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

UNIVERSITY  **OF MYSORE**

Program: M. Sc., in Microbiology
Credit based Choice Based Continuous Evaluation Pattern System
(B.Sc. Honors and M. Sc. Microbiology) 80
credits course

DEPARTMENT OF STUDIES IN MICROBIOLOGY
MANASAGANGOTRI
MYSORE – 570 006

2012 -13

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)+ 40 (Masters) = 80 credits
Core papers	: 16 credits
Trans-border/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 2012-2013

Semester-I Credits: 20

No	Paper Code	Title of the course paper	Credit pattern in L:T:P	Credits
1.	**Hard Core** MB- 1.1	Bacteriology and Virology - Theory & Practical	2:1:1	4
2	**Hard Core** MB- 1.2	Mycology - Theory & Practical	2:1:1	4
3	**Hard Core** MB- 1.3	Microbial Genetics- Theory & Practical	2:1:1	4
Choose two among the three Soft Core				
4	**Soft Core-1** SMB-1.1	Microbial Diversity- Theory & Practical	2:1:1	4
	Soft Core -2 SMB-1.2	Techniques in Microbiology Theory & Practical	2:1:1	4
	Soft Core -3 SMB-1.3	Applied Microbiology Theory & Practical	2:1:1	4
			Total	**20**

HC=03; SC=02; O.E=0.

Semester-II Credits: 20

No	Paper Code	Title of the course paper	Credit pattern in L:T:P	Credits
1.	**Hard Core** MB- 2.1	Microbial Physiology- Theory & Practical	2:1:1	4
2	**Hard Core** MB- 2.2	Immunology- Theory & Practical	2:1:1	4
Choose two among the three Soft Core				
3	**Soft Core-1** SMB-2.1	Food Microbiology– Theory & Practical	2:1:1	4
	Soft Core -2 SMB-2.2	Dairy Microbiology- Theory & Practical	2:1:1	4
	Soft Core -3 SMB-2.3	Fermentation Technology- Theory	1:1	2
4	**Open Elective** OMB-2.1	Microbial Techniques- Theory & Practical	2:1:1	4
			Total	**20**

HC=02; SC=02; O.E=01.

M. Sc. Microbiology

Credit Based Choice Based Continuous Evaluation Pattern System

Proposed Semester-wise distribution of the course structure

Semester-III Credits: 20

No	Paper Code	Title of the course paper	Credit pattern in L:T:P	Credits
1.	**Hard Core**MB-3.1	Medical microbiology - Theory & Practical	2:1:1	4
2	**Hard Core**MB-3.2	Industrial Microbiology-Theory & Practical	2:1:1	4
3	**Hard Core**MB-3.3	Agricultural Microbiology-Theory & Practical	2:1:1	4
Choose one among the three Soft Core				
4	**Soft Core-1** SMB- 3.1	Environmental Microbiology - Theory & Practical	2:1:1	4
	Soft Core-2 SMB- 3.2	Soil Microbiology- Theory & Practical	2:1:1	4
	Soft Core-3 SMB- 3.3	Aerobiology- Theory & Practical	2:1:1	4
5	**Open Elective** OMB-3.1	General Microbiology	2:1:1	4
			Total	**20**

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

Semester-IV Credits: 20

No	Paper Code	Title of the course paper	Credit pattern in L:T:P	Credits
1.	**Hard Core**MB-4.1	Molecular Biology - Theory & Practical	2:1:1	4
Choose two among the three Soft Core				
2	**Soft Core** SMB- 4.1	Genetic Engineering- Theory& Practical	2:1:1	4
	Soft Core SMB- 4.2	Clinical& Diagnostic Microbiology- Theory & Practical	2:1:1	4
	Soft Core SMB- 4.3	Genomics and Proteomics - Theory	1:1	2
3	**PW MB- 4.3**	Project Work	0:2:6	8
			Total	**20**

HC=01; SC=02; O.E=00; Project work=08

Grand Total Credits: 80

SEMESTER I
HARD CORE 1.1: BACTERIOLOGY AND VIROLOGY

THEORY **32 Hours**

UNIT I **8 hours**

Historical overview of bacteriology, Contributions of scientists- Antony van Leeuwenhoek, Louis Pasteur, Robert Koch, Paul Ehrlich, Alexander Fleming. Important events in development of bacteriology, Scope and relevance of bacteriology.

Ultrastructure of Bacteria: An overview of bacterial size, shape and arrangement, Bacterial cell wall, Plasma membrane, Internal membrane systems, Cytoplasmic matrix, nucleoid, Inclusion bodies, Ribosomes, Flagella and pili, Bacterial motility and Endospore.

UNIT II **8 hours**

Microbial Growth and cultivation of Bacteria: Cell growth and binary fission, growth of bacterial population-growth cycle, Measuring microbial growth- direct and indirect measurements of microbial growth , Aerobic, anaerobic, batch and Continuous cultivation.Culture media: Simple, complex and special.

Economic importance of bacteria: A brief account of economic importance of bacteria in Agriculture (Biofertilizers- Rhizobium) growth promoting bacteria, Azospirillum. (Biopesticides – *Bacillus thurengiensis*), Industry-brewing, Medicine-vaccines, hormones and environment- bioleaching, bioremediation.

UNIT III **8 hours**

The science of virology: Foundations of virology: Virus prehistory, discovery of viruses. Definitive properties of viruses: Morphology, Ultra structure, Chemical composition - proteins, nucleic acids, and enzymes. Evolutionary importance of viruses.

Working with viruses: Visualization and enumeration of virus particles, Biological activity of viruses, Physical, chemical and structural components of viruses. Isolation and purification of viruses, Detection of viruses: physical, biological, immunological and molecular methods.

UNIT IV: **8hours**

Viruses and the future: Promises and problems. Emerging diseases, sources and causes of emergent virus diseases. **Silver lining**: viruses as therapeutic agents, viruses for gene delivery, viruses to destroy other viruses. Importance of studying modern virology.

PRACTICALS:

Bacteriology

1. Preparation of nutrient media and sterilization techniques, colony characters of bacteria.
2. Bacterial pure culture and subculture techniques. 3-
5. Isolation of bacteria from air, water, soil
6. Staining techniques – simple, gram, acid-fast.
7. Motility test
8. Endospore staining.
9. IMViC
10. Urease test
11. TSI
12. Capsule staining
13. Morphological characteristics of bacteria
14. Screening of amylase, protease and lipase producers
15. Quantification of the activity of microbial amylase

Virology

1. Plaque assay for Bacteriophages .
2. Cultivation and Enumeration of Bacteriophages.

3-4.Isolation of coliphages from sewage and testing for plaque formation by infecting susceptible bacterial culture.

5-6.Extraction and artificial inoculation of TMV to healthy tobacco plant and study of Viral symptoms

Reference: Bacteriology

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. Cappuccino, J. G. and Sherman, N. 1999. MICROBIOLOGY A Laboratory Manual 4th Edn. Addison – Wesley.
3. Barsanti, L and Gualtieri, P. 2005. Algae: Anatomy, Biochemistry, and Biotechnology. Taylor and Francis New York.
4. Becker, W. M., Kleinsmith, L.J. and Hardin, J. 2000. The world of the Cell. IVth Edition. Benjamin/Cummings.
5. Hogg, S. 2005. Essential Microbiology. John Wiley and Sons, Ltd.,
6. Holt T S, Krieq N R, Sneath PHA & Williams S T. 1994. Bergey's Manual of Determinative Bacteriology 9th Edn. Williams & Wilkim, Baltimore
7. Madigan M.T., Martinko M. J. and Jack Parker. 2003. Brock Biology of microorganisms. Pearson education., New Jercy.
8. Pelczar, (Jr.) M. J., Chan, E. C. S. and Kreig, N. R.1993. Microbiology. McGraw Hill, New York

   Perry, J.J. and Staley, J.T. 1997. Microbiology. Dynamics and Diversity. 4th edn. Wesley Longman pub. New York.
9. Perry, J.J., Staley, J.T. and Lory, S. 2002. Microbial Life. Sinauer Associates, Publishers, Sunderland, Massachusetts.
10. Presscott, L. M. Harley, J. P. and Klein, D. A. 1999. Microbiology, International edn. 4th edn. WCB Mc Graw-Hill.
11. Satyanarayana, T and Johri, B. N. 2005. Microbial Diversity – Current Perspectives and Potential Applications. I K Int. Pvt. Ltd. New Delhi.
12. Schaechter, M. Ingraham, J.L. and Neidhardt, F.C. 2006. Microbe. ASM Press, Washington.D.C.
13. Stainer, R. Y., Ingraha, J L, Wheelis, M. L. and Painter, P. K. 1986. General Microbiology. Mc Millan Edun. Ltd. London.
14. Stanley J.T. and Reysenbach A.L.1977. Biodiversity of microbial life. John Wiley 7 Sons Inc. Publication. New York.
15. Sullia, S.B. and Shantharam,S. 2000. General Microbiology (Revised) Oxford & IBH Publishing Co. Pvt. Ltd.
16. Talaro, K and Talaro A.1996. Foundations in Microbiology, II edition,WCB publishers.

