7: Open elective: MICROBIAL DIVERSITY

Course Pedagogy:

- To understand the ubiquitous nature and characteristics of microbes

- To impart knowledge on viral, bacterial, fungal diversity.
- Importance and conservation of microbial diversity.

Course Outcome:

After the completion of the course students would be able

- To differentiate various groups of Microbes.
- To learn about conservation methods.
- To have knowledge about the role of culture collection centers in conservation.

THEORY **32 hours**

UNIT I **8 hours**

Viral Diversity: Morphology, ultra structure, chemical composition of virus, classification of viruses, Group I – T2 Bacteriophage, Group II – Banana bunchy top virus, Group III – Reovirus, Group IV- TMV, Group V – Rhabdovirus, Group VI – HIV, Group VII – Hepatitis virus.

Sub-viral particles: Discovery, Structure, Classification, replication and diseases caused by Satellite, Satellites virus, Virusoids, Viroids and Prions.

UNIT II **8 hours**

Bacterial Diversity: Archaebacteria, Photosynthetic Eubacteria, Chemoautotrophic and Methophilic Eubacteria, Gliding Eubacteria, Spirochetes, Rickettsiae and Chlamydiae, Actinomycetes, Mollicutes, Protists. Classification based on Bergey's manual (Determinative & Systematic).

UNIT III **8 hours**

Fungal Diversity: Classification, Distribution, Importance, Structure, reproduction and general characteristics of the fungal divisions: Zygomycota (*Rhizopus*), Ascomycota (*Neurospora*), Basidiomycota (*Agaricus*), Deuteromycota (*Penicillium*), Chytridiomycota (*Allomyces*) , Myxomycotaand Yeast.

UNITIV **8 hours**

Importance and Conservation of Microbial Diversity: Importance of microbial diversity in agriculture, forestry, environment, industrial & food biotechnology, animal & human health. Metagenomics.Importance of conservation.*In situ* conservation and *Ex situ* conservation. Role of culture collection centers in conservation.

References

1. Alexopoulos, C. J. and Mims, C. W. 1979. Introductory Mycology. III edition, Wiley Eastern, New Delhi.
2. Dimmock, N. J., Easton, A. J. and Leppard, K. N. 2001. Introduction to Modern Vorology. 5thedn. Blackwell publishing,USA.
3. Ghosh, A. 2003. Natural Resource Conservation and Environment Management. Aph Publishing Corp.Calcutta.
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10. Stainer, R. Y., Ingraha, J, L, Wheelis, M. L. and Painter, P. K. 1986. General Microbiology. McMillanEdun. Ltd.London.
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12. Wagner, E.K. and Hewlett, M.J. 1999. Basic Virology. Blackwell Science.Inc.

SEMESTER III
MB 3.1 Hardcore: MOLECULAR BIOLOGY

Course Pedagogy:

- To extend the knowledge on structure and functions of genetic material
- To focus on genome organization, transcription and translation process in Prokaryotes.
- To understand the principles of oncogenes

Course Outcome:

After the completion of the course students would be able

- To have elaborate knowledge on nucleic acids
- To have better understanding of gene expressions
- To get thorough knowledge on Tumor viruses and oncogenes

THEORY 32 hours

UNIT I **8 hours**

Concepts in Molecular Biology: Microbes in molecular biology.

Organization of Genomes: Prokaryotic genome- Genetic and Physical organization of bacterial genome, Eukaryotic genome – Genetic and Physical organization of nuclear genome

DNA structure and Replication: DNA as Genetic material, Chemistry of DNA, Modes of DNA Replication, Meselson and Stahl's Experiment, θ model, replication fork. Enzymes of DNA replication, preprimosome, primosome and replisome complex. Molecular mechanism of DNA replication, Differences in prokaryotic and eukaryotic DNA replication.

UNIT II **8 hours**

DNA damage and recombination: Types of DNA damage - deamination, oxidative damage, alkylation and pyrimidine dimers; DNA repair – mismatch, short patch repair, nucleotide/base, excision repair, recombination repair and SOS repair. Recombination; Site specific recombination, Homologous recombination, transposition.

UNIT III **8 hours**

Gene Expression: Structure of RNA- Classes of RNA, Chemistry of RNA.

Transcription: Transcription in prokaryotes and eukaryotes, Eukaryotic transcription factors. RNA processing, Ribozymes, Antisense RNA, mi RNA, Si RNA, RNAi and other small RNAs.Inhibitors of transcription and their mechanism of action.

