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UNIVERSITY OF MYSORE

Estd. 1916

Vishwavidyanilaya Karyasoudha
Crawford Hall, Mysuru- 570 005

No.AC.2(S)/31/18-19 Dated: 24.07.2018

NOTIFICATION

Sub: Minor modifications in the existing syllabus of M.Sc. Microbiology from the academic year 2018-19.

Ref: 1. Decision of Board of Studies in Microbiology (PG) meeting held on 06.12.2017.
2. Decision of the Faculty of Science & Technology Meeting held on 21.04.2018.
3. Decision of Academic council meeting held on 19.06.2018.

*****

The Board of Studies in Microbiology (PG) which met on 06.12.2017 has recommended to make minor modification in the syllabus of M.Sc. Microbiology from the academic year 2018-19.

The Faculty of Science and Technology and Academic council meeting held on 21.04.2018 and 19.06.2018 respectively have approved the above said proposal and the same is hereby notified.

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

Draft approved by the Registrar

Sd/-
Deputy Registrar(Academic)

To:

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

UNIVERSITY OF MYSORE

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

DEPARTMENT OF STUDIES IN MICROBIOLOGY
MANASAGANGOTRI
MYSURU – 570 006
2018 -19

University of Mysore

Department of Studies in Microbiology

Credit Based Choice Based Continuous Evaluation Pattern System

SCHEME OF THE STUDY

For B.Sc. (Honors) in Microbiology

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

For M. Sc. in Microbiology

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

Honors in Microbiology
Credit Based Choice Based Continuous Evaluation Pattern System
Proposed Semester-wise distribution of the course structure for the year 2014-2015
Semester-I Credits: 20

NO	PAPER CODE	TITLEOF THE COURSE PAPER	CREDIT PATTERN IN L:T:P	CREDITS
1	**MB 1.1 Hardcore**	Virology	3:1:0	4
2	**MB 1.2 Hardcore**	Bacteriology	3:1:0	4
3	**MB 1.3 Hardcore**	Mycology	3:1:0	4
		Select 3 among 4 papers		
4	**MB 1.4 Softcore**	Microbial Genetics	3:1:0	4
5	**MB 1.5 Softcore**	Microbial Ecology & Diversity	3:1:0	4
6	**MB 1.6 Softcore**	Practical I(Virology & Bacteriology)	0:0:2	2
7	**MB 1.7 Softcore**	Practical II (Mycology & Microbial Genetics)	0:0:2	2

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

Semester-II Credits: 20

NO	PAPER CODE	TITLEOF THE COURSE PAPER	CREDIT PATTERN IN L:T:P	CREDITS
1	**MB 2.1 Hardcore**	Microbial Physiology	3:1:0	4
2	**MB 2.2 Hardcore**	Immunology	3:1:0	4
		Select 3 among 4 papers		
3	**MB 2.3 Softcore**	Food Microbiology	3:1:0	
4	**MB 2.4 Softcore**	Soil Microbiology	3:1:0	4
5	**MB 2.5 Softcore**	Practical III (Microbial Physiology & Immunology)	0:0:2	2
6	**MB 2.6 Softcore**	Practical IV (Food Microbiology)	0:0:2	2
7	**MB 2.7 OE**	**Microbial Diversity**	**2:2:0**	4

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

M. Sc. Microbiology

Credit Based Choice Based Continuous Evaluation Pattern System

Proposed Semester-wise distribution of the course structure

Semester-III Credits: 20

NO	PAPER CODE	TITLEOF THE COURSE PAPER	CREDIT PATTERN IN L:T:P	CREDITS
1	**MB 3.1 Hardcore**	Molecular Biology	3:1:0	4
2	**MB 3.2 Hardcore**	Genetic Engineering	3:1:0	4
3	**MB 3.3 Hardcore**	Industrial Microbiology	3:1:0	4
		Select 3 among 4 papers		
4	**MB 3.4 Softcore**	Medical Microbiology	3:1:0	4
5	**MB 3.5 Softcore**	Clinical & Diagnostic	3:1:0	4
6	**MB 3.6 Softcore**	Practical V (Molecular Biology & Genetic Engineering)	0:0:2	2
7	**MB 3.7 Softcore**	Practical VI (Industrial Microbiology & Medical Microbiology)	0:0:2	2
8	**MB 3.8 OE**	Techniques in Microbiology	1:1:0	2

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

Semester-IV Credits: 16

NO	PAPER CODE	TITLEOF THE COURSE PAPER	CREDIT PATTERN IN L:T:P	CREDITS
1	**MB 4.1 Hardcore**	Agricultural Microbiology	3:1:0	4
		Select 2 among 3 papers		
2	**MB 4.2 Softcore**	Environmental Microbiology	2:0:0	2
3	**MB 4.3 Softcore**	Genomics & Proteomics	2:0:0	2
4	**MB 4.4 Softcore**	Practical VII (Agricultural Microbiology & Environmental Microbiology)	0:0:2	2
5	**MB 4.5 Hardcore**	Project Work	0:2:6	8

HC= 01; SC=02; PW=01

Grand Total Credits: 76

SEMESTER I

MB 1.1 Hardcore: VIROLOGY

THEORY **32hours**

UNIT I **8 hours**

A) The science of virology: Concept and scope of virology. Definitive properties of viruses: Morphology, Ultra structure, Chemical composition - proteins, nucleic acids, and other contents. Classification and nomenclature of viruses. Evolutionary importance of viruses.

B) Working with viruses: Visualization and enumeration of virus particles, Biological activity of viruses, Physical and chemical manipulation of the structural components of viruses, Characterization of viral product expressed in the infected cells. Isolation and purification of viruses, Detection of viruses: physical, biological, immunological and molecular methods.

UNIT II **8hours**

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

B) Replication patterns of specific viruses: Identification of virus prototypes associated with different virus replication schemes; Details on important viruses namely Herpes virus, Poliovirus, Influenza virus, SV40 and Adeno Virus, Poxviruses, Hepatitis Viruses, Retroviruses.

UNIT III **8hours**

A) Propagation, purification, characterization and identification and genomics of plant viruses: General methods of propagation of plant viruses; purification of plant viruses using centrifugation, chromatography and electrophoresis techniques, methods employed in identification of plant viruses.