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

Reference: Virology

1. Dimmock N.J., Easton,A.J., and Leppard,K.N. 2001. Introduction to Modern Virology. 5th edn. Blackwell publishing, USA.
2. Madigan M.T., Martinko M. J. and Jack Parker. 2003. Brock Biology of microorganisms. Pearson education., New Jercy.
3. Pelczar, (Jr.) M. J., Chan, E. C. S. and Kreig, N. R.1993. Microbiology. McGraw Hill, New York Perry, J.J. and Staley, J.T. 1997. Microbiology. Dynamics and Diversity. 4th edn. Wesley Longman pub. New York.
4. Perry, J.J., Staley, J.T. and Lory, S. 2002. Microbial Life. Sinauer Associates, Publishers, Sunderland, Massachusett
5. Presscott, L. M. Harley, J. P. and Klein, D. A. 1999. Microbiology, International edn. 4th edn. WCB Mc Graw-Hill.
6. Stainer, R. Y., Ingraha, J L, Wheelis, M. L. and Painter, P. K. 1986. General Microbiology. Mc Millan Edun. Ltd. London.
7. Stanley J.T. and Reysenbach A.L.1977. Biodiversity of microbial life. John Wiley 7 Sons Inc. Publication. New York.
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11. Wagner,E.K. and Hewelett,M.J.1999.Basic virology.Blackwell Science, Inc.

HARD CORE 1.2: MYCOLOGY

THEORY **32 Hours**

UNIT I **8 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 **8 hours**

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

UNIT III **8 hours**

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

UNIT I V **8 hours**

Economic importance of fungi: Fungi as biocontrol agent, importance of Fungi in Agriculture, Industry and medicine. Fungi as SCP, Fungi as parasites of human and plants

PRACTICALS

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. Study of *Chlorella, Scenedesmus, Cyclotella, Pinnularia*
10. Study of *Entamoeba, Trypanosoma, Leishmania , Plasmodium*

Reference:

1. Alexopoulas C J and Mims C W, 1979 Introductory Mycology 3rd edn, Wiley Eastern.,New Delhi.
2. Bold,H.C. & Wyne.M.j. 1978. Introduction to the algae: Structure and Reproduction: Prentice Hall and Englewood Cliffs, N.J.
3. Chapman & Chapman 1973. The Algae; Macmillan Co. N.Y.
4. Deacon, J W,1997- Modern Mycology 3rd Edition, Blackwell Science publishers, London.
5. Landecker E M, 1972 Fundamentals of Fungi Prentice-Hall, Angelwood Cliff, New Jersey.
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7. Mehrotra, RS & Aneja, K R, 1998. An Introduction to Mycology. New Age International Pvt. Ltd. New Delhi.
8. Odum, E.P. 1971. Fundamentals of Ecology; Third Edition. Toppan Co. Ltd. Tokyo, Japan.

HARD CORE 1.3: MICROBIAL GENETICS

THEORY **32 Hours**

UNIT I **8 hours**

Concepts in Microbial Genetics: History and developments of Microbial genetics. Microbes as Genetic Tools for Basic and Applied Genetic studies. Generalized reproductive cycles of microbes (Bacteria, Viruses, *Neurospora, Chlamydomonas, Saccharomyces, Acetabularia*)

UNIT II **8 hours**

Viral Genetics: Lytic and Lysogenic cycles, Phage Phenotypes, Phenotypic Mixing, Recombination in viruses: Mapping of rII loci.

Bacterial Genetics: Bacterial Transformation: Types of transformation mechanisms found in prokaryotes,

Bacterial Conjugation: properties of the F plasmid, F^+ x F^- mating, F' x F^- conjugation, Hfr conjugation. Transduction: Generalized and specialized transduction, Transposable elements.

UNIT III **8 hours**

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

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

UNIT IV **8 hours**

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

PRACTICALS **4X8=32 Hours**

1. Replica plating technique for transfer of bacterial colonies.
2. Demonstration of Bacterial transformation.
3. Demonstration of Plate mating.
4. Genetic recombination (Conjugation) in Bacteria.
5. Isolation of streptomycin resistant strain of *E .coli* by gradient plate method.
6. Isolation of DNA from bacteria by heat lysis method.
7. Isolation of DNA from yeast by DNA spooning technique
8. Ordered and random ascospore analysis in *Neurospora crassa*
9. Ultra-violet killing curve and determination of mutant types in *Saccharomyces cerevisiae.*
10. Induction of mutation

References:

1. Brooker, R. J. 1999. Genetis – Analysis and Principles. Benjamin/Cummings, an imprient of addition Wesley longman, Inc.
2. Gardner, E. J. 1984. Principles of Genetics 7th edn. John Wiley & Sons. Inc. New York. Hartl, D.L. 1994. Genetics. Jones and Bartler Publishers, London.
3. Moat, A.G., Foster, J.W. and Spector, M.P. 2002. Microbial Physiology, 4th edn. Wiley-Liss, Inc., New York.
4. Stanley R. Maloy, *Microbial Genetics Second Edition,*University of Illinois, Urbana, John Cronan, Jr., University of Illinois, Urbana, David Freifelder, Late of the University of California, San Diego
5. Strickberger, M. W.1985. Genetics, 3rd Edn. Mac. Millan Pub. Co. Inc. NY.

SOFT CORE 1.1: MICROBIAL DIVERSITY

THEORY **32 Hours**

UNIT I **8 hours**

Microbial World: Concepts and Scope: Types of diversity: Morphological, Structural, Metabolic, Biological, Ecological and Evolutionary diversity (Genetic diversity) of microbial world.

Classifying and Naming Microorganisms: Classification systems, ICNB Rules, Major Characteristics used to Classify Microorganisms.

UNIT II **8 hours**

Viral Diversity: 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.

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

UNIT III **8 hours**

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

UNIT IV **8 hours**

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

PRACTICALS **4X8=32 Hours**

1. Isolation and identification of Bacteria (up to the generic level) from food and water.
2. Isolation and identification of air microflora by Andersen sampler.
3. Isolation and identification and study of Actinomycetes from soil.
4. Isolation and identification and study of Cyanobacteria from soil / paddy field.
5. Isolation and study of Bacteriophages from sewage.
6. Preparation of basic solid media agar slants and agar deep tubes for cultivation of fungi.
7. Isolation and identification of fungi from soil/cereals/water by serial dilution technique.
8. Study of symbiotic fungi.
9. Isolation and Staining of Vesicular Arbuscular Mycorrhizae from soil.
10. Isolation of Aquatic fungi.
11. Isolation and identification and study of Algae from water.
12. Measurement of concentration of microorganism by Haemocytometer.
13. .Measurement of microorganism by Micrometer.
14. Identification of Yeast

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 Perry, J.J. and Staley, J.T. 1997. Microbiology. Dynamics and Diversity. 4th edn. Wesley Longman pub. New York.
7. Presscott, L. M., Harley, J. P. and Klein, D. A. 1999. Microbiology. 4th edn. WCB Mc Graw- Hill, New Delhi.
8. Satyanarayana, T. and Johri, B. N. 2005. Microbial Diversity – Current Perspectives and Potential Applications. I K Int. Pvt. Ltd. New Delhi.
9. Stainer, R. Y., Ingraha, J, L, Wheelis, M. L. and Painter, P. K. 1986. General Microbiology. Mc Millan Edun. Ltd. London.
10. Stanley J.T. and Reysenbach A.L.1977. Biodiversity of microbial life. John Wiley 7 Sons Inc. Publication. New York.
11. Wagner, E.K. and Hewlett, M.J. 1999. Basic Virology. Blackwell Science. Inc.CORE PAPER

SEMESTER II

HARD CORE 2.1: MICROBIAL PHYSIOLOGY

THEORY **32 Hours**

UNIT I **8 hours**

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**

Metabolism of Carbohydrate: Glycolysis, Citric acid Cycle and Oxidative level 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**

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**

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

Autotrophic Mechanisms in bacteria: Hydrogen bacteria, Nitrifying bacteria, Sulfur bacteria, Iron bacteria, Methylotrophs.

