UNIVERSITY OF MYSORE, MYSURU

CHOICE BASED CREDIT SYSTEM (CBCS)

&

CONTINUOUS ASSESSMENT AND GRADING PATTERN (CGPA)

Based

M. Sc. MICROBIOLOGY SYLLABUS

For

2024-25 onwards

Board of Studies in Microbiology
Department of Studies in Microbiology
University of Mysore
Manasagangotri, Mysuru 570 006
Karnataka, India

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, enzymes and 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

For M.Sc. in Microbiology

Credits to be earned	40 credits
Core papers	28 credits
Open elective paper	04 credits
Total credits	**72 credits**

Honors in Microbiology

Credit Based Choice Based Continuous Evaluation Pattern System Proposed Semester wise distribution of the course structure for the year 2024-2025

Semester-I Credits: 18

No	Paper Code	Title of The Course Paper	Credit Pattern in L:T:P	Credits
1	**MB 1.1 Hard core**	Virology	3:1:0	4
2	**MB 1.2 Hard core**	Bacteriology	3:1:0	4
3	**MB 1.3 Hard core**	Mycology	3:1:0	4
		Select 3 among 4 papers		
4	**MB 1.4 Soft core**	Microbial Genetics	3:0:0	2
5	**MB 1.5 Soft core**	Microbial Ecology & Diversity	3:0:0	2
6	**MB 1.6 Soft core**	Practical I (Virology & Bacteriology)	0:0:2	2
7	**MB 1.7 Soft core**	Practical II (Mycology & Microbial Genetics)	0:0:2	2
		Total credits to be earned		**18**

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

Semester-II Credits: 18

No	Paper Code	Title of The Course Paper	Credit Pattern in L:T:P	Credits
1	**MB 2.1 Hard core**	Microbial Physiology	3:1:0	4
2	**MB 2.2 Hard core**	Immunology	3:1:0	4
		Select 3 among 4 papers		
3	**MB 2.3 Soft core**	Food Microbiology	3:0:0	2
4	**MB 2.4 Soft core**	Soil Microbiology	3:0:0	2
5	**MB 2.5 Soft core**	Practical III (Microbial Physiology & Immunology)	0:0:2	2
6	**MB 2.6 Soft core**	Practical IV (Food Microbiology)	0:0:2	2
7	**MB 2.7 OE**	Techniques in Microbiology	4:0:0	4
		Total credits to be earned		**18**

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

Semester-III Credits: 18

No	Paper Code	Title of The Course Paper	Credit Pattern in L:T:P	Credits
1	**MB 3.1 Hard core**	Molecular Biology	3:1:0	4
2	**MB 3.2 Hard core**	Genetic Engineering	3:1:0	4
3	**MB 3.3 Hard core**	Industrial Microbiology	3:1:0	4
		Select 3 among 6 papers		
4	**MB 3.4 Soft core**	Medical Microbiology	3:0:0	2
5	**MB 3.5 Soft core**	Clinical & Diagnostic	3:0:0	2
6	**MB 3.6 Soft core**	Practical V (Molecular Biology & Genetic Engineering)	0:0:2	2
7	**MB 3.7 Soft core**	Practical VI (Industrial Microbiology & Medical Microbiology)	0:0:2	2
8	**MB 3.8 Soft core**	MOOCS/ SWAYAM	2:0:0	2
9	**MB 3.9 OE**	Microbial Diversity	3:0:0	2
		Total credits to be earned		**18**

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

Semester-IV Credits: 18

No	Paper Code	Title of The Course Paper	Credit Pattern in L:T:P	Credits
1	**MB 4.1 Hard core**	Agricultural Microbiology	3:1:0	4
2	**MB 4.2 Hard core**	Environmental Microbiology	3:1:0	4
		Select 3 among 7 papers		
3	**MB 4.3 Soft core**	Microbial Nanotechnology	4:0:0	4
4	**MB 4.4 Soft core**	Genomics & Proteomics	4:0:0	4
5	**MB 4.5 Soft core**	Practical VII (Agricultural Microbiology)	0:0:2	2
6	**MB 4.6 Soft core**	Practical VIII (Environmental Microbiology)	0:0:2	2
7	**MB 4.7 Soft core**	Practical IX (Microbial Nanotechnology)	0:0:2	2
8	**MB 4.8 Soft core**	Project Work	0:0:6	6
9	**MB 4.9 Soft core**	MOOCS/ SWAYAM	2:0:0	2
		Total credits to be earned		**18**

HC= 02; SC=03

Grand Total Credits: 72

SEMESTER I

MB1.1 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 **48 hours**

UNIT I **12 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, protozoan viruses, Giant viruses and Bacteriophages.

UNIT II **12 hours**

Plant viruses: Propagation, Cultivation, Isolation and purification using centrifugation, chromatography and electrophoresis techniques. Detection and diagnosis of Plant Viruses **Cultivation and detection of animal 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, LD50, ID50, EID50, TCID50.

UNIT III **12 hours**

Sub-viral particles: Discovery, Structure, Classification, replication and diseases caused by Satellite virus, Virusoids, Viroids and Prions. 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 vaccines, Modern vaccines: peptide vaccines, edible vaccines, immune-modulators (cytokines), anti-idiotype, DNA and m-RNAvaccines.