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

C) Anti-viral strategies-prevention and control of viral diseases: Host specific and nonspecific defense mechanisms involved in resistance to and recovery from virus infections. Role of interferon in viral infections. Viral Chemotherapy: Nucleoside analogs, reverse transcriptase inhibitors, protease inhibitors, History of vaccines especially smallpox and polio. New methods: subunit vaccines, antiidiotype and DNA vaccines.

UNIT IV **8hours**

A) Microbial viruses: Diversity, classification, characteristics and applications of bacteriophages, and general account on algal, fungal and protozoan viruses.

B) Viruses and the future: Promises and problems. Emerging diseases, sources and causes of emergent virus diseases

References:

1. Marc H.V. van Regenmortel , Brian W.J. Mahy (2009) Desk Encyclopedia of General Virology , 1 edition , Academic Press.
2. Alan J. Cann (2011) Principles of Molecular Virology, 5th edition , Elsevier
3. Clokie, Martha R. J., Kropinski, Andrew (2009) Bacteriophages, Methods and Protocols, Volume 1: Isolation, Characterization, and Interactions, Humana Press
4. Edward K. Wagner, Martinez J. Hewlett , David C. Bloom , David Camerini (2007), Basic Virology, 3rd Edition, John Wiley & Sons.
5. Hunter-Fujita, Frances R., Philip F. Entwistle, Hugh F. Evans, and Norman E. Crook. Insect viruses and pest management. John Wiley & Sons Ltd, 1998.
6. 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
7. *John Carter, Venetia A. Saunders,(2007),Virology: Principles and Applications*, John Wiley & Sons, west Susscex , England.
8. Lobocka, Malgorzata, and Waclaw T. Szybalski, eds.(2012) Bacteriophages. Part 2 , Academic Press
9. Matthews, Richard Ellis Ford, and Roger Hull.(2002) Matthews' plant virology. 4th edition, Gulf Professional Publishing.
10. Nigel Dimmock, Andrew Easton, Keith Leppard, 2009, Introduction to Modern Virology, 6th Edition, Wiley-Blackwell

MB 1.2HardCore: BACTERIOLOGY

THEORY **32 Hours**

UNIT I **8 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 Archaebacteria, gram-negative bacteria, gram-positive bacteria and acid fast bacteria, cell wall deficient organisms including L-form structure, composition and function of cell membrane, capsule, flagella, pili, Inclusion bodies, ribosomes, mesosomes, reserve food materials , magnetosomes and phycobilisomes, endospores, bacterial nucleic acids – chromosome, plasmid, transposons, integrons and antibiotic resistance cassettes.

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

UNIT II **8 hours**

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

UNIT III **8 hours**

Growth, Cultivation and control of Bacteria: Nutrient requirements, nutritional types of bacteria, culture media, classification of media. Growth: Nutritional uptake, Growth kinetics, generation time, growth curve, factors affecting growth. Methods for measurement of microbial growth – direct microscopy, viable count estimates, turbidometry, and biomass. Aerobic, anaerobic, batch, continuous and synchronous cultures. Methods of pure culture isolation, Enrichment culturing techniques, single cell isolation, and pure culture development. Preservation and Maintenance of Microbial cultures: Repeated subculturing, preservation at low temperature, sterile soil preservation, mineral oil preservation, deep freezing and liquid nitrogen preservation, lyophilization. Advantages and disadvantages of each method. Control of microorganisms: Antimicrobial agents, physical and chemical methods. Principles, functioning and types of Biosafety cabinets.

UNIT IV **8 hours**

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

References:

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

9. Jerome J. Perry , James Staley , Stephen Lory (2002), Microbial Life, Sinauer Associates.
10. Stuart Hogg (2013) Essential Microbiology, 2nd Edition, Wiley-Blackwell

MB 1.3 Hardcore: MYCOLOGY

THEORY **32 Hours**

UNIT I **8 hours**

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

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

UNITII **8 hours**

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

UNIT III **8 hours**

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

UNIT IV **8 hours**

A) 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 symbiont.

Reference:

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

MB 1.4 Softcore: MICROBIAL GENETICS

THEORY **32 Hours**

UNIT I **8 hours**

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

UNIT II **8 hours**

A) Viral Genetics: Lytic and Lysogenic cycles, Phage Phenotypes, Phenotypic Mixing, Recombination in viruses: Mutations, Recombination and Mapping.

B) 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. Transduction: Generalized and specialized transduction, Transposable elements.

UNIT III **8 hours**

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

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

UNIT IV **8 hours**

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

References:

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

MB 1.5 Softcore: MICROBIAL ECOLOGY AND DIVERSITY

THEORY **32 Hours**

UNIT I **8 hours**

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

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

UNIT II **8 hours**

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

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

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

UNIT III **8 hours**

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

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

UNIT IV **8 hours**

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

References

1. OladeleOgunseitan (2008) Microbial Diversity: Form and Function in Prokaryotes; Wiley- Blackwell
2. Ronald M. Atlas, Richard Bartha (1997) Microbial Ecology: Fundamentals and Applications (4th Edition); Benjamin Cummings
3. David L. Kirchman (2012) Processes in Microbial Ecology; Oxford University Press
4. David L. Kirchman (2008) Microbial Ecology of the Oceans; Wiley-Liss
5. McArthur, J. Vaun (2006) Microbial Ecology An Evolutionary Approach; Academic Press
6. Atlas, Ronald M., Bartha, Richard (1997) Microbial Ecology Fundamentals and Applications; Addison-Wesley
7. Nelson, Karen E. (1997) Advances in Microbial Ecology; Springer
8. Pierre Davet (2004)Microbial Ecology of the Soil and Plant Growth; Science Pub Inc
9. Osborn, A. M., Smith, Cindy (2005) Molecular Microbial Ecology; Taylor & Francis Group
10. OladeleOgunseitan (2004) Microbial Diversity: Form and Function in Prokaryotes; Wiley- Blackwell
11. Satyanarayana, T., Johri, B. N. (2005) Microbial Diversity: Current Perspectives and Potential Applications; I.K. International Publishing House Pvt., Limited
12. James W.Brown (2014) Principles of Microbial Diversity; ASM Press
13. Colwell, R. R., Simidu, Usio, Ohwada, Kouicki (1996) Microbial Diversity in Time and Space; Springer

MB 1.6 Softcore: Practicals I (Virology and Bacteriology)

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

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

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

SEMESTER II

MB 2.1 Hardcore: MICROBIAL PHYSIOLOGY

THEORY **32 Hours**

UNIT I **8 hours**

A) Microbial Physiology: Microbial Energetics, The role of ATP in metabolism. Microbial enzymes: Structure and Classification, Mechanism of Enzyme actions: Lock and Key model, induced fit Theory, Factors affecting rates of enzyme mediated reactions (pH, temperature and substrate and enzyme concentration), Enzyme Inhibition and Enzyme regulation.