Microbial Stress Responses: Oxidative stress, Thermal stress, Starvation stress, Aerobic to anaerobic transitions.

PRACTICALS **4X8=32 Hours**

1. Effect of Environmental factors on microbial growth.
2. Study of acid and pH stress tolerance by microbes.
3. Population growth of yeast – *S. cerevisiae*.
4. Sugar fermentation tests.
5. Urease test.
6. Triple Sugar Iron Test.
7. IMViC tests.
8. Catalase activity.
9. Hydrolytic rancidity.
10. Casein hydrolysis.

References:

1. Alcomo, I.E. 2001. Fundamentals of Microbiology. VI Edition, Jones and Bartlett Publishers, Sudbury, Massachusetts.
2. Barsanti, L, and Gualtieri, P. 2005. Algae: Anatomy, Biochemistry and Biotechnology. Taylor and Francis New York.
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9. Palmer, T. 2004. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry. Affiliated East- West Press Pvt. Ltd. New Delhi.
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12. Perry, J.J., Staley, J.T. and Lory, S. 2002. Microbial Life. Sinauer Associates, Publishers, Sunderland, Massachusetts.
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14. Schaechter, M. Ingraham, J.L. and Neidhardt, F.C. 2006. Microbe. ASM Press, Washington.D.C.
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16. Stanley J.T. and Reysenbach A.L.1977. Biodiversity of microbial life. John Wiley 7 Sons Inc. Publication. New York.
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HARD CORE 2.2: IMMUNOLOGY

THEORY **32 Hours**

UNIT I **8 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; Acquired immunity: (specific) natural, artificial, passive immunity, Humoral or antibody mediated immunity, cell mediated immunity.

UNIT II **8 hours**

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 – structure and function, clonal selection, antibody diversity, monoclonal antibodies and its clinical applications, Antibody engineering (Construction of monoclonal antibodies Lymphoma and other diseases by genetically engineered antibodies.

UNIT III **8 hours**

Immunological disorders: Hypersensititivity Type I to Type IV, Immunodeficiency diseases; AIDS and other acquired or secondary immunodeficiencies, HIV – 1 infection and opportunistic infections. Autoimmuno diseases

UNIT IV **8 hours**

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

PRACTICALS **4X8=32 Hours**

1. Immunological Methods used for organism detection – production of antibodies for use in laboratory testing.
2. Serological Diagnosis of Infectious diseases – Serologic test Methods.

3-7 Precipitin test, ELISA, Ouchterlony Immunodifusion test, Immunoelectrophoresis, Complement fixation test.

8-10. Isolation of Antigens and raising antibodies from animals (from different Models), Development of polyclonal antibodies, purification of antibodies.

11. WIDAL Test.
12. VDRL Test (RPR).
13. HBs Ag Test.
14. HCG test(Agglutination inhibition test).
15. Detection of RA factor.
16. CRP test.
17. ASO Test (Anti streptolysin 'O' Test).

References:

1. Coleman, R.M.,Lombard, M.F. and Sicard, R.E. 1992. Fundamental Immunology, 2nd ed, Dubuque, Iowa:Wm. C.Brown.
2. Janeway, C.A., and Travers, P. 1997, Immunobiology: The immune system in health and disease, 3d ed. New York, Garland Publishing.
3. Kuby, J. 1997, Immunology, 3d ed. New York, W.H. Freeman.
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Baltimore.
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SOFT CORE 2.1: FOOD MICROBIOLOGY

THEORY **32 Hours**

UNIT I **8 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 **8 hours**

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

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

UNIT III **8 hours**

Food fermentations: bread, cheese, vinegar, fermented vegetables, fermented dairy products; Experimental and Industrial production methods. oriental Fermented foods, their quality standards and control.

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**

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

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

PRACTICALS **4X8=32 Hours**

1. Enumeration of food borne bacteria.
2. Enumeration of food borne fungi
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. Enumeration and quantification type of microorganisms present in fruit and vegetable.
9. Isolation and identification of pathogenic microorganisms from canned food. 10 –

11. Food Preservation Methods.
12. Enumeration of bacteria in raw and pasteurized milk by SPC method.
13. Determination of quality of a milk sample by MBRT.
14. Detection of number of bacteria in milk by breed-count method.
15. Litmus milk test.
16. Microbial quality of milk products.
17. Microbiological examination of Ice-cream and Dairy products.

References:

1. Adams M. R. and Moss M. O. 2000 Food Microbiology. Royal Society of Chemistry. Cambridge, U.K.
2. Ahmed E.Y. and Carlstrom C. 2003 Food Microbiology: A Laboratory Manual, John Wiley and Sons, Inc. New Jeresy.
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10. John S. Novak, Gerald M. Sapers, Vijay K. Juneja 2003. Microbial Safety of Minimally Processed Foods**.** CRC Press, Florida.
11. Koopmans M.P.G., Cliver D.O. and Bosch A 2008 Food-Borne Viruses Progresses and Challenges. ASM Press, U.S.A.
12. Lynne Ann McLandsborough 2003 Food Microbiology Laboratory. CRC Press, Florida. Neelam Khetarpaul 2006**.** Food Microbiology**.** Daya Publishing House**,** Delhi.
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16. Thomas J. Montville, Karl R. Matthews 2008**.** Food Microbiology: An Introduction.ASM Press, U.S.A.
17. Vijaya Ramesh K 2007 Food Microbiology. MJP Publishers, Chennai, India.

OPEN ELECTIVE PAPER 2.1-MICROBIAL TECHNIQUES

THEORY **32 Hours**

UNITI **8 hours**

Microscopy: Light microscopy- Simple, Compound and Stereomicroscopy.

Electron microscopy: Principles, construction and mode of operation of scanning and Transmission electron microscopy, Preparation of specimens for electron microscopic studies.

UNIT II **8 hours**

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

UNIT III **8 hours**

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

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

UNIT IV **8 hours**

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

Sterilization techniques: Principles, types of Sterilization, and their mode of action. Physical methods: Heat-dry heat, Incineration, Moist heat, Tyndalization (Fractional Sterilization), Filtration-Types of filters, Laminar airflow. Radiation methods.

PRACTICALS

1. Microscopy
2. Isolation of Microbes
3. Culturing of Microbes
4. Staining of Microbes
5. Motility test
6. Spread and spore plate Technique
7. Antimicrobial activity
8. Effect of alcohol and detergents on microbes

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SEMESTER III

HARD CORE 3.1: MEDICAL MICROBIOLOGY

THEORY **32 Hours**

UNIT I **8 hours**

Introduction to Medical Microbiology: History, Development and scope of Medical Microbiology. Contributions of Ronald Ross, Robert Koch, Paul Ehrlich, Elie Metchnikoff Nichole, Domagk, Alexander Fleming, Florey, Chain, Selman A. Waksman, Enders and Rous.

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

UNIT II **8 hours**

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

UNIT III **8 hours**

Epidemiology, Pathogenesis, Spectrum of disease, Laboratory diagnosis and Prevention:

Diseases caused by Viruses: Chicken pox, Rabies virus, hepatitis, encephalitis, AIDS, Herpes simplex infections, Influenza,Dengue

Diseases caused by Bacteria: Tuberculosis, Leprosy, cholera, Typhoid, Botulism, Shigellosis, Helicobacter pylori infection, Salmonellosis, Tetanus.

Diseases caused by Fungi: Candidiasis, Histoplasmosis, Blastomycosis, Coccidiomycosis, Dermatomycosis, Aspergillosis and Cryptococcosis, Anthrax

UNIT IV **8 hours**

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

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

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

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

PRACTICALS **4X8=32 Hours**

1. Pathogenic fungi of the skin (Dermatophytes).
2. Microbial flora of mouth – teeth crevices.
3. Microbial flora of saliva.
4. Microorganisms of respiratory tract-examination of sputum/ AFB acid – fast bacteria.
5. Estimation of bacteria in urine by calibrated loop direct streak method.
6. Antimicrobial assay – sensitivity test (MIC) for pathogenic bacteria.