Translation: Role of ribosome and different types of RNA in protein synthesis, deciphering the genetic code, basic feature of genetic code, mechanism of initiation, elongation and termination, Non ribosomal protein synthesis. Translational control and posttranslational events. Protein targeting, protein degradation, protein folding. Small peptides, peptitrols, therapeutic peptides.

UNIT IV **8 hours**

Regulation of Gene expression: Regulation of gene expression in prokaryotes and Eukaryotes. Regulation of gene expression in bacteriophage, gene silencing – gene regulation after transcription. **Recent trends in molecular biology research**: Targeted genome editing : ZFNs, TALENs, CRISPRs-gene editing, Knock -ins and Knock – outs.**Oncogenes**, protooncogenes, activation of protooncogenes.

References:

1. Benjamin, L. 1990. Gene 4th edn. Oxford Univ. Press,Oxford.
2. Brown, T. A. 1991. Essential Molecular Biology. A Practical Approach Vol-I & Vol.-II, Oxford Univ. Press.Oxford.
3. Flint, S.J., Enquist, L.W., Drug, R.M., Racaniello, V.R. and Skalka, A.M. 2000. Principles of Virology- Molecular Biology, Pathogenesis and Control. ASM Press, Washington,D.C.
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5. Hartl, D.L. 1994. Genetics. Jones and Bartler Publishers,London.
6. Lewin, B. 2000. Genes VII. Oxford Univ.Press.
7. Lodish, H., Berk, A., Zipursky, S. A., Matsudaira, P., Baltimore, D. and Darnell, J.1999.
8. Molecular Cell Biology, W.H. Freeman and Company, New York.

MB 3.2 Hardcore: GENETIC ENGINEERING

Course Pedagogy:

- To learn about genetic engineering, principles involved in manipulating genes and DNA.
- To know about cloning strategies and expression systems.
- To acquire basic understanding of techniques in genetic engineering.
- To provide basic knowledge on intellectual property rights and their implications in biological research and product development

Course Outcome:

After the completion of the course students would be able

- To acquire knowledge on the concepts and terminology in genetic engineering.
- Familiar with various cloning strategies in prokaryotes.
- To have awareness of IPR, the social and ethical issues concerning cloning by genetic engineering

THEORY32 hours

UNIT I **8hours**

Introduction to Genetic Engineering: Milestones in the development of genetic engineering. Genetic engineering as tool in biotechnology.Importance of gene cloning and future perspectives.

Tools in Genetic Engineering: Enzymes in genetic engineering. Cloning vectors; Plasmids (pUC series, pBR 322), Phage vectors (M13, λgt 10 and λZAP series), Ti vector.YAC, BAC vectors and specialist – purpose vectors; Expression vectors (pET vectors, pLITMUS). Synthetic construction of vectors.

UNIT II **8hours**

rDNA Technology: The basic principles of gene cloning strategies: Preparation, Manipulation and Insertion of desired DNA into vector. Introduction of DNA into host cells – Transformation, Transduction, Transfection, Microinjection, Biolistics, Electroporation, Liposome fusion. Preparation and applications of DNA libraries and cDNA libraries.Identification and Selection of recombinants.Applications of gene cloning in Biotechnology, Medicine, Agriculture, Forensic Science, Gene therapy.

UNIT III **8 hours**

Analysis of gene and gene products: Molecular markers. DNA based and PCR - based markers, RFLP, RAPD,RLGS, AFLP STS, EST, SSCP, VNTR, Multi locus probes, Microsatellites and minisatellites, STMS, DAF. **DNA analysis:** labeling of DNA and RNA probes. Southern and fluorescence in situ hybridization, chromosome walking. PCR – types and applications.

Techniques for gene expression: Northern and Western blotting, Gel retardation technique, DNA foot printing, Primer extension, Reporter assays. DNA sequencing and sequence assembly. Maxam-Gilbert's and Sanger's methods, next generation sequencing, techniques of *in - vitro* mutagenesis, Site-directed mutagenesis, Shot gun sequencing, chemical synthesis of oligonucleotides. Protein analysis; PAGE, IEP, 2D-GEL, protein sequencing.