UNIT II **8 hours**

A) 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.

UNIT III **8 hours**

A) Metabolism of other Substrates: **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. urea cycle, degradation and biosynthesis of essential and non-essential amino acids. **Nucleic acid metabolism**: Biosynthesis and degradation of purines and pyrimidines.

UNIT IV **8 hours**

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

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

C) Microbial Stress Responses: Oxidative stress, Thermal stress, Starvation stress, Aerobic to anaerobic transitions. Biofilm and quorum sensing

References:

1. Albert G. Moat,Michael P. Spector John W. Foster (2009) Microbial Physiology,; BWSTM
2. Albert G. Moat,Michael P. Spector John W. Foster (2009) Microbial Physiology; BWSTM
3. Byung Hong Kim,Geoffrey Michael Gadd (2008) Bacterial Physiology and Metabolism; Cambridge University Press
4. Daniel R.Caldwell (1999) Microbial Physiology and metabolism ; Star Pub Co
5. Daniel R.Caldwell (1999) Microbial Physiology and metabolism,; Star Pub Co
6. David White, James Drummond , Clay Fuqua (2011)The Physiology and Biochemistry of Prokaryotes, Oxford University Press
7. Frederick C. Neidhardt, John L. Ingraham ,MoselioSchaechter (1990)Physiology of the Bacterial Cell: A Molecular Approach; Sinauer Associates Inc
8. Robert K. Poole (2014) Advances in Microbial Systems Biology, Volume 64 (Advances in Microbial Physiology); Academic Press
9. Rose, Anthony H. ()Advances in Microbial Physiology, Vol. 9; Elsevier Science & Technology Book
10. Rose, Anthony H. (1976) Chemical Microbiology An Introduction to Microbial Physiology; Basic Books

MB 2.2 Hardcore: Immunology

THEORY **32 Hours**

UNIT I **8hours**

A)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.

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

UNIT II **8 hours**

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

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

UNIT III **8 hours**

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

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

UNIT IV **8 hours**

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

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

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

References:

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

MB 2.3: Softcore: FOOD MICROBIOLOGY

THEORY **32 Hours**

UNIT I **8 hours**

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

UNIT II **8 hours**

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

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

UNIT III **8 hours**

A)Food poisoning and intoxication: Significance of food borne diseases, Staphylo Food poisoning and intoxication: Significance of food borne diseases, Staphylococcal, Gasteroenteritis and enterotoxins: Types and incidence, Prevention of Staphylococcal and other food poisoning syndromes, *Clostridium perfringens* food poisoning and Botulism, *Bacillus cereus* food poisoning, Food borne Listeriosis by *Listeria monocytogenes*, Food borne Gastroenteritis by *Salmonella* and *Shigella*, *Vibrio*, *Campylobacter* and *Yersinia*, fungal spoilage and Mycotoxins.

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

UNIT IV **8 hours**

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

B) 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.

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, ArunBhunia. 2013. Fundamental Food Microbiology, Fifth Edition. CRC Press
4. C Blackburn.2006. Food Spoilage Microorganisms. Woodhead Publishing.
5. Dongyou Liu. 2009. Molecular Detection of Foodborne Pathogens. CRC Press.
6. Elmer H. Marth, James Steele. 2001. Applied Dairy Microbiology, Second Edition. CRC Press.
7. Frazier W.C. and Westhoff C.D. 2008 Food Microbiology. Tata Mc Graw Hill Publishing Company Limited, New Delhi. Indian Edition.
8. Jay, James M., Loessner, Martin J., Golden, David A. 2004.Modern Food Microbiology. 7th ed. Springer
9. Marshall, Richard J. (Ed.). 2007. Food Safety. Springer.
10. Pina M. Fratamico, Arun K. Bhunia, and James L. Smith. 2008. Foodborne Pathogens: Microbiology and Molecular Biology. Caister Academic Press.
11. Pitt, John I., Hocking, Ailsa D. 2009. Fungi and Food Spoilage 3rd Edition. Springer.
12. Sperber, William H., Doyle, Michael P. (Eds.). 2010. Compendium of the Microbiological Spoilage of Foods and Beverages. Springer.
13. Stephen J. Forsythe. 2010. The Microbiology of Safe Food, 2nd Edition. Wiley-Blackwell.

MB 2.4: Softcore: SOIL MICROBIOLOGY

THEORY **32 Hours**

Unit I **4 Hours**

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

Unit II **4 Hours**

A) Soil Microbial diversity: Diversity and abundance of dominant soil microorganisms, Methods of isolation of soil microflora, soil organic matter decomposition,

Unit III **4 Hours**

A) Biogeochemical cycles: carbon, sulphur and iron cycles in soil.

UNIT-IV **4 Hours**

A) 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- V **2 Hours**

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

Unit- VI **8 Hours**

A) Soil-Borne Diseases and Human Health: *Clostridium tetani* (tetanus), Toxoplasmosis, Aspergillosis, Actinomyces. **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; Symplasmids, 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. I.K. International Pvt. Ltd.
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.
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 3ed edn. John Willey and Sons, Inc.
10. Motsara, I.M.R., Bhattacharyya, P. and Srivastava, B. 1995. Biofertilizer Technology, Marketing and usage-A source Book-cum- glossary- FDCO, New Delhi.
11. Somasegaran, P and H.J. Hoben, 1994. Hand book for Rhizobia; methods in legume *Rhizobium* Technology. Springer-Verlan, New York.