UNIT IV **12 hours**

Viral transformation and oncogenesis: Oncogenic viruses and viral transformation mechanism by EBV, HPV, and HTLV-1. **Viruses and the future**: Promises and problems. Evolutionary importance of viruses: Antigenic shift, antigenic drift. Emerging and life threatening diseases – COVID-19 and variants, KFD virus, and ZIKA. Sources and causes of emerging viral diseases. Viruses as threat of bioterrorism, as

therapeutic agents, as gene delivery system, viruses to destroy other viruses. **Virus and nano-technology.**

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,Volume1: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 Ltd1998.
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. Part2, Academic Press
8. Marc H.V. van Regen mortel, 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.

MB1.2Hardcore: 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 Achaea.
- To use different microscopes for studying bacterial morphology.
- To work in medical laboratories, pharmacological, food and fermentation industries.

THEORY **48hours**

UNIT I **12 hours**

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 Archae bacteria, 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 brightfield microscope, fluorescent microscope, dark field microscope, phase contrast microscope, stereomicroscope, confocal microscopy and electron microscope. Preparation of sample for electron microscopic studies. Application and importance of above microscopes. Measurement of microscopic objects.

UNIT II **12 hours**

Bacterial classification and taxonomy: Criteria for the classification of bacteria. Phenetic, Phylogenetic, Genotypic, Numerical taxonomy. Techniques for determining microbial taxonomy and Phylogeny. ICNB rules. 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 **12 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 **12 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),Mc Graw-Hill
10. Stuart Hogg (2013) Essential Microbiology, 2nd Edition, Wiley-Blackwell

MB 1.3 Hard core: 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 **48hours**

UNIT I **12 hours**

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 and Mims).

UNIT II **12 hours**

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 **12 hours**

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

Opportunistic fungal infections: *Candida albicans, Aspergillus fumigatus* and Mucormycosis.

UNIT IV **12 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 arbuscular mycorrhiza. 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 CJ and Mims C W,1979 Introductory Mycology 3rd edn, Wiley Eastern., New Delhi.
2. David Moore, Geoffrey D. Robson, Anthony P. J. Trinci (2011) 21st Century Guidebook to Fungi. Cambridge University Press.
3. Deacon, JW, 1997- Modern Mycology 3rd Edition, Black well Science publishers, London.
4. Kevin Kavanagh (2011) Fungi: Biology and Applications. John Wiley & Sons, Sussex, U.K.
5. Mehrotra, R S & 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 Soft-core: MICROBIAL GENETICS

Course Pedagogy:

- Describe the fundamental molecular principle 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 constituents 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 **48 hours**

UNITI **12 hours**

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 **12 hours**

Viral Genetics: Lytic and Lysogenic cycles, Phage Phenotypes, Phenotypic Mixing, Recombination in viruses: Mutations, Recombination and Mapping (r II 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. Regulation of competence in *Bacillus.*

UNIT III **12 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, Nucleo cytoplasmic interactions and gene expression in *Acetabularia*. Extranuclear (Cytoplasmic) inheritance.

UNIT IV **12 hours**

Mutation and mutagenesis: Nature, type and effects of mutations. Concept of gene: muton, recon and cistron. 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,7th edition; Benjamin Cummings
4. Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick (2012) Lewin's GENES XI,11th 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)GeneticsandMicrobialBiotechnology;DominantPublishers&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 Soft-core: 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 **48 hours**

UNITI **12 hours**

Introduction to microbial ecology: Structure of microbial communities. Interaction among microbial populations. Interaction between microorganisms and plants. Biotransformation, biodegradation, bioremediation and phyto remediation. 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 **12 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 **12 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 **12 hours**

Importance and Conservation of Microbial Diversity: Importance of microbial diversity in environment, pharmaceuticals & human health. Metagenomics. Importance of conservation. *Insitu* conservation and *Exsitu* 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. Mc Arthur, J. Vaun (2006) Microbial Ecology An Evolutionary Approach; Academic Press
7. Nelson, Karen E.(1997) Advances in Microbial Ecology; Springer
8. Oladele Ogunseitan (2004) Microbial Diversity: Form and Function in Prokaryotes; Wiley-Blackwell
9. Oladele Ogunseitan (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 (4thEdition); 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 Soft core: Practical I (Virology and Bacteriology)

1. Microbiology 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, gelatin, starch, casein, esculin hydrolysis and Litmus Milk test.
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 Soft core: 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. Isolation of genomic DNA from bacteria by heat lysis method.
14. Isolation of genomic DNA from yeast by DNA spooning method.
15. 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.

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 **48hours**

UNITI **12 hours**

Microbial bioenergetics: The role of ATP in metabolism. Microbial enzymes and mechanism of Enzyme action and kinetics. Inhibition and regulation– allosteric, feed back, 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 **12 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 **12 hours**

Microbial Photosynthesis: Photosynthetic Pigments and apparatus in bacteria. Oxygenic and Anoxygenic. Photosynthesis. Autotropic CO_2 fixation and mechanism of Photosythesis. Utilization of light energy by Halobacteria.

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

UNIT IV **12 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, osmolarity porin 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. Byung Hong Kim, Geoffrey Michael Gadd (2008) Bacterial Physiology and Metabolism; Cambridge University Press
3. Daniel R. Caldwell (1999) Microbial Physiology and metabolism; Star Pub Co
4. David White, James Drummond, Clay Fuqua (2011) The Physiology and Biochemistry of Prokaryotes, Oxford University Press
5. Frederick C. Neidhardt, John L. Ingraham , Moselio Schaechter (1990) Physiology of the Bacterial Cell: A Molecular Approach; Sinauer Associates Inc
6. Robert K. Poole (2014) Advances in Microbial Systems Biology, Volume 64 (Advances in Microbial Physiology); Academic Press
7. Rose, Anthony H. () Advances in Microbial Physiology, Vol. 9; Elsevier Science & Technology Book
8. 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 **48 hours**

UNIT I **12 hours**

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.