UNIT IV **8 hours**

Bioinformatics and Molecular Databases: Primary Databanks – NCBI, EMBL, DDBJ, KEGG; Secondary Databases – UNIPROT; Structural Database –PDB; Alignment: Pairwise and Multiple sequence alignment; Genome Annotation and Gene Prediction; Primer designing**;** Phylogenetic analysis

and tree construction.

Safety of recombinant DNA technology: Restriction and regulation for the release of GMOs into Environment. Ethical, Legal, Social and Environmental Issues related to rDNA technology.

Introduction to IPR: Kinds of IPR; patents, copyright, design, trademark, geographical indicators, industrial design and trade secrets. India's new National IP Policy.

References:

1. Brown, T.A. (2010)Gene Cloning and DNA Analysis-An Introduction 6thedn. BlackwellScience.
2. Brown, T.A. (2011) Introduction to Genetics: A Molecular Approach 1stEd.
3. Setlow, Jane K. (2004) Genetic Engineering: Principles and Methods.Springer.
4. Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger(2007) Molecular Cell Biology 6thEd.
   W.H. Freeman and Company, New York.
5. Alexander N. Glazer, Hiroshi Nikaido(2007) Microbial Biotechnology Fundamentals of Applied Microbiology 2nd Ed. Cambridge UniversityPress
6. H.-J. Rehm, G. Reed. (2008) Biotechnology: Genetic Fundamentals and Genetic Engineering, Volume 2, Second Edition.Wiley.
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10. P. K. Gupta. (2008) Molecular Biology and Genetic Engineering. Deep and Deep Publications.India.
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12. J.F.Sambrook and D.W.Russell, ed. (2001), Molecular Cloning; A Laboratory Manual, 3rd ED, Vols 1,2& 3, Cold Spring Harbor Laboratory Press.

MB 3.3 Hardcore: INDUSTRIAL MICROBIOLOGY

Course Pedagogy:

- To give knowledge on strain improvement methods
- To learn different fermentation techniques, bioreactor design, inoculum development.
- To understand techniques involved in downstream fermentation process

Course Outcome:

After the completion of the course students would be able

- To get knowledge on strain improvement
- To understand methods of manipulating the metabolic pathways to get desired yield.
- To understand industrial production and purification of antibiotics, enzymes, amino acids and steroids.
- To work in fermentation industry
- To understand the application of these bio-molecules in benefit to mankind

THEORY **32 hours**

UNIT I **8hours**

Introduction: Fermenter design and types of fermenters, achievement and maintenance of aseptic conditions, Types of fermentation processes (Surface, submerged, Batch, Continuous, solid-substrate, Dual, Fed batch fermentation and its applications),

Industrial Microorganisms: Screening, Isolation. Identification and characterization o**f** industrially important microbes. Strain improvement- mutation, recombination- gene regulation and genetic manipulation. Preservation of industrially important microbes. Culture collection centers**.**

UNITII **8 hours**

Media for Industrial Fermentations: Media formulation, growth factors, carbon, nitrogen, Energy and Mineral sources, buffers, inhibitors, precursors, inducers, Oxygen requirements Antifoam agents and others, Sterilization: Sterilization of bioreactor, media, air and exhaust air and filter sterilization

Downstream processing and fermentation economics: Steps in recovery and purification Methods of cell separation – filtration and centrifugation, cell disruption, liquid liquid extraction, chromatography, membrane processes. Fermentation economics- expenses for industrial organisms, strain improvement, media sterilization, heating, cooling, aeration and agitation. Cost of Plant and equipments, batch process cycle time, continuous culture, recovery and effluent treatment, cast recovery due to waste usages and recycling.

UNITIII **8 hours**

Industrial production of energy fuels: Industrial alcohol production: Biosynthesis, methods of production, recovery and applications of ethanol, acetone – butanol and glycerol through microbial process.

Industrial production of Organic acids and Enzymes: biosynthesis, media, production process, product recovery and application of citric acid and lactic acid, Enzymes: Fungal and Bacterial Amylase; Bacterial proteases.

UNITIV **8 hours**

Industrial production of food additives: amino acid production, methods of production, product recovery of L-Glutamic acid and L-lysine. Commercial uses of Amino acids Vitamins: Commercial production of Vitamin B_{12}, and Riboflavin. Alcoholic beverages (Beer, Wine,)

Industrial production of health care product: Industrial production of β-lactum antibiotic (Penicillin): Biosynthesis, production and recovery. Streptomycin.Biosynthesis, production and recovery. Antitumor and anticholesterol agents, SCP and SCO, I P R: Patent Laws: Patent regulations of processes, products and microorganisms.