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

1. Population growth of yeast – *S. cerevisiae*.
2. Population growth of bacteria – *E coli*.
3. Sugar fermentation tests.
4. Catalase activity.
5. Hydrolytic rancidity.
6. Casein hydrolysis.
7. Carbohydrate catabolism by microbes
8. Study of acid and pH stress tolerance by microbes.
9. Effect of molecular oxygen on microbial growth.
10. Effect of osmotic pressure on microbial growth.
11. Effect of relative humidity on microbial growth.
12. Effect of different wavelengths of light on microbial growth.
13. Immunological Methods used for organism detection – production of antibodies for use in laboratory testing.
14. Serological Diagnosis of Infectious diseases – Serologic test Methods.
15. Precipitin test, ELISA, Ouchterlony Immunodifusion test, Immunoelectrophoresis, Complement fixation test.
16. Isolation of Antigens and raising antibodies from animals (from different Models),
17. Development of polyclonal antibodies, purification of antibodies.
18. WIDAL Test.
19. VDRL Test (RPR).
20. HBs Ag Test.
21. HCG test (Agglutination inhibition test).
22. Detection of RA factor.
23. CRP test.
24. ASO Test (Anti streptolysin 'O' Test).

MB 2.6 Softcore: PRACTICAL IV (FOOD AND DAIRY MICROBIOLOGY)

1. Bacterial examination of drinking water by membrane filter technique.
2. Study of important microbes in the degradation of wastes.
3. Determination of TDT.
4. Determination of TDP.
5. Detection and quantification of Aflatoxin B1.
6. Detection of food-borne bacteria by immunoassays.
7. Detection and enumeration of Microorganisms present in Utensils.
8. Isolation and identification of pathogenic microorganisms from canned food.
9. Enumeration of bacteria in raw and pasteurized milk by SPC method.
10. Determination of quality of a milk sample by MBRT.
11. Detection of number of bacteria in milk by breed-count method
12. Litmus milk test.
13. Microbial quality of milk products.
14. Microbiological examination of Ice-cream and Dairy products
15. Soil microbes interaction *In vitro* by dual culture method
16. Isolation, identification and enumeration of Rhizosphere and Rhizoplane microorganism
17. Isolation of *Rhizobium* from roots of leguminous plant

MB 2.7: Open elective: MICROBIAL DIVERSITY

THEORY **32 Hours**

UNIT I **8 hours**

A)Viral Diversity: Morphology, ultra structure, chemical composition of virus, classification of viruses, Group I – T2 Bacteriophage, Group II – Banana bunchy top virus, Group III – Reovirus, Group IV- TMV, Group V – Rhabdovirus, Group VI – HIV, Group VII – Hepatitis virus. **Sub-viral particles**: Discovery, Structure, Classification, replication and diseases caused by Satellite, Satellites virus, Virusoids, Viroids and Prions.

UNIT II **8 hours**

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

UNIT III **8 hours**

A)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 **8 hours**

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

References

1. Alexopoulos, C. J. and Mims, C. W. 1979. Introductory Mycology. III edition, Wiley Eastern, New Delhi.
2. Dimmock, N. J., Easton, A. J. and Leppard, K. N. 2001. Introduction to Modern Vorology. 5th edn. Blackwell publishing, USA.
3. Ghosh, A. 2003. Natural Resource Conservation and Environment Management. Aph Publishing Corp. Calcutta.
4. Landecker, E. M. 1972. Fundamentals of Fungi. Prentice-Hall, Angelwood Cliff, New Jersey.
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6. Pelczar, (Jr.) M. J., Chan, E. C. S. and Kreig, N. R.1993. Microbiology. McGraw Hill, New York
7. Perry, J.J. and Staley, J.T. 1997. Microbiology. Dynamics and Diversity. 4th edn. Wesley Longman pub. New York.
8. Presscott, L. M., Harley, J. P. and Klein, D. A. 1999. Microbiology. 4th edn. WCB Mc Graw- 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. Mc Millan 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. Blackwell Science. Inc.

SEMESTER III

MB 3.1 Hardcore: MOLECULAR BIOLOGY

THEORY **32 Hours**

UNIT I **8 hours**

A) Concepts in Molecular Biology: Microbes in molecular biology. **Organization of Genomes:** Prokaryotic genome- Genetic and Physical organization of bacterial genome, Eukaryotic genome – Genetic and Physical organization of nuclear genome

B) DNA structure and Replication: DNA as Genetic material, Chemistry of DNA, Modes of DNA Replication, Enzymes of DNA replication, Molecular mechanism of DNA replication, Differences in prokaryotic and eukaryotic DNA replication.

UNIT II **8 hours**

A) 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. Molecular basis of mutation, Recombination; Site specific recombination, Homologous recombination, transposition

UNIT III **8 hours**

A) 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, Inhibitors of transcription and their mechanism of action.

B)Translation: Role of ribosome and different types on RNA in protein synthesis, basic feature of genetic code, mechanism of initiation, elongation and termination, Translational control and posttranslational events.

UNIT IV **8 hours**

A) Regulation of Gene expression: Regulation of gene expression in prokaryotes and Eukaryotes. Regulation of gene expression in bacteriophages, gene silencing – gene regulation after transcription.

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. and Darnell, J. 1999.
8. Molecular Cell Biology, W.H. Freeman and Company, New York.

MB 3.1 Hardcore: GENETIC ENGINEERING

THEORY **32 Hours**

UNIT I **8 hours**

A) Introduction to Genetic Engineering: Historical perspectives and milestones in Recombinant DNA Technology. Importance of gene cloning and future perspectives.

B) Tools in Genetic Engineering: Enzymes in genetic engineering. Cloning vectors: Ti Plasmid, pBR322, pUC –series. Phage vectors-M13 phage vectors, Cosmids-Types, Phasmids or Phagemids, Shuttle vectors. YAC and BAC vectors, Adenovirus vector, Synthetic construction of vectors, Ti cloning vector

UNIT II **8 hours**

A) rDNA Technology: The basic principles of gene cloning strategies: Preparation, Manipulation and Insertion of desired DNA into vector. Introduction of DNA into host cells – Transformation, Transduction, Transfection, Microinjection, Biolistics, Electroporation, Liposome fusion. Shotgun cloning. Genomic and c-DNA Libraries. Cloning and expression in bacteria, yeasts, Identification and Selection of recombinants.

UNIT III **8 hours**

A) Analysis of gene and gene products: Isolation and purification of nucleic acids, staining, Molecular markers in genome analysis: RFLP, RAPD, AFLP and ISSR analysis, DNA sequencing. Blotting techniques- Southern, Northern and Western blotting techniques. PCR –principles, types, and applications. **Introduction to Bioinformatics and Molecular Databases**, Primary Databanks – NCBI, EMBL, DDBJ; Secondary Databases – UNIPROT; Structural Database –PDB; Database similarity search (FASTA, BLAST); Alignment: Pairwise and Multiple sequence alignment; Genome Annotation and Gene Prediction; Primer Designing**;** Phylogenetics analysis and Tree construction; Protein Sequence Analysis; DNA microarrays. DNA sequencing methodology – Sangers dideoxy method.