UNIT II **12 hours**

Antigens and Antibodies:

Antigens: Properties of antigen, Super antigen, Hapten. **`Major Histo-compatibility Complex (MHC) and Antigen presentation:** Types, Structure and functions of MHC molecules, Presentation of Bacterial and Viral Antigens: Phagocytosis, Processing and presentation of antigens by Class I and class II MHC molecules.

Antibodies (Immunoglobulins) – Structure and function. Ig gene organization and generation of Ab diversity. Monoclonal antibodies production and its clinical applications; Antibody engineering. **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 sclerosis multiplex, psoriasis vulgaris, Rheumatoid arthritis), Immunodeficiency diseases

UNIT III **12 hours**

Transplantation of tissues and organs: Nomenclature of transplantations. Recognition of self and non-self-Transplantation reactions, HvG and GvH. Exception from rejections. HLA Typing: Antibody dependent cell mediated cytotoxicity, mixed lymphocyte reactions. Kidney and bone marrow transplantations.

Immuno stimulatory and immune suppressive drugs and their mechanism.

Antigens and Antibody reactions: Agglutination, complement fixation test, ELISA, immunodiffusion, immunoelectrophoresis, immunoflourescence, immunoprecipitation, radioimmunoassay, Western blotting,

flow-cytometry and immunohistochemistry.

UNIT IV **12 hours**

Immune response to infectious diseases and Vaccines:

Viral Diseases: Neutralization of Viruses, Cell mediated immunity to control viral pathogens, Viruses can evade defense mechanisms. **Bacterial Diseases:** Immune response to extracellular and intracellular bacteria, bacteria can evade defense mechanisms, Immune response to Bacterial pathogenesis. **Parasitic Diseases:** Immune response to Malaria, Trypanosoma, Leishmaniasis. **Fungal Diseases:** Innate and Acquired Immunity to control fungal infections.

Vaccines – Definition, active and passive immunization, designing vaccines for active immunization. Live attenuated vaccines, Inactivated or killed vaccines, Subunit vaccines (Toxoids, Bacterial polysaccharide capsules, viral glycoproteins, Recombinant vaccines, multivalent subunit vaccines), DNA vaccines. Effectiveness of vaccines, Vaccine safety, current vaccines and National vaccination schedule**.**

References:b

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, Mansel Haeney, Siraj Misbah, Neil Snowden (2014) Essential 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: Soft-core: 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; microbiological 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.
- Toanalyzetheimportanceofmicrobiologicalqualitycontrolprogramme's in food production.
- To describe the rationale for the use of standard methods and procedures for the microbiological analysis of food.

THEORY **48 hours**

UNITI **12 hours**

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 **12 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. Prebiotics and Probiotics.

UNIT III **12 hours**

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

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

UNIT IV **12 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, Salmonella1-2.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. New Jeresy.
3. Bibek Ray, Arun Bhunia. 2013. Fundamental Food Microbiology, Fifth Edition. CRC Press
4. C Blackburn. 2006. Food Spoilage Microorganisms. Wood head Publishing.
5. Dongyou Liu.2009. Molecular Detection of Food borne Pathogens. CRC Press.
6. Elmer H. Marth, James Steele.2001.Applied Dairy Microbiology, Second Edition. CRC Press.
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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.
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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: Soft core: 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
- To be employable in the field of Agronomy/Soil Science
- To acquires kills and knowledge on the importance of microorganisms in biogeochemical cycles biological fertility of soil.

THEORY **48hours**

UNIT I **12hours**

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 **12 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 **12 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

UNITIV **12 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 of Plants.
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, New York.
   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 Company Limited.
9. Metcalf, R.L. and Luckmann, W.H. 1994. Introduction to insect pest management 3 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, P and H.J. Hoben, 1994. Hand book for Rhizobia; methods in legume *Rhizobium* Technology. Springer-Verlan, New York.

MB 2.5 Soft core: PRACTICAL III (Microbial Physiology and Immunology)

1. Glucose and sugars other than glucose fermentation tests.
2. Catalase activity.
3. Hydrolytic rancidity.
4. Casein hydrolysis.
5. Study of acid and pH stress tolerance by microbes.
6. Effect of temperature on microbial growth
7. Effect of molecular oxygen on microbial growth.
8. Effect of osmotic pressure on microbial growth.
9. Effect of relative humidity on microbial growth.
10. Effect of different wavelengths of light on microbial growth.
11. Precipitin test, ELISA, Ouchterlony Immunodifusion test, and Radial Immunodiffusion
12. Determination of Blood grouping and rh factor
13. WIDAL Test.
14. VDRL Test (RPR).
15. HBs Ag Test.
16. HCG test (Agglutination inhibition test).
17. Detection of RA factor.
18. CRP test.
19. ASO Test (Antistreptolysin 'O' Test).