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20. Raymond Bonnett 2010 Wine Microbiology and Biotechnology CRCpress
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MB 3.4 Softcore: MEDICAL MICROBIOLOGY

Course Pedagogy:

- To understand the role of normal flora and pathogenic microbes
- To understand the pathogenesis of various diseases
- To understand the various clinical microbiological techniques.

Course Outcome:

After the completion of the course students would be able

- To learn the concept, etiology and epidemiology of infections and mechanisms of infection
- To have knowledge on clinical lab techniques
- To acquire knowledge on control measures of diseases

THEORY32 hours

UNIT I **8hours**

Introduction to Medical Microbiology: History, Development and scope of Medical Microbiology. Concept of Disease, disorder, syndrome, Communicable diseases- Microbial infections and diseases.Factors responsible for microbial pathogenicity.

Microbial infections: Types of infections, modes of transmission, portal of entry: Urinary tract infection, sexually transmissible infection, Infection of the central nervous system, Infections of circulatory system, Oral cavity and respiratory infection, gastrointestinal infection.

UNIT II **8 hours**

Nosocomial infection: Incidence of nosocomial infections, types of nosocomical infections, emergence of antibiotic resistant microorganisms, hospital infection control programmes, preventing nosocomical infections and surveillance, General concepts for specimen collection and handing of specimen, specimen processing and biosafety.

Chemotherapeutic agents: antibiotics (Classification based on chemical structure, mode of action and range of effectiveness). Recent trends-Drug resistance and its consequences, antibiotic policy, NCCLS (CLSI) guidelines and standards, WHO guidelines.MDR strains.

UNITIII **8 hours**

Epidemiology, Pathogenesis, Spectrum of disease, **Laboratory diagnosis and Prevention:** Diseases caused by Viruses**:** Chicken pox, Rabies virus, hepatitis, encephalitis, AIDS, Herpes simplex infections, Influenza, Dengue

Diseases caused by Bacteria: Tuberculosis, Leprosy, cholera, Typhoid, Botulism, Shigellosis, Helicobacter pylori infection, Salmonellosis, Tetanus. Diseases caused by Fungi**:** Candidiasis, Histoplasmosis, Blastomycosis, Coccidiomycosis, Dermatomycosis, Aspergillosis and Cryptococcosis, Anthrax

UNITIV **8 hours**

Diseases caused by Mycoplasma: *Mycoplasma pneumoniae, M. urealyticum, M. homonis*.

Diseases caused by Protozoa: Giardiasis, Trichomoniasis, Celebral Malaria, Toxoplasmosis, Cryptosporidium.

Disease caused by Chlamydiae: Psittacosis, LymphogranulomaVenereum, Trachoma and Inclusion conjunctivitis.

Emergent Diseases: Hemorrhagic fever, Swine flu, SARS, Chikungunya, Ebola, Hanta, Leptospoirosis, Marburg

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6. Timothy JJ Inglis (2013) Clinical Microbiology and Infectious Diseases; Point of CarePublications
7. Patricia Tille (2013) Bailey & Scott's Diagnostic Microbiology; Mosby Marjorie Kelly Cowan (2012) Microbiology Fundamentals: A Clinical Approach; McGraw-HillScience/Engineering/Math
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10. Jawetz (2010)Medical Microbiology ,25th Edition; Tata McGraw – HillEducation

MB 3.5 Softcore: CLINICAL & DIAGNOSTIC MICROBIOLOGY

Course Outcome:

After the completion of the course students would be able

- To develop skill to isolate and identify microorganism form clinical sample.
- To do antibiotics sensitivity and resistance test
- To do detection of parasite/ pathogens using diagnostic kits.

Course Pedagogy:

- Knowledge about microbes causing disease.
- Knowledge about various laboratory techniques like microscopy, immunological assessments, radiology, biomarker tests, ELISA, serology checks, vaccines and vaccines schedule.
- Many microbes have developed resistance to medications.

THEORY32 hours

UNITI 8hours

Introduction to clinical Microbiology: Role of Microbiologist in Diagnostic laboratory, General concepts for specimen collection, handling, transportation, processing, specimen workup, Laboratory safety and infection control.