8-14. Laboratory diagnosis of important human diseases: Diphtheria, Tuberculosis, Typhoid, Wound infections, Malaria, Leprosy, AIDS and Hepatitis.

References:

1. Brooks, G.F., Butel, J.S., and Ornston, L.N.1995. Jawetz, Melnick & Adelberg's Medical Microbiology, 20th ed, Stamford, Conn, Appleton & Lange.
2. Forbes, A.B., Sahm, D.F. and Weissfeld, A.S. Diagnostic microbiology. X Edn. Mosby publishers. New York.
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4. Rothman, K.J., and Greenland, S. 1998, Modern epidemiology, 2nd ed, Philadelphia, Lippincott- Raven.
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6. Stokes, J., Ridway, G.L. and Wren, M.W.D. 1993. Clinical Microbiology, 7th Edn. Edward Arnold – a division of hodder and Stoughton.
7. Straeiner, D, Norman, G. and Munroe-Blum, H. 1989. Epidemiology, Toronto, B.C. Decker.

HARD CORE PAPER 3.2: INDUSTRIAL MICROBIOLOGY

THEORY **32 Hours**

UNIT I **8 hours**

Introduction: Concepts and Scope. Modern era of industrial fermentation technology. Fermentation - concept and range of fermentation processes.

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 **8 hours**

Media for Industrial Fermentations: Continuous and batch culture, Media formulation, growth factors, carbon, nitrogen, Energy and Mineral sources, buffers, inhibitors, precursors, inducers, Oxygen requirements Antifoam agents and others, **Sterilization:** Media and Fermenter sterilization

Down stream processing: Steps in recovery and purification of fermented products. Solid matter, Foam separation, Precipitation, Filtration, Centrifugation, Cell disruption, Liquid- Liquid extraction, Solvent recovery, Supercritical fluid extraction, chromatography, Membrane processes, Drying, Crystallization, Whole broth processing.

UNIT III **8 hours**

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.

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. Production of proteases: Alkaline proteases, Neutral proteases and acid proteases.

UNIT IV **8 hours**

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 B_{12}, and Riboflavin.

Industrial production of health care product: Industrial production of β-lactum antibiotic (Penicillin): Biosynthesis, production and recovery. **Streptomycin.** Biosynthesis, production and recovery. **I P R: Patents:** Patent regulations of processes, products and microorganisms.

PRACTICALS **4X8=32 Hours**

1. Fermentor design and working principles.
2. Temperature, pH and gaseous analysis parameters.
3. Antifoam control device and detection of foam.
4. Roto meter and tachometer in the fermentor.
5. Sterilization of Fermentor/Media/air in a fermentor.
6. Batch and continuous sterilization process in a fermentor.
7. Primary inoculum development in a seed fermentor.
8. On-line measurement of a fermentation process.
9. Isolation of antibiotic/ amino acid/organic acid producing microbes and their preservation. 10.Batch fermentation of Citric acid production , recovery and estimation of citric acid.
10. Production of any vitamin and its quantification by bioassay.

11. Antibiotic fermentation and estimation of penicillin.
12. Preparation of wine and estimation of alcohol by specific gravity method.
13. Alcoholic fermentation and determination of total acidity and non-reducing sugars
14. Preparation of banana juice using Pectinase.
15. Culturing of *Chlorella / Spirulina.*
16. Visits to food industries, Dairy industries, Distilleries and Pharmaceutical industries and research laboratories. Student shall submit a report on the visits along with practical record for evaluation.

References:

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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.
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18. Puri, R.S. and Viswanathan, A. 2009. Practical Approach to Intellectual Property Rights. I.K. International Publishing House. New Delhi.
19. Raymond Bonnett 2010 Wine Microbiology and Biotechnology CRC press
20. Reed. G. 1999. Prescott and Dunn's Industrial Microbiology. CBS Publishers and Distributors. Richard H Baltz, Julian E Davies and Arnold L Demain 2010. Manual of Industrial Microbiology and Biotechnology 3e ASM Publisher
21. Robert Wayne Hutkins. 2006. Microbiology and technology of fermented foods, *IFT Press series, Volume 32 of Institute of Food Technologists Series.* Wiley-Blackwell.
22. Stanbury, P.H., Whitaker, A. and Hall, S.J. 1997. Principles of Fermentation Technology IInd Edition, Aditya Books (P) Ltd., New Delhi.

23. Stanbury. 1995. Principles of fermentation Technology, Pergamon Press, London.
24. Waites, M.J., Morgan, N.L., Rockey, J.S. and Higton, G. 2002. Industrial Microbiology: An Introduction. Blackwell Science.

HARD CORE 3.3: AGRICULTURAL MICROBIOLOGY

THEORY **32 Hours**

UNIT I **8 hours**

Introduction to Agricultural Microbiology: Concepts and scope of Agricultural Microbiology.

Plant Pathology: 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, Kochs' postulates.

UNIT II **8 hours**

Parasitism and Disease Development: Parasitism and pathogenecity, Host range of pathogens, Disease triangle, Diseases cycle / Infection cycle, Relationship between disease cycles and epidemics;

Mode of entry into the host plant – Mechanical forces, Microbial enzymes and toxins, Growth regulators.

Defense Mechanisms of Plant Disease Pre-existing structural and chemical defenses, Induced structural and biochemical defenses;

UNIT III **8 hours**

Plant Disease & their management: Tobacco Mosaic Disease, Potato Spindle Tuber 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.

UNIT IV **8 hours**

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

PRACTICALS **4X8=32 Hours**

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.*

5-6. Recording environmental factors (Temperature, RH, Rainfall and wind velocity).

7. Splash liberation of spores from diseased tissue.
8. Estimation of total phenols in diseased and healthy plant tissues.
9. Seed health testing by SBM.

10-14. 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.

References:

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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.
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15. Vidhyasekaran , P. 2008. Fungal pathogenesis in plants and crops: molecular biology and host defence mechanisms, *Volume 58 of Books in soils, plants, and the environment*, 2nd ed., illustrated, CRC Press.
16. Vidhyasekaran, P. 2004. Concise encyclopedia of plant pathology, *Food Products*, *Crop science*

SOFT CORE 3.1: ENVIRONMENTAL MICROBIOLOGY

THEORY **32 Hours**

UNIT I **8 hours**

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 II **8 hours**

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 III **8 hours**

Microbes in extreme environment: Microbes of extreme environments, Thermophiles, 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 **8 hours**

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.

PRACTICALS **4X8=32 Hours**

1. Isolation and identification sewage micro flora.
2. Isolation and identification soil micro flora.
3. Isolation and Identification of airborne microbes– indoor and outdoor.
4. Microbes as indicators of water pollution – Determination of indices of water quality.
5. Determination of BOD of pollution water.
6. Determination of COD of polluted water.
7. Effect of high salt concentration on microbial growth.
8. Degradation of cellulose by *Chaetomium globosum.*
9. Bacterial examination of drinking water by membrane filter technique.
10. Study of associated soil microorganisms with plants, Actinorhiza, Mycorrhiza.
11. Study of important microbes in the degradation of wastes.

References:

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3. Bhatia, A.L. 2010. Textbook of Environmental Biology. . I.K. International Publishing House. New Delhi.
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8. Suresh, G. 2007. Envirnomental Studies and Ethics. I.K. International Publishing House. New Delhi.
9. Tiwari, M., Khulbe, K. and Tiwari, A. 2007. Environmental Studies. I.K. International Publishing House. New Delhi.

OPEN ELECTIVE PAPER 3.1: GENERAL MICROBIOLOGY

THEORY **32 Hours**

UNIT I **8 hours**

Historical overview of Microbiology, Contributions of scientists- Antony van Leeuwenhoek, Louis Pasteur, Robert Koch, Paul Ehrlich, Alexander Fleming. Important events in development of microbiology, Scope and relevance of microbiology,

Classifying and Naming Microorganisms: Classification systems, ICNB Rules, Major Characteristics used to Classify Microorganisms.

UNIT II **8 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.