MB 2.6 Soft core: PRACTICAL IV (FOOD MICROBIOLOGY)

1. Detection and enumeration of Microorganisms present in Utensils.
2. Isolation and identification of microorganisms from canned food.
3. Enumeration of bacteria in raw and pasteurized milk by SPC method.
4. Determination of quality of a milk sample by Dye reduction test (MBRT, Rezasurin).
5. Detection of number of bacteria in milk by breed-count method
6. Microbial quality of milk and milk products.
7. Microbiological examination of Fermented products
8. Evaluation of antimicrobial activity of food preservatives
9. Isolation and identification of common food borne pathogens (Enterobacteriaceae – *E.coli, Enterobacter aerogenes*, *Salmonella, Shigella*, *Staphylococcus, Listeria*, *Vibrio, Aspergillus, Penicillium,* and *Fusarium*)
10. Bacterial examination of drinking water by membrane filters technique.
11. Determination of TDT.
12. Determination of TDP.
13. Detection and quantification of Aflatoxin B1.

MB 2.7: OPEN ELECTIVE: MICROBIAL TECHNIQUES

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 **48 hours**

UNIT I **12 hours**

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 and 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 **12 hours**

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

UNIT III **12 hours**

Culture media for Microbes Types of media- general purpose media, special purpose media, selective, elective, diagnostic, resustication media, Media for fungi, algae, bacteria, mycoplasma and viruses.

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 **12 hours**

Control of Microorganisms: Chemical methods: Definition of terms- Disinfectants, Antiseptics, Sanitizers, Microbicides (bactericide, fungicide and Sporicide), Microbistatic (bacteristatic and fungistatic 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 method

References:

1. Alcomo, I.E. 2001. Fundamentals of Microbiology. VI Edition, Jones and Bartlett Publishers, Sudbury, Massachusetts.
2. Aneja, K.R. 1993. Experiments in Microbiology, Plant Pathology. Rastogi and Company, Meerut.
3. Cappuccino, J. G. and Sherman, N. 1999. MICROBIOLOGY A Laboratory Manual 4th Edn. Addison – Wesley.
4. Becker, W.M., Kleinsmith, L.J. and Hardin, J.2000. The world of the Cell. IVth Edition. Benjamin/Cummings.
5. Kango.N.2010. Textbook of Microbiology. I.K. International Publishing House. New Delhi.
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8. Presscott, L.M. Harley, J.P. and Klein, D. A.1999.Microbiology, International edn.4th edn. WCB Mc Graw-Hill.
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11. Stanley J.T. and Reysenbach A.L.1977. Biodiversity of microbial life. John Wiley 7 Sons Inc. Publication. New York.
12. Sullia, S.B. and Shantharam, S. 2000. General Microbiology (Revised) Oxford & IBH Publishing Co. Pvt. Ltd.
13. Talaro, K and Talaro, A.1996. Foundations in Microbiology, II edition, WCB publishers.
14. Tortora, G.J., Funke, B.R. and Case, C.L. 2004. Microbiology-An Introduction. Benjamin Cummings. San Francisco.

SEMESTER III
MB 3.1Hard-core: 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 **48 hours**

UNITI **12 hours**

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 **12 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 **12 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 and therapeutic peptides.

UNIT IV **12 hours**

Regulation of Gene expression: Regulation of gene expression in prokaryotes. Operon concept: lac, trp and arabinose. Regulation of gene expression in Eukaryotes. 2 component regulatory system (Sensor Kinases, response regulators, enhances and silencers): constitutive, regulatory genes. 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**, proto-oncogenes, activation of proto-oncogenes

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.
4. Garrett and Grisham.1999.Biochemistry.2nd edn. Saunders college pub.USA.
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.andDarnell,J.1999.
8. Molecular Cell Biology,W.H. Freeman and Company, NewYork.

MB 3.2 Hardcore: GENETIC ENGINEERING

Course Pedagogy:

- To learn about genetic engineering, principals 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

THEORY **48 hours**

UNIT I **12 hours**

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.

UNITII **12 hours**

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

UNIT III **12 hours**

Analysis of gene and gene products: Molecular markers. DNA based and PCR - based markers, RFLP,RAPD, AFLP STS, EST, SSCP, VNTR, Microsatellites and mini-satellites. **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. Sanger's methods, Next Generation Sequencing, techniques of Site-directed mutagenesis, Shot gun sequencing, chemical synthesis of oligonucleotides. Protein analysis; PAGE, 2D-GEL, **Protein sequencing**-N-terminal sequencing by Edman degradation method, C-terminal amino-acid analysis by carboxy peptidase digestion and Dansyl Chloride method.

UNIT IV **12 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, copy right, 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 6th edn.Black well Science.
2. Brown, T.A. (2011) Introduction to Genetics: A Molecular Approach1st Ed.
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 6th Ed. W.H. Freeman and Company, New York.
5. Alexander N. Glazer, Hiroshi Nikaido (2007) Microbial Biotechnology Fundamentals of Applied Microbiology2ndEd. Cambridge University Press
6. H.-J. Rehm, G. Reed. (2008) Biotechnology: Genetic Fundamentals and Genetic Engineering, Volume 2, Second Edition. Wiley.
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9. Maheshwari, D.K., Dubey, R.C. and Kang, S.C.(2006) Biotechnological Applications of Microorganisms. I.K. International Publishing House. New Delhi.
10. P.K. Gupta. (2008) Molecular Biology and Genetic Engineering. Deep and Deep Publications. India.
11. VK Gupta, M Schmoll, M Maki, M Tuohy, M A Mazutti. (2013)Applications of Microbial Engineering. CRC Press.
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 down-stream 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 the bio-molecules in benefit to mankind

THEORY **48 hours**

UNIT I **12 hours**

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 of industrially important microbes. Strain improvement- mutation, recombination-gene regulation and genetic manipulation. Preservation of industrially important microbes. Culture collection centers**.**

UNIT II **12 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 equipment, batch process cycle time, continuous culture, recovery and effluent treatment, cast recovery due to waste usages and recycling.