UNIT IV **8 hours**

Applications of gene cloning and Ethics in Genetic Engineering: Applications of gene cloning in Biotechnology, Medicine, Agriculture, Forensic Science, Antisense technology. RNAi and Gene silencing, Gene therapy.

A) 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.

References:

1. Brown, T.A. (2010)Gene Cloning and DNA Analysis-An Introduction 6thedn. Blackwell Science.
2. Brown, T.A. (2011) Introduction to Genetics: A Molecular Approach 1st 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 Microbiology 2nd Ed. Cambridge University Press
6. H.-J. Rehm, G. Reed. (2008) Biotechnology: Genetic Fundamentals and Genetic Engineering, Volume 2, Second Edition. Wiley.
8. Desmond, S. T. and Nicholl. (2002) An Introduction to Genetic Engineering. Cambridge Univ. Press. Cambridge
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, MSchmoll, M Maki, MTuohy, MAMazutti. (2013) Applications of Microbial Engineering. CRC Press.

MB 3.3 Hard core INDUSTRIAL MICROBIOLOGY

THEORY **32 Hours**

UNIT I **8 hours**

A) 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),

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

UNIT II **8 hours**

A) 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

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

UNIT III **8 hours**

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

B) 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 **8 hours**

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

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

References:

1. Barsanti, L and Gualtieri, P. 2005. Algae: Anatomy, Biochemistry, and Biotechnology. Taylor and Francis New York.
2. Casida, L.E. 1997. Industrial Microbiology. New Age International Publishers.
3. Crueger, W. and Crueger, A. 2003. Biotechnology- A text book of Industrial Microbiology. Panima Publishing corporation.
4. Demain, A. L. 2001. Industrial Microbiology and Biotechnology IInd Edition. ASM Press, Washington.
5. Demain, A.L. and Davies, J.E. 1999. Manual of Industrial Microbiology and Biotechnology IInd Edition. ASM Press, Washington.
6. El-Mansi, E.M.T. and Bryce, C.F.A. 2004. Fermentation Microbiology and Biotechnology. Taylor and Francis Group.
7. Horton, H.R., Moran, L. A., Scrimgeour, K.G. Perry, M.D and Rawn, J.D. 2006. Principles of Biochemistry, IVth Edition. Pearson Education Internationl. London.
8. Julian E Davies and Arnold L Demain 2009 Manual of Industrial Microbiology and Biotechnology ASM Publisher
9. Maheshwari, D.K., Dubey, R.C. and Saravanamtu, R. 2010. Industrial Exploitation of Microorganisms. I.K. International Publishing House. New Delhi.
10. Mansi El-Mansi, C. F. A. Bryce. 2007. Fermentation microbiology and biotechnology. CRC Press.
11. Michael J Waites , Neil L Morgan , John S Rockey , Gary Higton 2009. Industrial Microbiology
12. Nduka Okafor 2010. Modern Industrial Microbiology and Biotechnology ASM Publisher

13. Nupur Mathur Anuradha 2007 Industrial Microbiology A Laboratory Manual**.**
14. Patel A H: 2008 Industrial Microbiology: PB Books**.**
15. Patel, A. H. 1999. Industrial Microbiology, Mc Millan India Limited, India.
16. Peppler, H.J. and Perlman, D. 1979. Microbial Technology. Academic Press, New York.
17. Peppler, H.J. and Perlman, D. 2005. Microbial Technology: Fermentation Technology Second Edition Volume 1. Elsevier India Private Limited.
18. Peppler, H.J. and Perlman, D. 2005. Microbial Technology: Fermentation Technology Second Edition Volume 2. Elsevier India Private Limited.
19. Puri, R.S. and Viswanathan, A. 2009. Practical Approach to Intellectual Property Rights. I.K. International Publishing House. New Delhi.
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 Softcore: MEDICAL MICROBIOLOGY

THEORY: **32 Hours**

UNIT I **8 hours**

A) 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.

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

UNIT II **8 hours**

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

B**)** 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.

UNIT III **8 hours**

A) 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

B) 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

UNIT IV **8 hours**

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

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

c. Disease caused by Chlamydiae**:** Psittacosis, Lymphogranuloma Venereum, Trachoma and Inclusion conjunctivitis.

d. Emergent Diseases**:** Hemorrhagic fever, Swine flu, SARS, Chikun gunya, 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, Geo F., Carroll, Karen C., Butel, Janet S. (2012) JawetzMelnick&Adelbergs Medical Microbiology ; McGraw-Hill Medical Publishing Division
4. Kenneth Ryan, C. George Ray , Nafees Ahmad , W. Lawrence Drew, Michael Lagunoff ,Paul Pottinger, L. Barth Reller, Charles R. Sterling (2014) Sherris Medical Microbiology, Sixth Edition; McGraw-Hill Medical
5. Robert W. Bauman Ph.D. (2011) Microbiology with Diseases by Body System (3rd Edition); Benjamin Cummings
6. Timothy JJ 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) Textbook 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 Softcore: CLINICAL & DIAGNOSTIC MICROBIOLOGY

THEORY **32 Hours**

UNIT I **8 hours**

A) 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.