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

UNIT III **8 hours**

Control of Microorganisms: Chemical methods: Definition of terms- Disinfectants, Antiseptics, Sanitizers, Microbicides, Microbistatic. Use and mode of action of Alcohols, Aldehydes, Halogens, Phenols, Heavy metals, and Detergents.

Sterilization techniques: Principles, types of Sterilization, and their mode of action. Physical methods: Heat-dry heat, Incineration, Moist heat, Tyndalization (Fractional Sterilization), Filtration-Types of filters, Laminar airflow. Radiation methods.

UNIT IV **8 hours**

Economic importance of Microorganism: Agriculture, Industry, Medicine, Environment.

PRACTICALS

10. Preparation of nutrient media and sterilization techniques, colony characters of bacteria.
11. Bacterial pure culture and subculture techniques.
12. Isolation of bacteria from air, water, soil
13. Culturing of Microbes
14. Staining of Microbes
15. Motility test
16. Spread and spore plate Technique
17. Antimicrobial activity
18. Effect of alcohol and detergents on microbes
19. Measurement of concentration of fungal conidia by Haemocytometer.

REFERENCES:

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2. Aneja, K.R. 1993. Experiments in Microbiology, Plant Pathology. Rastogi and Company, Meerut. Cappuccino, J. G. and Sherman, N. 1999. MICROBIOLOGY A Laboratory Manual 4th Edn. Addison – Wesley.
3. Becker, W. M., Kleinsmith, L.J. and Hardin, J. 2000. The world of the Cell. IVth Edition. Benjamin/Cummings.
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Madigan M.T., Martinko M. J. and Parker,J. 2003. Brock Biology of microorganisms. Pearseducation., New Jercy.

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10. Stainer, R. Y., Ingraha, J L, Wheelis, M. L. and Painter, P. K. 1986. General Microbiology. McMillan Edun. Ltd. London.
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SEMESTER IV

HARD CORE 4.1: MOLECULAR BIOLOGY

THEORY **32 Hours**

UNIT I **10 hours**

Concepts in Molecular Biology: Microbes in molecular biology.

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

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, Proof reading and correction mechanism.

UNIT II **6 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, DNA recombination: Homologus recombination, Site specific Recombination and Retrotransposition.

UNIT III **8 hours**

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

Transcription: Transcription in prokaryotes and eukaryotes, Eukaryotic transcription factors. RNA processing, Ribozymes, Antisense RNA, Inhibitors of transcription and their mechanism of action.

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 post-translational events.

UNIT IV **8 hours**

Regulation of Gene expression: Regulation of gene expression in prokaryotes. Regulation of gene expression in bacteriophages, eukaryotes. Gene regulation during development, gene silencing – gene regulation after transcription.

PRACTICALS **4X8=32 Hours**

1. Preparation of stock solutions and working solutions for molecular biology practicals.
2. Isolation of Genomic DNA from *E. coli*.
3. Purification, concentration and quantification of DNA.
4. Determination of purity and concentration of isolated DNA using spectrophotometer.
5. Isolation of RNA and its quantification.
6. Salt fractionation of Yeast protein and quantification.
7. Separation of proteins by SDS PAGE.
8. Separation of aminoacids by paper chromatography.
9. Isolation and purification of plasmids from bacteria by agarose gel electrophoresis.
10. Determination of base ratios (Tm) in nucleic acids

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. Hartl, D.L. 1994. Genetics. Jones and Bartler Publishers, London.
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SOFT CORE 4.1: GENETIC ENGINEERING

THEORY **32 Hours**

UNIT I **8 hours**

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.

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, Adenoviruses, Retroviruses, Synthetic construction of vectors, Ti cloning vector

UNIT II **8 hours**

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**

Analysis of gene and gene products: Isolation and purification of nucleic acids, staining, DNA finger printing - RFLP,RAPD, DNA sequencing. Protein Sequencing. Blotting techniques- Southern, Northern and Western blotting techniques. PCR and its variants.

Microbial genome sequencing projects: DOE microbial genome programme, TIGR microbial database. Analysis of genome sequences, DNA chips: studying gene expression using DNA microarrays.

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.

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.

PRACTICALS **4X8=32 Hours**

1. Estimation of DNA
2. Estimation of RNA
3. Estimation of protein by Lowry's method
4. Separation of amino acids by paper chromatography
5. Digestion of the gene of interest with suitable restriction enzymes.
6. Ligation of the digested gene in a vector.
7. Preparation of competent *E. coli* cells for Bacterial transformation.
8. Transformation of the vector into the host cell and selection of the desired clones.

9. Induction of gene expression and purification of the induced protein from the host.
10. Amplification, Purification and separation of PCR product.
11. Determination of DNase activity on isolated DNA.
12. Determination of RNase activity on isolated RNA.
13. Determination of Proteinase activity on proteins.
14. Demonstration of Western, Northern and Southern Blotting.
15. RFLP.

References:

1. Boylan, M. and Brown, K.E. 2003. Genetic Engineering- Science and Ethics on the New Frontier. Pearson Education (Singapore) Pte. Ltd.,
2. Brown, T.A. 2001.Gene Cloning and DNA Analysis-An Introduction 4th edn. Blackwell Science
3. Chauhan, A.K and Varma, A. 2006. Microbes Health and Environment. I.K. International Publishing House. New Delhi.
4. Chauhan, A.K and Varma, A. 2009. A Text Book of Molecular Biotechnology. I.K. International Publishing House. New Delhi.
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6. Lodish, H., Berk, A., Zipursky, S. A., Matsudaira, P., Baltimore, D. and Darnell, J. 1999. Molecular Cell Biology, W.H. Freeman and Company, New York.
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9. Ron Fridell. 2006. An Introduction to genetic engineering Lerner Publication company USA. Sateesh, M.K. 2008. Bioethics and Biosafety. I.K. International Publishing House. New Delhi.
10. Snyder, L., and Chapness, W. 2003. Molecular Genetics of Bacteria. 2nd edn. American society for Microbiology. USA.
11. Verma, A. and POdila, G.K. 2005. Biotechnological Applications of Microbes. I.K. International Publishing House. New Delhi.
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13. Winnacker, E. L. 1987. From Genes to Genomes. Introduction to Gene Technology. VCH. Weinheim.

SOFT CORE 4.2: CLINICAL & DIAGNOSTIC MICROBIOLOGY

THEORY **32 Hours**

UNIT I **8 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 Detection of infectious diseases: RPR, WIDAL, VDRL, HBs-Ag, HIV, H1N1, SARS, Dengue, TB & Malaria.

UNIT II **8 hours**

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

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

UNIT III **8 hours**

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

UNIT IV **8 hours**

Antimicrobial Chemotherapy: Development of chemotherapy and chemoprophylaxis 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.

PRACTICALS **4X8=32 Hours**

1. Collection of clinically important specimens, processing and identification of specimens.
2. Common stains used in Microbiology.
3. Microscopic examination of blood, feacus, CSF, other body fluids, pus (including drainage tube, catheter, ear, eye and genital swab.
4. Isolation and enumeration of Anaerobic bacteria from wound specimen.
5. Isolation and identification of Human pathogenic fungi and other opportunistic organisms.
6. Isolation and identification of microorganisms from sputum, throat, nose, ears swabs and urine samples.
7. Antimicrobial susceptibility testing and Serum Assay for Antimicrobial Content.
8. Conventional methods for bacterial identification- TSI, Catalase, Oxidase, Indole, Urease, Carbohydrate, PYR-Test, Urease strip test.
9. Detection of infectious diseases: RPR, WIDAL, HBsAG, HIV, Tuberculosis, Malaria, *Candida, Aspergillus, Cryptosporidium*.
10. Preparation of Antigens, control sera for serological tests.

Reference

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2. Fernandes, P.B. 1996, Pharmaceutical perspective on the development of drugs to treat infectious diseases. ASM Press.
3. Gootz.T.D. 1990. Discovery and development of new antimicrobial agents, Clinical Microbiology.
4. Isenberg, H.D.,editor, 1992, Clinical microbiology procedures handbook, Washington, D.C. American Society for Microbiology.
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6. Murray, P.R., editor-in-chief, 1995, Manual of clinical microbiology, 6th ed. Washington, D.C., ASM Press.
7. Rose, N.R., Macario, E., Fahey, J., Friedman, H., and Penn, G., edigtors. 1997, Manual of clinical laboratory immunology, 5th ed, Washington, D.C., American society for Microbiology.
8. Stites, D.P., Terr, A. I., and Parslow, T.G. 1994, Basic and clinical immunology, 8th ed, Norwalk, Conn, Appleton and Lange.
9. Turgeon, M.L., 1990. Immunology and serology in laboratory medicine, St.Louis, C.V. Mosby Co.