UNIT III **12 hours**

Industrial production of energy fuels: Industrial alcohol production: Biosynthesis, methods of production, recovery and applications of ethanol: crab tree and pasture effect, 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.

UNIT IV **12 hours**

Industrial production of food additives: aminoacid 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 anti-cholesterol 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 CRC press
21. Reed.G. 1999. Prescott and Dunn's Industrial Microbiology. CBS Publishers and Distributors.

MB 3.4 Soft-core: 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

THEORY **48 hours**

UNITI **12 hours**

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.

UNITII **12 hours**

Nosocomial infection: Incidence of nosocomial infections, types of nosocomical infections, emergence of antibiotic resistant microorganisms, hospital infection control programs, 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 **12 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 **12 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, Lymphogranuloma Venereum, Trachoma and Inclusion conjunctivitis.

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

References:

1. Robert W. Bauman Ph.D. (2011) Microbiology with Diseases by Body System (3rd Edition); Benjamin Cummings
2. Patrick R. Murray PhD, Ken S. Rosenthal PhD, Michael A. Pfaller MD (2012)Medical Microbiology; Saunders
3. Brooks, GeoF., Carroll, Karen C.,Butel, Janet S.(2012)Jawetz Melnick & Adelbergs Medical Microbiology; McGraw-Hill Medical Publishing Division
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5. Sherris Medical Microbiology, Sixth Edition; McGraw-Hill Medical Robert W. Bauman Ph.D. (2011) Microbiology with Diseases by Body System (3rd Edition); Benjamin Cummings
6. Timothy J J Inglis (2013) Clinical Microbiology and Infectious Diseases; Point of Care Publications
7. Patricia Tille (2013) Bailey & Scott's Diagnostic Microbiology; Mosby Marjorie Kelly Cowan (2012) Microbiology Fundamentals: A Clinical Approach; McGraw-Hill Science/Engineering/Math
8. Connie R. Mahon, Donald C. Lehman, George Manuselis Jr. (2010) Text book of Diagnostic Microbiology; Saunders
9. Ananthanarayan, Paniker (2009) Textbook of Microbiology,8th Edition; University Press
10. Jawetz (2010) Medical Microbiology, 25th Edition; Tata McGraw –Hill Education

MB 3.5 Soft-core: 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.

THEORY **48 hours**

UNITI **12 hours**

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 **12 hours**

Immunotechniques and Immunodiagnosis: Antigens and Antibody reactions *in vitro;* Agglutination, complement fixation, ELISA, Western Blotting Immuno-diffusion, Immuno-electrophoresis, Immunoflurescence, Immuno-precipitation, Radioimmuno assay 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 **12 hours**

Recent Diagnostic tools and techniques: Principle, working and application of a) Auto analyser b)Biosensor glucometer /labon chip/microfluidics c) Diagnositic kits- ELISA, Western Blot d) Enzymes inDiseasediagnosisandtherapy:Lactatedehydrogenase,Aspartateaminotransferase,Alkalinephosphatase,Creatinekinase, Acid phosphotase, Cholinesterase.

UNIT IV **12 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

1 Alberto M. Marchevsky and Mark Wick. (2011). Evidence Based Pathology and Laboratory Medicine. Springer publication.

2 David E. Bruns; Edward R. Ashwood; Carl A. Burtis; Barbara G. Sawyer (2007). Fundamentals of Molecular Diagnostics St. Louis, Mo. : Saunders Elsevier

3 Goura Kudesia (2009) Clinical and Diagnostic Virology. Cambridge University Press. UK.

4 Henrik Winther and Jan T. Jorgensen (2010).Molecular Diagnostics. Springer publications.

5 Huggett and Justin O'Grady *LGC (2014)* Molecular Diagnostics: Current Research and Applications. Caister Academic Press.

6 Huw Llewelyn , Hock Aun Ang, Keir E Lewis and Anees Al-Abdullah (2009). Oxford Handbook of Clinical Diagnosis. Oxford publications.

7 J. Andre Knottnerus and Frank Buntinx (2008) The Evidence Base of Clinical Diagnosis: Theory and Methods of Diagnostic Research, 2nd Edition. Wiley Publication.

8 Peter Hu Madhuri Hegde and Patrick Alan Lennon (2012). Modern Clinical Molecular Techniques. Springer publications.

9 Prakash S. Bisen, Mousumi Debnath and GBKS Prasad (2010) Molecular Diagnostics: Promises and Possibilities. Springer publications

10 Richard A. Mc Pherson and Matthew R. Pincus (2011). Henry's clinical diagnosis and management by laboratory methods. (22nd Edi) Philadelphia, PA :Elsevier/Saunders,

11 Stephen B. Hulley; Steven R. Cummings; Warren S. Browner; Deborah G. Grady; Thomas B. Newman (2007) Designing clinical research (3rd edition). Philadelphia, PA: Lippincott Williams & Wilkins.