Scientific and Laboratory basis for Clinical/Diagnostic Microbiology: Microscopic examination of infectious diseases, Growth and biochemical characteristics, Rapid methods of identification.

UNIT II 8 hours

Immunotechniques and Immunodiagnosis: Antigens and Antibody reactions *in vitro;* Agglutination, complement fixation, ELISA, Western Blotting Immunodiffusion, Immunoelectrophoresis, Immunoflurescence, Immuno precipitation, Radioimmunoassay and serotyping.

Vaccines and Vaccination: Vaccines – definition, types, Antigens used as Vaccines, effectiveness of vaccines, Vaccine safety, current vaccines, adjuvants, active immunization and passive immunization.

UNIT III **8 hours**

Recent Diagnostic tools and techniques: Principle, working and application of a) Autoanalyser b) Biosensor glucometer /labon chip/microfluidics c) Diagnositic kits- ELISA, Western Blot d) Enzymes in Disease diagnosis and therapy: Lactate dehydrogenase, Aspartate aminotransferase, Alkaline phosphatase, Creatine kinase, Acid phosphotase, Cholinesterase.

UNIT IV **8 hours**

Antimicrobial Chemotherapy: Development of chemotherapy; General characteristics of drugs and their testing; Mechanism of action. Antibacterial drugs; antifungal drugs, antiviral and antiprotozoan drugs; antibiotic sensitivity testing, MIC, Drug resistance; mechanism of drug resistance; multi drug resistance.

Reference

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1. GouraKudesia (2009) Clinical and Diagnostic Virology. Cambridge University Press.UK.
9. HenrikWinther and Jan T. Jorgensen (2010). Molecular Diagnostics. Springerpublications.
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5. Vinay Kumar et al., (2010) Robbins and Cotran pathologic basis of disease. Philadelphia, PA: Saunders/Elsevier.

MB 3.6Softcore: PRACTICAL V (Molecular Biology and Genetic engineering)

1. Isolation of Genomic DNA from *E. coli*.
2. Determination of purity and concentration of isolated DNA usingspectrophotometer
3. Separation of proteins by SDSPAGE.
4. Salt fractionation of Yeast protein andquantification.
5. Isolation of plasmids from bacteria by agarosegelelectrophoresis.
6. Estimation ofDNA
7. Estimation ofRNA
8. Estimation of protein by Lowry'smethod
9. Digestion of the gene of interest with suitable restrictionenzymes.
10. Ligation of the digested gene in avector.
11. Preparation of competent *E. coli* cells for Bacterialtransformation.
12. Transformation of the vector into the host cell and selection of the desiredclones.
13. Induction of gene expression and purification of the induced protein from thehost.
14. Amplification, Purification and separation of PCRproduct.
15. Determination of DNase activity on isolatedDNA.
16. Determination of RNase activity on isolatedRNA.
17. Determination of Proteinase activity onproteins.

MB 3.7 Softcore: PRACTICAL VI (Industrial and Medical Microbiology)

1. Study design of Fermentor and Parameters
2. Isolation of antibiotic/ amino acid/organic acid producing microbes and their preservation.
3. Batch fermentation of Citric acid production, recovery and estimation of citric acid.
4. Production of any vitamin and its quantification by bioassay.
5. Antibiotic fermentation and estimation of penicillin.
6. Preparation of wine and estimation of alcohol by specific gravity method.
7. Alcoholic fermentation and determination of total acidity and non-reducing sugars
8. Preparation of banana juice using Pectinase
9. Pathogenic fungi of the skin (Dermatophytes).
10. Microbial flora of mouth – teeth crevices.
11. Microbial flora of saliva.
12. Microorganisms of respiratory tract-examination of sputum/ AFB acid – fast bacteria.
13. Estimation of bacteria in urine by calibrated loop direct streak method.
14. Antimicrobial assay – sensitivity test (MIC) for pathogenic bacteria.
15. Demonstration of laboratory diagnosis of important human diseases: Diphtheria, Tuberculosis, Typhoid, Wound infections, Malaria, Leprosy, AIDS and Hepatitis.

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MB 3.8 OPEN.ELECTIVE: MICROBIAL TECHNOLOGY

Course Pedagogy:

The course will impart a comprehensive knowledge and understanding of techniques used in Microbiology, like microscopy, staining technique, culture media, sterilization methods and control of microorganisms.