UNIVERSITY  **OF MYSORE**

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

DEPARTMENT OF STUDIES IN MICROBIOLOGY
MANASAGANGOTRI
MYSURU – 570 006
2015 -16

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 Outcome

Microbiology is a subject where, students' study about different bacteria, archaea, fungi, algae and viruses. They isolate bacteria, fungi and viruses from different sources like soil, water, air, sewage, different food samples and characterize and identify them based on their cultural and biochemical characteristics. Microbiology involves the study about concepts, mechanism and applications in the field of genetics, physiology, immunology, medical microbiology, molecular biology, industrial microbiology and genetic engineering which makes them to learn about genome organization, metabolism, manipulation of genes, molecular basis of microbes, production of antibiotics, enzymes. 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.

Microbiologists have various opening in fields like pharmacy, diary, food industry, clinical research, water industry, agriculture, chemical technology, nanotechnology, agrochemistry biotechnology, biorefinery, environment, pollution control and bioremediation, pathology labs or they can find career in hospitals apart from research. In the field of agriculture, microbiologists act as environmental and health specialists to study the role of microbes in plant disease, pest control, nutrition and soil fertility. In the field of medicine and health care, the work is usually associated with diagnosis, prevention and treatment of illnesses associated with microbes.

They can also be entrepreneurs starting up small-scale industry for production of SCP (Single cell protein), production of bio-fertilizers etc. A microbiologist can innovate new diagnostic kits, discover new drugs, Student with PG in microbiology, he/she can work in microbiology-based industries like pharmacy, dairy, breweries, distilleries, enzyme, etc. and you also can pursue PhD. On completion of Ph.D. they can take up teaching at the universities and PG colleges. They can also take up a post-doctoral research.

Program Pedagogy

The seminar presentation will improve the oration skills of students and group discussion will kindle their logical ability to analyse 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.

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
Trans-border/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	Title of the course paper	Credit pattern in L:T:P	Credits
1	MB 1.1 Hardcore	Virology	3:1:0	4
2	MB 1.2 Hardcore	Bacteriology	3:1:0	4
3	MB 1.3 Hardcore	Mycology	3:1:0	4
Select 3 among 4 papers				
4a	MB 1.4 Softcore	Microbial Genetics	3:1:0	4
	MB 1.5 Softcore	Microbial Ecology & Diversity	3:1:0	4
5	MB 1.6 Softcore	Practical I(Virology & Bacteriology)	0:0:2	2
6	MB 1.7 Softcore	Practical II (Mycology & Microbial Genetics)	0:0:2	2

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

Semester-II Credits: 20

No	Paper Code	Title of the course paper	Credit pattern in L:T:P	Credits
1	MB 2.1 Hardcore	Microbial Physiology	3:1:0	4
2	MB 2.2 Hardcore	Immunology	3:1:0	4
Select 3 among 4 papers				
3	MB 2.3 Softcore	Food Microbiology	3:1:0	4
	MB 2.4 Softcore	Soil Microbiology	3:1:0	4
4	MB 2.5 Softcore	Practical III(Microbial Physiology & I Immunology)	0:0:2	2
5	MB 2.6 Softcore	Practical IV (Food Microbiology)	0:0:2	2
6	MB 2.7 O.E	Microbial Diversity	2:2:0	4

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

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

Semester-III Credits: 20

No	Paper Code	Title of the course paper	Credit pattern in L:T:P	Credits
1	MB 3.1 Hardcore	Molecular Biology	3:1:0	4
2	MB 3.2 Hardcore	Genetic Engineering	3:1:0	4
3	MB 3.3 Hardcore	Industrial Microbiology	3:1:0	4
Select 3 among 4 papers				
4	MB 3.4 Softcore	Medical Microbiology	3:1:0	4
	MB 3.5 Softcore	Clinical & Diagnostic	3:1:0	4
5	MB 3.6 Softcore	Practical V(Molecular Biology & Genetic Engineering)	0:0:2	2
6	MB 3.7 Softcore	Practical VI (Industrial Microbiology & Medical Microbiology)	0:0:2	2
7	MB 3.8 O.E	Techniques in Microbiology	1:1:0	2

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

Semester-IV Credits: 16

No	Paper Code	Title of the course paper	Credit pattern in L:T:P	Credits
1	MB 4.1 Hardcore	Agricultural Microbiology	3:1:0	4
Select 2 among 3 soft core				
2	MB 4.2 Softcore	Environmental Microbiology	2:0:0	2
	MB 4.3 Softcore	Genomics & Proteomics	2:0:0	2
3	MB 4.4 Softcore	Practical VII (Agricultural Microbiology & Environmental Microbiology)	0:0:2	2
4	MB 4.5 Hardcore	Project Work	0:2:6	8

HC= 01; SC=02; PW=01

Grand Total Credits: 76

SEMESTER I

MB 1.1 Hardcore: VIROLOGY

Course Outcome: Upon successful completion of the course, the student:

- Is able to describe classification of viruses
- Is able to describe tools for studying virus structure, process of virus attachment and entry, virus assembly and release
- Is able to describe steps in replication of genome of RNA viruses, retroviruses, and DNA viruses
- Is able to describe steps in virus infection, transmission, patterns of infection, virus virulence, and host defense against virus infection
- Is able to describe methods of making virus vaccines and anti-viral drugs, drivers of virus evolution, and emerging viruses
- Is able to describe unusual infectious agents, virus mediated cellular transformation and oncogenesis
- Is able to describe evasion strategies used by viruses, and learn to apply their knowledge to investigate virus outbreak

Course pedagogy: Virology is a sub-discipline of Microbiology which focuses on the basic knowledge of viruses, their reproduction and pathogenesis within a host cell.

The contents of the course are divided into four units. This course will emphasize basic concepts of viruses, their diversity (structural, host range and genetic), various methods employed in virus studies, replication strategies, host virus interactions, emerging viral diseases, antiviral strategies in prevention and control of viral diseases and their applications, evolution and future prospective. These concepts are taught across thirty two hours, which include lectures in which students are provided information and illustrations of various virus aspects, and tutorials in which students present seminars of the topics assigned.

The lecture will impart students with knowledge and make them understand how viruses are built, replicate and evolve, cause disease, prevention of infection and their applications. The knowledge gained about viruses helps the students to develop interest in this field and helps the students to work in laboratories that are interested in isolation of viruses from various ecological niche, molecular pathogenesis, vaccines, antiviral drugs, applications such as virus vectors development and in health and diagnostic laboratories.

THEORY **32hours**

UNIT I **8 hours**

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.

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 2 **8 hours**

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.

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 3 **8 hours**

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.

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

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, anti- idiotype and DNA vaccines.

UNIT 4 **8 hours**

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

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

References:

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

ELECTIVE PAPER 1.2: BACTERIOLOGY

Course Outcome: Upon successful completion of the course, the student:

- Will be able to describe the morphological features, cell arrangement and structural components of bacterial cell in detail. Is able to differentiate between Gram-positive and Gram-negative bacteria.

- Will have gained knowledge about cell wall structure and extracellular appendages in different bacteria and will be acquainted with current methodologies available for production of protoplasts and L-forms
- Can enlist the characteristics of archaea that differentiate it from eubacteria, and will have learnt key features of some model archaeal organisms.
- Will have gained in-depth knowledge about density based signal transduction in bacteria and its significance in competence, sporulation and antibiotic resistance. Will know about quorum quenching and its uses

Teaching and Learning Activity:

- Detailed discussion on the general morphology of bacteria and the basic differences in gram-positive and gram-negative cell structure and the detailed structure of gram-negative and gram-positive bacterial cell walls and extracellular appendages through diagrammatic representations.
- Employing video lectures and interactive diagrams of the secretion systems that exist in bacteria for enabling students to differentiate between the Sec, SRP and Tat secretion pathway. Acquainting students with bacterial sortases.