12 Vinay Kumar et al., (2010) Robbins and Cotran pathologic basis of disease. Philadelphia, PA: Saunders/Elsevier.

MB 3.6 Soft-core: PRACTICALV (Molecular Biology and Genetic engineering)

1. Isolation of Genomic DNA from *E.coli*.
2. Isolation of plasmids from bacteria by agarose gel electrophoresis.
3. Determination of purity and concentration of isolated DNA using spectrophotometer
4. Estimation of DNA by DPA method
5. Determination of DNase activity on isolated DNA
6. Amplification, Purification and separation of PCR product.
7. Estimation of RNA by Orcinol Method
8. Determination of RNase activity on isolated RNA.
9. Salt fractionation of Yeast protein and quantification
10. Estimation of protein by Lowry's method
11. Determination of Proteinase activity on proteins
12. Separation of proteins by SDS PAGE
13. Digestion of the gene of interest with suitable restriction enzymes.
14. Ligation of the digested gene in a vector.
15. Preparation of competent *E.coli* cells for Bacterial transformation.
16. Transformation of the vector in to the host cell and selection of the desired clones.
17. Induction of gene expression and purification of the induced protein from the host.

MB 3 .7 Soft-core: PRACTICALVI (Industrial and Medical Microbiology)

1. Study design of Fermentor and Parameters
2. Isolation of antibiotic-producing microbes and their preservation.
3. Antibiotic fermentation and estimation of penicillin
4. Batch fermentation of Citric acid production, recovery and estimation of citric acid.
5. Preparation of wine and estimation of alcohol by specific gravity method.
6. Alcoholic fermentation and determination of total acidity and non-reducing sugars
7. Clarification of banana juice using Pectinase
8. Mushroom cultivation
9. Isolation of Pathogenic fungi of the skin (Dermatophytes).
10. Isolation and identification of clinically important microbes from throat swab
11. Isolation and identification of clinically important microbes from nasal swab
12. Isolation and identification of clinically important microbes from wound infections
13. Microbial flora of mouth–teeth crevices and saliva.
14. Estimation of bacteria in urine by calibrated loop direct streak method.
15. Antimicrobial assay–sensitivity test (MIC) for pathogenic bacteria.
16. Demonstration of laboratory diagnosis of important human diseases:–Tuberculosis, Typhoid, Malaria, and Hepatitis.

MB 3.8 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 **48 hours**

UNIT I **12 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, GroupV– 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 **12 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 **12 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*) , Myxomycota and Yeast.

UNIT IV **12 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

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2. Dimmock, N. J., Easton, A. J. and Leppard, K. N. 2001. Introduction to Modern Virology. 5th edn. Blackwell publishing, USA.
3. Ghosh, A. 2003. Natural Resource Conservation and Environment Management. Aph Publishing Corp. Calcutta.
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8. Presscott, L. M., Harley, J. P. and Klein, D. A. 1999. Microbiology. 4th edn. WCB McGraw- Hill, New Delhi.
9. Satyanarayana, T. and Johri, B. N. 2005. Microbial Diversity – Current Perspectives and Potential Applications. I K Int. Pvt. Ltd. New Delhi.
10. Stainer, R. Y., Ingraha, J, L, Wheelis, M. L. and Painter, P. K. 1986. General Microbiology. McMillan Edun. Ltd. London.
11. Stanley J.T. and Reysenbach A.L.1977. Biodiversity of microbial life. John Wiley 7 Sons Inc. Publication. New York.
12. Wagner, E.K. and Hewlett, M.J. 1999. Basic Virology. Black well Science. Inc.

SEMESTER IV
MB4.1Hardcore: 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 bio-control agents and to reduce drug resistance and environmental pollution.

THEORY **48hours**

UNIT I **12 hours**

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 plant diseases.

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

UNIT II **12 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 stress management.

UNIT III **12 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.

UNIT IV **12 hours**

Microbes and Plant interaction- Mycorrhizae- Biology and their applications, Bio fertilizers – 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, 5thedition,U.K.
2. Mehrotra. R.S. and Ashok Aggarwal (2002), Plant pathology, Tata MC Graw-Hill publishers, 2ndedition, Delhi.
3. Kannaiyan.S. (2002), Biotechnology of Biofertilizers, Alpha science international,1st edition.
4. Bagyaraj D.G. and Rangaswami. G. (2005). Agricultural Microbiology, Prentice- Hall of India, 2ndedition, New Delhi.
5. Neelima Rajvaidya and Dilip Kumar Markandey. (2006). Agricultural Applications of Microbiology, Nangia S.B. And A.P.H. publishing corporation, New Delhi.
6. Oerke,E.C. Dehne,H.C. Schönbeck, F. Weber, A.(1999).Crop Production and Crop Protection, Elsevier academic press, 5th edition, U.K.
8. Roger Hull (2013). Plant virology, Elsevier academic press,11th edition, U.K.
9. Hermann H. Prell, Peter R. Day. (2001). Plant-Fungal Pathogen Interaction: A Classical and Molecular View, 1st edition, Springer-Verlag Berlin Heidelberg, Germany.
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 Soft-core: ENVIRONMENTAL MICROBIOLOGY

Course Pedagogy:

- To give basic idea on environmental sample analysis; Topics covered in detail include soil microbiology, aquatic microbiology, aero microbiology, bio-fertilizers 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 Bio-oxidation & 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 principles of environmental microbiology to solve the current environmental issues
- To be employable in pollution control boards

THEORY **48 hours**

UNIT I **12 hours**

Environment and Ecosystem: Physical, chemical and biological aspects of environment, natural habitats of microorganisms, microorganisms in ecosystem as producers and decomposers.