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

UNIT II **8 hours**

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

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

UNIT III **8 hours**

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

UNIT IV **8 hours**

A) 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. Goura Kudesia (2009) Clinical and Diagnostic Virology. Cambridge University Press. UK.
2. J. Andre Knottnerus and Frank Buntinx (2008) The Evidence Base of Clinical Diagnosis: Theory and Methods of Diagnostic Research, 2nd Edition. Wiley Publication.
3. Huggett and Justin O'Grady *LGC (2014)* Molecular Diagnostics: Current Research and Applications. Caister Academic Press.
4. Vinay Kumar et al., (2010) Robbins and Cotran pathologic basis of disease. Philadelphia, PA: Saunders/Elsevier.
5. Richard A. McPherson and Matthew R. Pincus (2011). Henry's clinical diagnosis and management by laboratory methods. (22nd Edi) Philadelphia, PA : Elsevier/Saunders,
7. Alberto M. Marchevsky and Mark Wick. (2011). Evidence Based Pathology and Laboratory Medicine. Springer publication.
8. David E. Bruns; Edward R. Ashwood; Carl A. Burtis; Barbara G. Sawyer (2007). Fundamentals of Molecular Diagnostics St. Louis, Mo. : Saunders Elsevier
9. 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.
10. Huw Llewelyn , Hock Aun Ang, Keir E Lewis and Anees Al-Abdullah (2009). Oxford Handbook of Clinical Diagnosis. Oxford publications.
11. Peter Hu Madhuri Hegde and Patrick Alan Lennon (2012). Modern Clinical Molecular Techniques. Springer publications.
12. Henrik Winther and Jan T. Jorgensen (2010). Molecular Diagnostics. Springer publications.
13. Prakash S. Bisen, Mousumi Debnath and GBKS Prasad (2010) Molecular Diagnostics: Promises and Possibilities. Springer publications

MB 3.6 Softcore: PRACTICAL IV (Industrial and Medical Microbiology)

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

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MB 3.7 Softcore: PRACTICAL V (Molecular Biology and Genetic engineering)

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

MB 3.7 OPEN.ELECTIVE: MICROBIAL TECHNOLOGY

THEORY **32 Hours**

UNIT I **8 hours**

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

UNIT II **8 hours**

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

UNIT III **8 hours**

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

B) 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 cathode rays).

UNIT IV **8 hours**

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

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

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

SEMESTER IV

MB 4.1 Hardcore: AGRICULTURAL MICROBIOLOGY

THEORY **32 Hours**

UNIT I **8 hours**

A) 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.

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

UNIT II **8 hours**

A)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.

B) 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 **8 hours**

A)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 **8 hours**

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

B)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:

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2. Mehrotra. R.S. and Ashok Aggarwal (2002), Plant pathology, Tata MC Graw-Hill publishers, 2nd edition, Delhi.
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4. Bagyaraj D.G. and Rangaswami. G. (2005). Agricultural Microbiology, Prentice- Hall of India, 2nd edition, New Delhi.
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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 Softcore: ENVIRONMENTAL MICROBIOLOGY

THEORY **32 Hours**

UNIT I **8 hours**

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

UNIT II **8 hours**

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

UNIT III **8 hours**

A) Microbes in extreme environment: Microbes of extreme environments, Thermophiles, acidophiles, alkaliphiles, halophiles. barophiles and their survival mechanisms.

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

UNIT IV **8 hours**

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

MB 4.3 Softcore*:* GENOMICS AND PROTEOMICS

THEORY **32 Hours**

UNIT I **8 hours**

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

B) **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**

A) **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.

UNIT III **8 hours**

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

UNIT IV **8 hours**

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

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

UNIT V **8 hours**

A)**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.

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3. Nawin Mishra (2010). Applications of Proteomics I: Proteomics, Human Disease, and Medicine. Wiley publication. UK
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10. Malcolm Campbell, Laurie J. Heyer (2003). Discovering genomics, proteomics and bioinformatics. Benjamin Cummings publications.
11. Nachimuthu Saraswathy and Ponnusamy Ramalingam (2011). Concepts and Techniques in Genomics and Proteomics . Woodhead Publishing groups.
12. R. S. Dassanayake, Y. I. N. Silva Gunawardene (2011). Genomic and Proteomic Techniques: In Post Genomics Era. Narosa Book Distributors.

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

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

Date: 06.12.2017

ANNEXURE –II

AMENDMENT OF SYLLABUS FOR M.SC MICROBIOLOGY

EXISTING	AMENDED
I SEMESTER **MB 1.2 HARDCORE – BACTERIOLOGY**	
UNIT - I **A) Historical overview of bacteriology:** Spontaneous generation conflict, Antony van Leeuwenhoek, Louis Pasteur, Robert Koch, Paul Ehrlich, Alexander Fleming. Important events in development of bacteriology, Scope and relevance of bacteriology. **B) Morphology and Ultra structure of Bacteria**: An overview of bacterial size, shape and arrangement, Structure, chemical composition of cell wall of archaebacteria, gram-negative bacteria, gram-positive bacteria and acid fast bacteria- 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, bacterial nucleic acids and genome organization	**UNIT- I** **Introduction:** Important events in development of bacteriology, Scope and relevance of bacteriology. Economic importance of bacteria. **Cell Structure:** An overview of bacterial size, shape and arrangement, structure, chemical composition of cell wall of Archaebacteria, gram-negative bacteria, gram-positive bacteria and acid fast bacteria, cell wall deficient organisms including L-form structure, composition and function of cell membrane, capsule, flagella, pili, Inclusion bodies, ribosomes, mesosomes, reserve food materials , magnetosomes and phycobilisomes, endospores, bacterial nucleic acids – chromosome, plasmid, transposons, integrons and antibiotic resistance cassettes. **Microscopy:** Working Principles of bright field microscope, fluorescent microscope, dark field microscope, phase contrast microscope, stereo microscope, confocal microscopy and electron microscope. Preparation of sample for electron microscopic studies. Application and importance of above microscopes. Measurement of microscopic objects.
UNIT- II **Bacterial growth and cell division**: Fission, budding, binary cell division, septum formation, planes of cell division, control of cell division: conjugation, transformation, transduction and Bacterial motility and Endospore: spore forming bacteria-formation, properties and germination of endospores, induction of endospore formation. Diversity of bacteria: metabolic diversities-phototrophy, lithotrophy, organotrophy- molecular mechanisms, adaptations and type studies. **Cultivation of Bacteria**: Aerobic, anaerobic, batch and continuous cultivation. Nutritional requirements: Micro and macro nutrients, Chemical elements as nutrients.	**UNIT- II** **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. Nonculturable methods for the identification of pathogenic microorganisms.