Course Outcome:

After the completion of the course students would be able

- To acquire knowledge of culturing methods and identification of microorganisms.
- To enable them to isolate pure culture and preserve them and control measures.

THEORY **32 hours**

UNIT I **8hours**

Microscopy: Light microscopy- Simple microscopy (dissection microscope), Compound microscopy (Bright field, Dark field, phase contrast, and Fluorescence microscopy) and stereomicroscopy. Electron microscopy: Principles, construction and mode of operation of scanning and Transmission electron microscopy, limitations. Preparation of specimens for electron microscopic studies (Ultra-thin sectioning, negative staining, shadow casting and freeze etching). Confocal/Laser scanning, programmable array microscopes.

UNIT II **8 hours**

Microbiological stains and staining techniques: Types of stains and principles of staining. Stains for bacteria, fungi, algae and protozoa, spirochetes, stains for Azotobacter cysts, stains for mycoplasma. Preparation of bacterial smears for light microscopy: Fixation, simple staining, Differential staining, Structural staining (Capsule, Flagella, Cell wall and Endospore of bacteria), and nuclear staining.

UNIT III **8 hours**

Culture media for Microbes Types of media- general purpose media, special purpose mediaselective, elective, diagnostic, resustication media, Media for fungi, algae, bacteria, mycoplasmaandviruses.

Sterilization techniques: Principles, types of Sterilization, and their mode of action. Physical methods: Heat-dry heat (Hot-Air oven), Incineration, Moist heat (Autoclave and Pressure cooker), Tyndalization (Fractional Sterilization), Filtration-Types of filters, Laminar airflow. Radiation methods (UV radiation, x- rays and cathoderays). Biosafety cabinets – Level I – IV, Containment labs – containment, high containment and maximum containment labs.

UNIT IV **8 hours**

Control of Microorganisms: Chemical methods: Definition of terms- Disinfectants, Antiseptics, Sanitizers, Microbicides (bactericide, fungicide and Sporicide), Microbistatic (bacteristatic and fungi static agents). Use and mode of action of Alcohols, Aldehydes, Halogens, Phenols, Heavy metals, and Detergents.

Pure culture techniques: Different types of inoculation techniques - Spread plate, Pour plate and Streak plate methods.

References:

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14. Tortora, G.J., Funke, B.R. and Case, C.L. 2004. Microbiology-An Introduction. Benjamin Cummings. SanFrancisco.

SEMESTER IV
MB 4.1 Hardcore: AGRICULTURAL MICROBIOLOGY

Course Pedagogy:

- To study the microbes associated with the plant and soil fertility.
- To understand about beneficial microbes and their uses in protecting agriculture, preserving food, enhancing the value of food products and providing general benefits to health and wellbeing.
- To classify various aspects of N2 fixation, P solubilization, PGPR, are easily grasped by students
- To understand microbe and plant interactions
- Enable them to understand plant disease, plant defense mechanism and disease management.

Course Outcome:

After the completion of the course students would be able

- To develop newer approaches for plant disease management.
- Have better knowledge of pathogen interactions and plant defense mechanisms
- To know the application of microbial biocontrol agents and to reduce drug resistance and environmental pollution.

THEORY **32 hours**

UNITI **8hours**

Introduction to Agricultural Microbiology:, Introduction to agricultural microbiology, concepts and scope of agricultural microbiology, Agronomy and production of important crop plants, Green revolution. Plant Pathology: Concept of disease, History of Plant Pathology, Significance of plant diseases, Symptoms and types of plantdiseases.

Plant Pathology in Practice: Plant Clinic and Plant Doctor Concept. Diagnosis of Plant Diseases – Infectious diseases, Non-infectious diseases, Kochs'rules;

UNITII **8 hours**

Parasitism and Disease Development Parasitism and pathogenecity, Host range of pathogens, Disease triangle, Diseases cycle / Infection cycle, Relationship between disease cycles and epidemics; Pathogens Attack Plants – Mechanical forces, Microbial enzymes and toxins, Growth regulators. Effect on physiology of Host – Photosynthesis, Translocation and transpiration, Respiration, Permeability, Transcription and translation.Environment and Plant Disease– Effect of Temperature, Moisture, Wind, Light, Soil, pH and structure, Nutrition and Herbicides.

Defense Mechanisms of Plant: Disease Pre-existing structural and chemical defenses, Induced structural and biochemical defenses. Microbe mediated strategies for abiotic stressmanagement.