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.

UNIT II **12 hours**

Air Microbiology: Microorganisms in air, sources of air-borne microorganisms. Airspora of indoor and outdoor environment, factors affecting airspora, Techniques of trapping air borne microorganisms.
Brief account of air-borne diseases of humans, plants and their significance.

Aquatic Microbiology: Distribution of microorganisms in the aquatic environment, Water pollution sources, Biological indicators of water pollution. Eutrophication- role of nitrogen and phosphorus in eutrophication, process and control of eutrophication. Determination of sanitary quality of water, Waste water microbiology- Primary, secondary, tertiary treatment and reclamation of wastewater.

UNIT III **12 hours**

Culture- dependent and independent approaches for microbial diversity in environment.

Culture- dependent approaches and their limitations, and culture-independent molecular approaches for understanding microbial diversity in the environment. Viable but non-culturable bacteria. Introduction to Metagenomics.

Microbes in extreme environment: acidophiles, alkaliphiles, halophiles, barophiles and their survival mechanisms.

Space microbiology: Historical development of space microbiology, Life detection methods a) Evidence of metabolism (Gulliver) b) Evidence of photosynthesis (autotrophic and heterotrophic).

UNIT IV **12 hours**

Microbes in the degradation of wastes: Treatment of solid and liquid industrial wastes, Microbial degradation of pesticides, Xenobiotics, degradation of lignin, cellulose, pectin and plastic. Bio-remediation. Geo microbiology: 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.

References:

1. Microbial Ecology by R.M. Atlas, R. Bartha. 3rd edition. Benjamin Cummings Publishing Co, USA. 1993.
2. Environmental Microbiology by A.H. Varnam, M.G. Evans. Manson Publishing Ltd. 2000.
3. Manual of Environmental Microbiology edited by C.J. Hurst, R.L. Crawford, J.L. Garland,
4. D.A. Lipson, A. L. Mills, L.D. Stetzenbach. 3rd edition. Blackwell Publishing. 2007.
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8. Lignocellulose Biotechnology: Future Prospects by R.C. Kuhad, A. Singh. I.K. International. 2007.
9. Environmental Microbiology of Aquatic & Waste systems by N. Okafor. 1stedition, Springer, New York. 2011
10. Bioremediation by Baker K.H. and Herson D.S. 1994.. Mac Graw Hill Inc. N.Y.
11. Waste Water Engineering - Treatment, Disposal and Re-use by Metcalf and Eddy, Inc., Tata MacGraw Hill, New Delhi.
12. Pollution: Ecology and Biotreatment by Ec Eldowney, S. Hardman D.J. and Waite S. 1993. - Longman Scientific Technical.
13. Environmental Microbiology edited by Ralph Mitchell. A John Wiley and Sons. Inc.
14. Waste Water Microbiology 2nd Edition by Bitton.
15. Chemistry and Ecotoxicology of pollution. Edited by Des. W. Connell, G.J. Miller. Wiley Interscience Publications.
16. Environmental Biotechnology. Edited by C. F. Forster and D.A., John Wase. Ellis Horwood Ltd. Publication.
17. Advances in Waste Water Treatment Technologies. 1998. Volumes II and I by R. K. Trivedy. Global Science Publication.
18. Biocatalysis and Biodegradation: Microbial transformation of organic compounds. 2000 by Lawrence P. Wacekett, C. Douglas Hershberger. ASM Publications.
19. A Manual of Environmental Microbiology. 2nd Edition. 2001 by Christon J. Hurst (Chief Editor), ASM Publications.
20. Biodegradation and Bioremediation, Academic Press, San Diego.
21. Biotechnology in the sustainable environment, Plenum Press, N.Y.
22. Basic Principles of Geomicrobiology by A. D. Agate, Pune.

MB 4.3 Soft-core*:* 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, CLUSTALW, 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 Insilco analysis using web based tools, will help the students in their research

THEORY **32 hours**

UNIT I **8 hours**

Genome - Overview of Genome; Sequence of Genome Acquisition and Analysis - Homologies - Snps – Genetic Analysis, Linkage Mapping,

High Resolution 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, Maxam and 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.

UNITIII **8 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 Wusch Algorighm – 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 of metabolomics, designing of metaboilimic study. Data base for repository of metabolites, CHEBI, EMBL, EBI, reactome data base.

References

1. Devarajan Thangadur and Jeybalan Sangeetha (2015). Genomics and Proteomics Principles, Technologies, and Applications. Apple Academic Press.
2. Ferenc Darvas, András Guttman, György Dormán (2013). Chemical Genomics and Proteomics (2nd Ed). CRC Press.
3. Ganapathy Subramanian and Nawin Mishra (2012). Science of Proteomics: Historical Perspectives and Possible Role in Human Healthcare. WileyPublications.UK
4. Lynn Jorde, Peter Little, Mike Dunn and Shankar Subramaniam (2014). Encyclopedia of Genetics, Genomics, Proteomics and Bioinformatics. Wiley Publication.UK
5. Malcolm Campbell, Laurie J. Heyer (2003). Discovering genomics, proteomics and bioinformatics. Benjamin Cummings publications.
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9. R. S. Dassana yake, Y. I. N. Silva Guna wardene (2011). Genomic and Proteomic Techniques: In Post Genomics Era. Narosa Book Distributors.
10. Ruchi Singh (2014). BIOINFORMATICS: GENOMICS AND PROTEOMICS. Vikas Publications. New Delhi.
11. Suhai, Sándor (2002). Genomics and Proteomics. Springer publications.