UNIT – III **A) Characteristics and Salient features of major groups of Bacteria**: Classification based on Bergey's manual (Determinative & Systematic**). Archaebacteria**: general characteristics and classification; extremophiles, halophiles, thermophiles and barophiles; type studies- adaptation, role of archaebacteria in the evolution of microbial world. **Actinomycetes**- general characteristics and classification, diversity and distribution, economic importance. Cyanobacteria- general characteristics and classification, ultra structure, reproduction and economic importance. **Bioluminescent bacteria**; characteristics and examples, mechanism of bioluminescence applications. **Mycoplasma**- general characteristics and examples, growth and multiplication, their significance. **Richettsiae and Chlamydia**- general characteristics and examples, life cycle, growth and multiplication, their significance.	**UNIT – III** **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 subculturing, preservation at low temperature, sterile soil preservation, mineral oil preservation, deep freezing and liquid nitrogen preservation, lyophilization. Advantages and disadvantages of each method. Control of microorganisms: Antimicrobial agents, physical and chemical methods. Principles, functioning and types of Biosafety cabinets.
UNIT – IV Economic importance of bacteria: A brief account of economic importance of bacteria. In Agriculture, industry- brewing, medicine- Vaccines, hormones and environment- bioleaching, bioremediation.	**UNIT –IV** **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**
MB 1.6 SOFTCORE –PRACTICALS I (VIROLOGY AND BACTERIOLOGY)	
1. Isolation of coliphages from sewage and testing for plaque formation by infecting susceptible 2. bacterial culture. 3. Extraction and artificial inoculation of TMV to healthy tobacco plant and study of viral 4. symptoms.	1. Laboratory safety rules 2. Microscopic measurement of microorganisms by micrometry 3. Culturing and maintenance of bacterial cultures 4. Isolation and enumeration of bacteria from soil

5. Isolation of bacteria from water. 6. Isolation of bacteria from soil. 7. As study of bacterial growth curve with determination of growth rate of *E.coli* culture 8. Evaluation of bacterial growth in liquid media: Diauxic growth curve. *9.* Endospore formation and staining in *Bacillus subtilis* 10. Motility test 11. Endospore staining. 12. IMViC 13. Urease test 14. TSI 15. Capsule staining 16. Morphological characteristics of bacteria	5. Isolation and enumeration of bacteria from water 6. Cultural characteristics of bacteria 7. Staining techniques – simple (positive and negative), differential (Grams and acid fast), structural (endospore and capsule) 8. Motility test (hanging drop method and soft agar method) 9. Biochemical tests for the identification of bacteria – catalase, oxidase, IMViC, Urease, TSIA, Nitrate reduction, gelatine, starch, casein, chitin and esculin hydrolysis. 10. Determination of growth curve in E.coli. 11. Diauxic growth curve in E.coli 12. Isolation of coliphages from sewage 13. Study of morphological changes due to viral infection in plants
III SEMESTER **MB 3.2 Hardcore: GENETIC ENGINEERING**	
UNIT I **A) Introduction to Genetic Engineering**: Definition, concepts and scope of genetic engineering. Historical perspectives and milestones in Recombinant DNA Technology. Importance of gene cloning and future perspectives. **B) Tools in Genetic Engineering:** Enzymes in genetic engineering. Cloning vectors: Ti lasmid, pBR322, pUC –series. Phage vectors-M13 phage vectors, Cosmids-Types, Phasmids or Phagemids,Shuttle vectors. YAC and BAC vectors, Adenoviruses, Retroviruses, Synthetic construction of vectors, Ti cloning vector	**UNIT I** **A) Introduction to Genetic Engineering**: Historical perspectives and milestones in Recombinant DNA Technology. Importance of gene cloning and future perspectives. **B) Tools in Genetic Engineering:** Enzymes in genetic engineering. Cloning vectors: Ti Plasmid, pBR322, pUC –series. Phage vectors-M13 phage vectors, Cosmids-Types, Phasmids or Phagemids, Shuttle vectors. YAC and BAC vectors, Adenoviruse vector, Synthetic construction of vectors, Ti cloning vector.
UNIT III **A) Analysis of gene and gene products:** Isolation and purification of nucleic acids, staining, Molecular markers in genome analysis: RFLP, RAPD, AFLP and ISSR analysis, DNA sequencing. Blotting techniques-Southern, Northern and Western blotting techniques. PCR –principles, types, and applications Synthetic Genes of microbes .	**UNIT III** **A) Analysis of gene and gene products:** Isolation and purification of nucleic acids, staining, Molecular markers in genome analysis: RFLP, RAPD, AFLP and ISSR analysis, DNA sequencing. Blotting techniques-Southern, Northern and Western blotting techniques. PCR –principles, types, and Applications.

b) Microbial genome sequencing projects: DOE microbial genome programme, TIGR microbial database. Analysis of genome sequences, DNA chips: studying gene expression using DNA microarrays. Next Generation sequence.	b) **Introduction to Bioinformatics and Molecular Databases**, Primary Databanks – NCBI, EMBL, DDBJ; Secondary Databases – UNIPROT; Structural Database –PDB; Database similarity search (FastA, BLAST); Alignment: Pairwise and Multiple sequence alignment; Genome Annotation and Gene Prediction; Primer Designing**;** Phylogenetics analysis and Tree construction; Protein Sequence Analysis; DNA microarrays. DNA sequencing methodology – Sangers dideoxy method.
Unit- IV **A) Applications of gene cloning and Ethics in Genetic Engineering:** Applications of gene cloning in Biotechnology, Medicine, agriculture, Forensic Science, Antisense technology.	**Unit- IV** **A) Applications of gene cloning and Ethics in Genetic Engineering:** Applications of gene cloning in Biotechnology, Medicine, Agriculture, Forensic Science, Antisense technology. RNAi and Gene silencing, Gene therapy.
MB 3.3 Hardcore: INDUSTRIAL MICROBIOLOGY	
UNIT - I **A) Introduction:** Concepts and Scope. Modern era of industrial fermentation technology.Fermentation: aerobic and anaerobic fermentation processes and their application. Substrate and oxidative phosphorylation and their energy yield, Types of fermentation processes (Surface, submerged, Batch, Continuous, solid-substrate, Dual, Fed batch fermentation and its applications), Fermentation economics and feasibilities.	**UNIT – I** A) 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).
Unit-II **B)** Downstream processing: Steps in recovery and purification of fermented products.	**Unit-II** **B)** 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, agitation etc. Cost of Plant and equipments, batch process cycle time,