Course Pedagogy: Bacteriology is the sub-disciplinary course of Microbiology. Bacteriology is the study of bacteria and their importance in medicinal and other areas such as agriculture, industries. Bacteria are single celled microorganisms which can live as independent organisms or dependently as parasites. Superficially bacteria appear to be relatively simple forms of life; in fact they are sophisticated and highly adaptable.

The discipline of bacteriology evolved from the need of physicians to test and apply the germ theory of disease and from economic concern relating to the spoilage of food and wine. The contents of this course are divided into various units and each unit focuses on various aspects of bacteriology such as serial dilution technique, microscopy, staining technique, classification and taxonomy and economic importance of bacteria.

Under this subject we are studying scope and history, economic importance of bacteria, cell structure and microscopy. Growth, cultivation and control of bacteria. Salient features of some major groups of bacteria.

Bergey's manual- the primary purpose of the 4 volumes was to provide detailed information on bacterial classification and detailed characteristics of taxa and species. We are still following Bergey's manual as a standard to classify bacteria.

In beginning bacteriology parallel to the development of microscope. Microscopes are used to study the microbes and their cells, crystalline structure and the molecular structure, mainly scanning and transmission electron microscope. The staining makes the procedure of visualization easier as microbes appear colored against a white background. Cells may be stained to highlight metabolic processes or to differentiate between live and dead cells in a sample. Different staining techniques are used to differentiate different stages of bacteria.

Bacteria have its economic importance in various fields like industries, pharmaceuticals, agriculture, food industries. Bacteria have both beneficial and harmful effects. Certain bacteria cause diseases in humans such as Cholera, Salmonellosis, Tuberculosis, Typhoid and Diphtheria. Hence there is a need to study these disease causing bacteria and we can prevent these diseases.

The knowledge gained under this subject helps the student to work in laboratories, pharmacological industries, and in any industries where microorganisms are used as chief source.

THEORY **32 Hours**

UNIT I **8 hours**

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.

Morphology and Ultra structure and 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 II **8 hours**

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 III **8 hours**

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 IV **8 hours**

Economic importance of bacteria: A brief account of economic importance of bacteria in Agriculture, industry- brewing, medicine-Vaccines, hormones and environment-bioleaching, bioremediation.

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

Course outcome:

- In mycology classes they understand the world of fungi and lichens,
- Appreciate the adaptive strategies of the fungi and lichens,
- understand the economic and pathological importance of fungi, and Identify common plant diseases and device control measures
- In tutorial classes they do group discussions on use full and pathogenesis of different fungi involved in daily life.
- In practical classes they mount the fungi, learn microscopic views and the key characteristics to identify different species of fungi.

Course Pedagogy: Mycology is the sub-branch of Microbiology, which is concerned with the study of fungi. It includes the study of taxonomic classification, fungal genetics, and biochemical properties. Fungi are fundamental for life as symbionts, also takes part in biodegradation process. They are socially and economically important as they are capable of causing diseases in plants, animals and human beings.

Study of fungi is highly important as it plays major role in production of food supplements like SCP, fermentation industries, vitamins, enzymes, organic acids. Another notable element is production of secondary metabolites like antibiotics which acts against other microbes. In agriculture, knowledge pertaining to fungi should be maximum as it causes plant diseases leading to economic loss. Fungal infections have more devastating effects on human health and hence clinical significance of fungi has gained more attention, due to its wide applications and effects, the study of fungi is highly recommended.

THEORY **32 Hours**

UNIT I **8 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).

UNITII **8 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 **8 hours**

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

UNIT I V **8 hours**

Economic importance of fungi: Fungi as biocontrol agent, Economic importance of Fungi in Agriculture, Industry and medicine. Fungi as SCP, Fungi as parasites of human and plants.

Role of fungi in bio deterioration of wood and paper. Mycorrhiza – ectomycorrhiza, endomycorrhiza, vesicular 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

Course outcome:

- Can discuss the importance of mutation analysis, can analyze mutations by complementation and recombination tests, and can design a strategy to create gene replacement in bacteria
- Is able to explain how plasmid copy number is regulated, can differentiate between Hfrstrains and strains carrying F plasmid, and can construct a genetic map of bacterial genome using conjugation-based method
- Is able to compare and contrast generalized versus specialized transduction, knows how to construct genetic linkage maps using two-factor and three factor cross, is able to discuss the basis of natural competence in bacteria.
- Is able to list the events in the lytic and lysogenic phases of lambda phage life cycle and the regulatory factors and events involved.
- Can list the outcomes of transposition events, can design strategies to mutagenize bacteria using transposons, can explain the construction of conditional knockouts
- Can differentiate between positive and negative regulation of gene expression, inducible and repressible systems. Can describe the regulation of the lac, trp, gal,ara and tol operons.
- Will have learnt about the model organisms used in biological studies.

Course Pedagogy: Microbial genetics deals with the transmission of hereditary characters in microorganisms like bacteria, viruses and algae which play a unique role in developing field of molecular and cell biology and plays wide role in applications in the field of medicine, agriculture, food and pharmaceutical industry. The benefits of microbial genetics in the field of agriculture are increased in crop yields which reduce the cost for food or drug production, reduce need for pesticide and medical benefits to the worlds growing population by recombinant DNA technology and as vectors.

The importance of genetics study involves; To understand the gene function of microorganisms. Microbes provide relatively simple system for studying genetic

phenomenon and thus useful to other higher organisms. Microorganisms are used for isolation and multiplication of specific genes of higher organisms which is referred as gene cloning. Microbes provide many values added products like antibiotics, growth hormones etc. Microbial genetics will be helpful to increase these products productivity by microbial technology. Understanding the genetics of disease-causing microorganisms especially virus, will be crystal to control disease. Gene transfer among the prokaryotes play major role in the spread of the genes in a particular environment. Microbial genetics will be useful to study the gene transfer from one organism to another.

THEORY **32 Hours**

UNIT I **8 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 **8 hours**

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

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**

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

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

UNIT IV **8 hours**

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

References:

1. 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; Benjamin Cummings

MB 1.5 Softcore: MICROBIAL ECOLOGY AND DIVERSITY

Course Outcome:

- To understand the ubiquitous nature of microbes.
- To provide knowledge on characteristics of Microbes Outcome
- Students able to differentiate various groups of Microbes
- Get knowledge on adaptability of extremophiles
- Knowledge about microbial taxonomy.
- To create awareness on evolutionary relationship of ecosystem
- To learn about individual ecosystem and its interactions.
- To understand the concepts of community ecology Outcome
- Better understanding of evolutionary relationship of ecosystem
- Get more knowledge on individual ecology
- Able to understand the role of microbes in ecology

Course Pedagogy: Microbial ecology and diversity is a sub discipline of microbiology (environmental Microbiology) which focuses on the huge diversity of microbes, its interaction among themselves and the ecosystem. Microbes embody the vast diversity of life on earth. In their natural environments, microbes interact with each other, with plants and animals. Such interactions are essential for ecosystem function and may relate to plant and animal health, biogeochemical cycles and numerous other processes.

Overall this course enables students to learn how the microbial world rules over the entire ecosystem focusing on their interactions which form the basis of survival. The study helps us improve our lives via the use of microbes in environmental restoration, food production, bio-engineering of useful products such as antibiotics, food supplements and chemicals. This course is for all biology, allied heath, environmentalists and microbiology students.

The knowledge gained under this subject helps the students to work in laboratories like pharmacological industries, clinical health and diagnostic laboratories, environmental research fields, microbial research and any industry where microorganisms and involved. The need of the hour is to focus on the importance of conservation of microbial diversity mainly the role of culture centers in conservation.

THEORY **32 Hours**

UNIT I **8 hours**

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

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

UNIT II **8 hours**

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

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

.UNIT III **8 hours**

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

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

UNIT IV **8 hours**

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

References

1. 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
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10. OladeleOgunseitan (2004) Microbial Diversity: Form and Function in Prokaryotes; Wiley-Blackwell
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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 1.5 Softcore: Practicals I (Virology and Bacteriology)

1. Isolation of coliphages from sewage and testing for plaque formation by infecting susceptible bacterial culture.
2. Extraction and artificial inoculation of TMV to healthy tobacco plant and study of viral symptoms.
3. Isolation of bacteria from water.
4. Isolation of bacteria from soil.
5. As study of bacterial growth curve with determination of growth rate of *E.coli* culture

6. Evaluation of bacterial growth in liquid media: Diauxic growth curve.
7. Endospore formation and staining in *Bacillus subtilis*
8. Motility test
9. Endospore staining.
10. IMViC
11. Urease test
12. TSI
13. Capsule staining
14. Morphological characteristics of bacteria.