UNITIII **8 hours**

Plant Disease & their management: Tobacco Mosaic Disease, Sandal Spike Disease, Bacterial blight of Paddy, Citrus canker, Angular leaf spot of cotton, Late Blight of Potato, Downy Mildew of Bajra, Blast of paddy, Tikka disease of ground nut, Rust of coffee, Grain and Head smut of Sorghum. Powdery mildew of Cucurbits, Wilt of Tomato, and Root Knot of Mulberry.Bunchy top of Banana.

UNITIV **8 hours**

Microbes and Plant interaction-Mycorrhizae-Biology and their applications, Biofertilizers - microbial inoculants. Production and application of *Rhizobium, Azospirillum, Azotobacter,* phosphor bacteria and Cyanobacteria.PGPR's plant growth promoting *Rhizobacteria*and their uses.

Biopesticides: Definition, types-bacterial, viral, fungal and protozoan, mode of action, target pests, use of transgenic plants. mode of action, Bacteria-endo and ecto-toxins production by *Bacillus thuringiensis, and Pseudomonas.* Fungi- *Beauveria, Cephalosporium,* and*Trichoderma.*

References:

1. George. N. Agrios (2005),Plant pathology, Elsevier academic press, 5th edition,U.K.
2. Mehrotra. R.S. and Ashok Aggarwal (2002), Plant pathology, Tata MC Graw-Hill publishers, 2nd edition,Delhi.
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10. Geoffrey Clough Ainsworth (1981). Introduction to the History of Plant Pathology 1st edition, Cambridge university press,U.K.
11. Vidhyasekaran, P. (2007). Fungal Pathogenesis in Plants and Crops: Molecular Biology and Host Defense Mechanisms, 2nd edition, APS press,U.S.A

MB 4.2 Softcore: ENVIRONMENTAL MICROBIOLOGY

Course Pedagogy:

• To give basic idea on environmental sample analysis; Topics covered in detail include soil microbiology, aquatic microbiology, aero microbiology, biofertilizers and pesticides, microbial waste recycling and bioremediation etc.
• To understand the basic principles involved in waste water management
• To get the information on usage of Bioremediation-biotechnology
• To inform students about Biooxidation& microbial leaching

Course Outcome:

After the completion of the course students would be able

- To apply advanced knowledge on environmental sample analysis
- To use the knowledge for better waste management
- To formulate technique for bioremediation process
- To apply principle's of environmental microbiology to solve the current environmental issues
- To be employable in pollution control boards

THEORY **32 hours**

UNITI **8hours**

Air Microbiology: Airspora of indoor and outdoor environment, factors affecting airspora, Techniques of trapping air borne microorganisms.
Aquatic Microbiology: Distribution of microorganisms in the aquatic environment, Water pollution sources, Biological indicators of water pollution, Determination of sanitary quality of water, Waste water microbiology-Primary, secondary, tertiary treatment and reclamation of waste water

UNITII **8 hours**

Soil Microbiology: Characteristics and classification of soil. Interactions between microorganisms: Mutualism, commensalism, ammensalism synergism, parasitism, predation, competition. Rhizosphere, rhizosphere, microflora and its beneficial activity.Role of microorganism in nitrogen, phosphorous and sulphurcycle.Detrimental effects of diverted biogeochemical cycles. Biological nitrogen fixation in detail: Symbiotic, asymbiotic and associated nitrogen fixation. Structure, function and genetic regulation of nitrogenases.Viable but nonculturable bacteria.

UNITIII **8 hours**

Microbes in extreme environment: Microbes of extreme environments, Thermophiles, acidophiles, alkaliphiles, halophiles. barophiles and their survivalmechanisms.
Space microbiology: Historical development of space microbiology, Life detection methods a) Evidence of metabolism (Gulliver) b) Evidence of photosynthesis (autotrophic andheterotrophic).

UNITIV **8 hours**

Microbes in the degradation of wastes: Treatment of solid and liquid industrial wastes, Microbial degradation of pesticides, Xenobiotics, degradation of lignin, cellulose and pectin. Bioremediation. Geomicrobiology: Microbes in metal extraction, mineral leaching and mining, copper extraction by leaching and microbes in petroleum product formation. Global Environmental Problems: Global

Warming, Acid rain, Ozone depletion. Bio deterioration of wood and metals.