	continuous culture, recovery and effluent treatment, cast recovery due to waste usages and recycling
UNIT - III **A)** Industrial production of energy fuels: Industrial alcohol production: Importance of ethanol, biosynthesis, methods of production-recovery and applications of ethanol, Acetone-butanol production: Importance of acetone-butanol, biosynthesis, production process, recovery and application, production of glycerol through microbial process.	**UNIT – III** **A)** Industrial production of energy fuels: Industrial alcohol production: biosynthesis, methods of production, recovery and applications of ethanol, acetone-butanol and glycerol through microbial process.
B)Industrial production of Organic acids and Enzymes: Citric acid: strains for citric acid production, biosynthesis, nutrient media, production process, product recovery and application. Lactic acid: Nutrient media, production process recovery and purification. Enzymes: Production of Amylases-Fungal and Bacterial Amylase, bacterial proteases: Alkaline proteases, Neutral proteases and acid proteases.	B) Industrial production of Organic acids and Enzymes: Citric acid: biosynthesis, media, production process, product recovery and applications of citric acid and Lactic acid, Enzymes: Fungal and Bacterial Amylase; Bacterial proteases.
UNIT – IV **A)** Industrial production of food additives: strains for amino acid production, methods of production production, process,: product recovery of L-Glutamic acid and L-lycine. Commercial uses of Amino acids Vitamins: Commercial production of Vitamin B12, and Riboflavin. Alcoholic beverages (Beer, Wine, Brandy, Rum)	**UNIT- IV** **A)** Industrial production of food additives: amino acid production, methods of production and product recovery of L-Glutamic acid and L-lycine. Commercial uses of Amino acids Vitamins: Commercial production of Vitamin B12, and Riboflavin. Alcoholic beverages (Beer, Wine)
MB 4.2 Softcore: ENVIRONMENTAL MICROBIOLOGY	
UNIT – I **Environmental Microbiology:** Concepts and scope of environmental microbiology. Microbiology of Air: Airspora of indoor and outdoor environment, factors affecting airspora, Techniques of trapping air borne microorganisms	UNIT - I **Air Microbiology:** Airspora of indoor and outdoor environment, factors affecting airspora, Techniques of trapping air borne microorganisms. **Aquatic Microbiology:** Distribution of microorganisms in the aquatic environment, Water pollution sources, Biological indicators of water pollution, Determination of sanitary quality of water, Waste water microbiology-Primary, secondary, tertiary treatment and reclamation of waste water

UNIT II **Aquatic Microbiology:** Distribution of microorganisms in the aquatic environment, Water pollution sources, Biological indicators of water pollution, Determination of sanitary quality of water, Waste water treatment.	**UNIT – II** **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, sulphur cycle. Detrimental effects of diverted biogeochemical cycles. Biological nitrogen fixation in detail: Symbiotic, asymbiotic and associated nitrogen fixation. Structure, function and gentic regulation of nitrogenases. Viable but nonculturable bacteria.
Unit –IV **Microbes in the degradation of wastes:** Treatment of solid and liquid industrial wastes, Microbial degradation of pesticides, Xenobiotics, bioremediation - advantages and disadvantages. Geomicrobiology: Microbes in metal extraction, mineral leaching and mining, copper extraction by leaching and microbes in petroleum product formation.	**Unit –IV** **Microbes in the degradation of wastes:** Treatment of solid and liquid industrial wastes, Microbial degradation of pesticides, Xenobiotics, degradation of lignin, cellulose and pectin. Bioremediation. Geomicrobiology: Microbes in metal extraction, mineral leaching and mining, copper extraction by leaching and microbes in petroleum product formation. Global Environmental Problems: Global Warming, Acid rain, Ozone depletion. Biodeterioration of wood and metals.
4.4 Softcore: PRACTICAL VI (Agricultural Microbiology &Environmental Microbiology)	
1. Isolation, culturing and seed inoculation of *Rhizobium* and testing of nodulation ability and beneficial effects. 2. Isolation and testing the efficiency of various biofertilizers like *Rhizobium, Azotobacter, Azospirillum*. 3. Mass multiplication techniques of *Azolla.* 4. Estimation of total phenols in diseased and healthy plant tissues. 5. Seed health testing by SBM. 6. Collection and Identification of following disease: Tobacco mosaic disease, Bunchy top of Banana, Bean Mosaic, Sandal spike, Bacterial blight of paddy. Citrus canker, Downy mildew of Bajra, Powdery mildew of mulberry, Head smut of sorghum, Leaf rust of coffee, Blast disease of paddy, Tikka disease of groundnut, Leaf spot of paddy and Grassy shoot of sugarcane. 7. Isolation and identification sewage micro	1. Isolation, culturing and seed inoculation of *Rhizobium* and testing of nodulation ability and beneficial effects. 2. Isolation and testing the efficiency of various biofertilizers like *Rhizobium, Azotobacter, Azospirillum*. 3. Mass multiplication techniques of *Azolla.* 4. Estimation of total phenols in diseased and healthy plant tissues. 5. Seed health testing by SBM. 6. Collection and Identification of following disease: Tobacco mosaic disease, Bunchy top of Banana, Bean Mosaic, Sandal spike, Bacterial blight of paddy. Citrus canker, Downy mildew of Bajra, Powdery mildew of mulberry, Head smut of sorghum, Leaf rust of coffee, Blast disease of paddy, Tikka disease of groundnut, Leaf spot of paddy and Grassy shoot of sugarcane. 7. Isolation and identification of microflora of

flora. 8. Isolation and identification soil micro flora. 9. Isolation and Identification of airborne microbes– indoor and outdoor. 10. Microbes as indicators of water pollution – Determination of indices of water quality. 11. Determination of BOD of polluted water. 12. Determination of COD of polluted water. 13. Effect of high salt concentration on microbial growth. 14. Degradation of cellulose by *Chaetomium globosum.* 15. Bacterial examination of drinking water by membrane filters technique. 16. Study of associated soil microorganisms with plants, Actinorhiza, Mycorrhiza. 17. Study of important microbes in the degradation of wastes.	soil, sewage and air 8. Microbes as indicators of water pollution – Determination of indices of water quality. 9. Determination of BOD of polluted water. 10. Determination of COD of polluted water. 11. Degradation of cellulose by *Chaetomium globosum.* 12. Bacterial examination of drinking water by membrane filters technique. 13. Study of associated soil microorganisms with plants, Actinorhiza, Mycorrhiza. 14. Study of important microbes in the degradation of wastes. 15. Isolation of cellulose degraders, chitin and pesticide degraders 16. Determination of TS and MLSS