MB 4.4 Soft core: Microbial Nanotechnology

Theory **48 hours**

Unit I **12 hours**

Introduction to Nanotechnology: Characteristic scale for quantum phenomena, nanoparticles, nano-clusters, nanocomposite, nanotubes, nanowires and Characterization of nanoparticles – UV-VIS IR spectroscopy, TEM, SEM, AFM, EDS, XRD. Emergence of bionanotechnology.

Unit II **12 hours**

Microbial nanotechnology – Microbial synthesis of Nanoparticles. Synthesis of nanodrugs – metal nanoparticles and drug delivery vehicles – Nanoshells – Tectodentrimers Nanoparticle drug systems – Diagnostic applications of nanotechnology.

Unit III **12 hours**

Preparation of nano biomaterials – Polymeric scaffolds collagen, Elastins: Mucopolysaccharides, proteoglycans, cellulose and derivates, Dextrans, Alginates, Pectins and Chitin. Nanoparticles – types (Silver, Gold and Titanium). Physical and chemical properties and functions. Drug delivery – protein mediated and nanoparticle mediated. Hybrid conjugates of gold nanoparticles – DNA oligomers in nano mechanics and Computing. Nanoparticles as carrier for genetic material.

Unit IV **12 hours**

Applications in biology and medicine: Nanotechnologies for biology and medicine – Micro and nano- fluidics - Scanning probe microscopy in biology and medicine – Self-assembly of biological molecules.

Health and safety implications: Health issues – Environmental issues – regulation guidelines. Societal implications- Possible military applications – Potential benefits and risks to developing countries – Intellectual property issues – Criticism of Nanotechnology.

Reference Books:

1. Parthasarathy, B.K. (2007). Introduction to Nanotechnology, Isha Publication.
2. Elisabeth Papazoglou and Aravind Parthasarathy (2007).Bionanotechnology. Morgan & Claypool Publishers.
3. Bernd Rehm (2006). Microbial Bionanotechnology: Biological Self-assembly Systems and Biopolymer-based Nanostructures. Horizon Scientific Press.
4. David E. Reisner, Joseph D. Bronzino (2008). Bionanotechnology: Glo
5. Chaudhery Hussain (2022) Handbook of Microbial Nanotechnology, 1st Edition.

MB 4.6 Soft-core: PRACTICAL VII (Agricultural Microbiology)

1. Isolation of Rhizobium from roots of leguminous plants
2. Assay of bio-fertilizers (*Rhizobium, Azotobacter, Azospirillum)* (Seed treatment/ seedling inoculation and measurement of root and shoot length)
3. Mass multiplication techniques of *Azolla.*
4. Estimation of total phenols in diseased and healthy plant tissues.
5. Isolation of phosphate solubilizing bacteria and fungi.
6. Isolation of phylloplane microorganisms
7. Soil microbes interaction In vitro by dual culture method
8. Isolation, identification and enumeration of Rhizosphere and Rhizoplane microorganism
9. Seed health testing by SBM
10. Collection and Identification of following disease:
    i. Tobacco mosaic disease
    ii. Bunchy top of Banana
    iii. Bean Mosaic
    iv. Sandal spike
    v. Bacterial blight of paddy
    vi. Citrus canker
    vii. Downy mildew of Bajra
    viii. Powdery mildew of mulberry
    ix. Head smut of sorghum
    x. Leaf rust of coffee
    xi. Blast disease of paddy
    xii. Tikka disease of groundnut
    xiii. Leaf spot of paddy
    xiv. Grassy shoot of sugarcane

MB 4.7 Soft-core: PRACTICAL VIII (Environmental Microbiology Practical)

1. Isolation and study of airborne microbes by different techniques
2. Determination of microbes as indicators of water pollution
3. Determination of indices of water quality.
4. Determination of Total Solids from Sewage Water
5. Determination of BOD of pollution water.
6. Determination of COD of polluted water.
7. Degradation of cellulose by *Chaetomium globosum*.
8. Study of Actinorhiza, Mycorrhiza.
9. Isolation of pesticide degrading microbes
10. Isolation of plastic degrading microbes

MB 4.8 Soft-core: PRACTICAL IX: Microbial Nanotechnology Practical

1. Synthesis of gold nano particles from bacteria and its confirmation by UV-Spectroscopy
2. Synthesis of gold nano particles from fungi and its confirmation by UV-Spectroscopy
3. Synthesis of silver nano particles from bacteria and its confirmation by UV-Spectroscopy
4. Synthesis of silver nano particles from fungi and its confirmation by UV-Spectroscopy
5. Synthesis of Nano metal particles from microbes and its confirmation by UV-Spectroscopy
6. Evaluation of antimicrobial properties of gold nano particles produced by microbes
7. Evaluation of antimicrobial properties of silver nano particles produced by microbes
8. Determination of MIC values of synthesized nanoparticles
9. Evaluation of plant growth promotion of nano metals/composites.
10. Determination of size of nanoparticles by SEM/TEM
11. Characterization of nanoparticles by using XRD, EDX and DLS