MB 4.3 Softcore*:* GENOMICS AND PROTEOMICS

Course Pedagogy:

- The objectives of this course are to provide introductory knowledge concerning genomics, proteomics and their application
- To have knowledge about bioinformatics using web based tools (NCBI, CLUSTAL W, MSA etc.,)

Course Outcome:

After the completion of the course students would be able

- To acquire knowledge and understanding of the fundamentals of genomics and proteomics, transcriptomics and their applications in various applied areas of biology.
- Do In silico analysis using web based tools will help the students in their research

THEORY **32 hours**

UNIT I **8hours**

Genome - Overview Of Genome; Sequence Of Genome Acqusition And Analysis - Homologies - Snps - Genetic Analysis, Linkage Mapping,

HighResolution Chromosome Mapping And Analysis - Physical Mapping, Yac, Hybrid Mapping, Strategies, Sequence Specific Tags (Sst), Sequence Tagged Sites(Sts), Ish, Fish, Rflp,Rapd.

UNIT II **8 hours**

DNA Sequencing - Methods, MaxamAnd Gilbert Method, Ladder, Fluorescent, Shot Gun, Mass Spectrometry, Automation Sequencing – Find Gene Mutations, Implications of DNA – Sequencing And Sequencing Genomes.

Genome Data Bank, Metabolic Pathway Data - Construction And Screening Of cDNA, Libraries And Microarrays - Application Of DNA Arrays - PCR - Variations In PCR - Gene Disruptions – Sage And Sade, Pharmacogenomics.

UNIT III8 hours

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

Profiling - Protein - Protein Interaction - Protein Modifications. Automation - Nucleic Acid Data Bank – EMBL Nucleotide Sequence Data Bank - Aids Virus Sequence Data Bank - RNA Data Bank.

UNITIV **8 hours**

Tools For Data Bank - Pairwise Alignment - Needleman And WuschAlgorighm – Smith Waterman - Multiple Alignment - Clustral - Pras - Blast - Fast, Algorithms To Analyse Sequence Data - Pdb, Cambridge Structure Data Base (Lsd), 2d Electrophoresis, Ief, Hplc, Protein Digestion Technique, Mass Spectrometry, Maldi, Tof, Peptides, Mass Finger Printing Protein.

Metabolomics: Introduction, importance ofmetabolomics, designing of metaboilimic study. Database for

repository of metabolites, CHEBI, EMBL, EBI, reactome database.

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6. MetinAkay (2007). Genomics and Proteomics Engineering in Medicine and Biology. Wiley Publications.UK.
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8. Nawin Mishra (2010). Applications of Proteomics I: Proteomics, Human Disease, and Medicine. Wiley publication.UK
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10. Ruchi Singh (2014). BIOINFORMATICS: GENOMICS AND PROTEOMICS. Vikas Publications. New Delhi.
11. Suhai, Sándor (2002). Genomics and Proteomics. Springer publications.

MB 4.4 Softcore: PRACTICAL VII (Agricultural Microbiology &Environmental Microbiology)

1. Isolation, culturing and seed inoculation of *Rhizobium* and testing of nodulation ability and beneficial effects.
2. Isolation and testing the efficiency of various biofertilizers like *Rhizobium, Azotobacter,Azospirillum*.
3. Mass multiplication techniques of *Azolla.*
4. Estimation of total phenols in diseased and healthy plant tissues.
5. Seed health testing by SBM.
6. Collection and Identification of following disease: Tobacco mosaic disease, Bunchy top of Banana, Bean Mosaic, Sandal spike, Bacterial blight of paddy. Citrus canker, Downy mildew of Bajra, Powdery mildew of mulberry, Head smut of sorghum, Leaf rust of coffee, Blast disease of paddy, Tikka disease of groundnut, Leaf spot of paddy and Grassy shoot of sugarcane.
7. Isolation and identification of micro flora of soil, sewage and air
8. Microbes as indicators of water pollution – Determination of indices of water quality.
9. Determination of BOD of pollution water.
10. Determination of COD of polluted water.
11. Degradation of cellulose by *Chaetomiumglobosum.*
12. Bacterial examination of drinking water by membrane filters technique.
13. Study of associated soil microorganisms with plants, Actinorhiza, Mycorrhiza.
14. Study of important microbes in the degradation of wastes.

15. Isolation of cellulose degraders, chitinase and pesticide degraders
16. Determination of TS and MLSS