MB 1.6 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

SEMESTER II

MB 2.1 Hardcore: MICROBIAL PHYSIOLOGY

Course Outcome:

- Will be acquainted with methods of measuring microbial growth, calculating growth kinetic parameters with understanding of steady state and continuous growth.
- Will have gained an in-depth knowledge of primary, secondary and group translocation transport systems existing in bacteria, simultaneously learning membrane transport proteins and kinetics of solute transport.
- Will have learnt central metabolic pathways for carbon metabolism in bacteria enlisting differences with eukaryotic systems and their regulation in diverse physiological conditions. This allows students to apply the acquired knowledge in engineering metabolic pathways for developing industrially useful strains.
- Will have gathered understanding of inorganic and organic nitrogen assimilation and its regulation. Also knows role of glutathione in cellular redox regulation and biochemistry of glutamate overproducing strains.
- Will have learnt basic concepts of enzyme biochemistry, its kinetics and regulation.
- Will understand details of lipid and nucleotide metabolism in E. coli and its regulation along with biochemical basis of lipid accumulation in yeasts.
- Is conversant with intracellular signaling in bacteria in response to various nutritional and physiological stresses.

Course Pedagogy: Microbial physiology is defined as the study of microbial cell functions which includes the study of microbial growth, microbial metabolism and microbial cell structures. Microbial physiology is important in the field of metabolic engineering and also functional genomics. Study of microbial structures, functions and response of microbial activity to environmental stress, metabolism, genetic composition of microbes. The contents of the course are divided into four main chapters or units those are: A) Microbial physiology, B) Carbohydrate metabolism, C) lipid metabolism, D) Microbial photosynthesis and each unit focuses on various aspects of microbial physiology. A changing environment creates conditions that can be stressful for microorganisms, and they are neither immortal, nor impervious to stress. Microbes must have physiological acclimation mechanisms to survive and remain active in the face of stress or they will die. However, those adaptation and acclimation strategies create physiological costs at the organism level and can alter the composition of the active microbial community, creating shifts in ecosystem-level C, energy, and nutrient flows. Microbial physiology is an important research field, not only in fundamental research on microbial species but also in all applied aspects of microbiology i.e, Industrial Microbiology, Environmental Microbiology and Medical Microbiology. Microbial physiology is an important research field, not only in fundamental research on microbial species but also in all applied aspects of microbiology i.e, Industrial Microbiology, Environmental Microbiology and Medical Microbiology. The microbial physiology group studies the physiology of the aerobic microorganisms and anaerobic microbial communities that play an important role in environmental biotechnological processes, such as waste water treatment, soil remediation, production of chemicals and biofuels and recovery of metals. The microbial physiology group studies the physiology of the aerobic microorganisms and anaerobic microbial communities that play an important role in environmental biotechnological processes, such as waste water treatment, soil remediation, production of chemicals and biofuels and recovery of metals.

THEORY **32 Hours**

UNIT I **8 hours**

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**

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**

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**

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

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

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

MB 2.2 Hardcore: Immunology

Course Outcome:

- Will be able to understand the fundamental bases of immune system and immune response
- Will be able to gather information about the structure and organization of various components of the immune system
- Will be able to understand the genetic organization of the genes meant for expression of immune cell receptors and the bases of the generation of their diversity
- Will be able to understand the operation and the mechanisms which underlie the immune response
- Will be able to apply the knowledge gained to understand the phenomena like host defense, hypersensitivity (allergy), organ transplantation and certain immunological diseases

Course Pedagogy: Immunology is the branch of biology which deals with various aspects that forms an integrated network of cells, molecules, and organs within the immune system. This course helps students to learn and understand basic concepts as well as its application in various fields of biology.
The content of the course consist of four units where each unit focuses on basic aspects of immunology and its application. The course begins with the brief introduction regarding overview of immune system followed by the mechanism of immunological reactions, immunotechniques, immunodiagnosis and its application in the field of medicine. At the end of each unit a student is able to understand how the immune system develops, how the body defends itself against disease, and what happens when it all goes wrong.
Studying this subject will equip students with basic practical skills to work in vast fields like pathology, pharma industries, diagnostics and hospitals.

THEORY **32 Hours**

UNIT I **8hours**

Introduction to Immunology: An overview of immune system, Phagocytes, Natural killer cells, mast cells, basophils, Dendritic cells and other cells of the inmate immune system. Immunity**:** Types- Innate immunity: (nonspecific) physical, biochemical and genetic factors involved in governing innate immunity, molecules of inmate immunity – complement, acute phase proteins and interferons; Chemokines and Cytokines . Acquired immunity: (specific) natural, artificial, passive immunity, humoral or antibody mediated immunity, cell mediated immunity.
Antigens and Antibodies: Antigen processing and presentation, properties of antigen, Super antigen, Hapten; Haptens and the study of antigenicity Microbes as antigen Antigen recognition and MHC molecules. Antibodies – 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**

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

UNIT III **8 hours**

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

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

UNIT IV **8 hours**

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

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

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

Course Outcome:

- Will know about production and evaluation of the quality of starter cultures and fermented milk products and understands the use and production of probiotics, prebiotics and nutraceuticals.
- Is aware of fermentation protocols for production of microbial biomass such as edible yeasts, mushrooms, single cell proteins and single cell oils. The student also learns about production of microbial carotenoid pigments such as lycopene and β-carotene.
- Gathers information regarding microbes causing food intoxications and food-borne infections.
- Knows traditional food preservation techniques including drying, salting, pickling, refrigeration, freezing, oxidation, vacuum packaging, canning/bottling, smoking, sugaring, chemical preservation and irradiation.

- Is able to utilize modern techniques viz. high-pressure processing (HHP), bacteriocins, manosonication (MS) and pulsed electric field (PEF) for effective food preservation. The student can also calculate kinetics of inactivation, process and product parameters.
- Gains knowledge about conventional methods for food quality analysis and is able to use the most recent and non-invasive techniques of quantification and detection of food borne microbes and pathogens such asESS and various new imaging techniques.
- Understands the relevance of microbial standards for food safety, quality assurance programs that revolutionize food safety.

Course Pedagogy: Food microbiology is a sub-discipline of Microbiology which focuses on the study of the microorganisms that ferment, inhibit or contaminate food. It also includes the study of microorganisms that cause food spoilage and those with other useful roles.

The course emphasizes basic concepts of food microbiology, contamination and food spoilage, dairy microbiology, food poisoning and intoxication, food produced by microbes, detection of food borne microorganisms and microbial indicators of food safety quality control, food law and legislation.

Dairy industry is an excellent example where bacteria, yeasts, molds and viruses are very important in determining the quality of final product. They are also used to produce fermented foods such as cheese, yogurt, bread, beverages, and those with other useful roles such as producing probiotics, single cell proteins and mushroom cultivation.

Food Microbiology is important to study food borne diseases of microbial origin, microbial food spoilage, beneficial uses of microbes in food, control of microbial growth in foods, destruction of microbes in foods, microbial food fermentation, pro-biotic bacteria, regulatory aspects to ensure consumers related to microbial hazards in food.

The lecture will impart students with knowledge, how microorganisms are useful to produce food, how they contaminate, spoil and cause diseases and how to detect their presence in the food. The knowledge gained about food microbiology helps the students to develop interest in this field and helps the students to work in the food industries that are interested in isolation, detection of food borne pathogens and production of food products from microorganisms.

THEORY **32 Hours**

UNIT I **8 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 **8 hours**

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

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

UNIT III **8 hours**

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 monocytogens*, Food borne Gastroenteritis by *Salmonella* and *Shigella, Vibrio, Campylobacter* and *Yersinia*, fungal spoilage and Mycotoxins.

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**

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

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

References:

1. Stephen J. Forsythe. 2010. The Microbiology of Safe Food, 2nd Edition. Wiley-Blackwell.
2. Jay, James M., Loessner, Martin J., Golden, David A. 2004.Modern Food Microbiology. 7th ed. Springer
3. Bibek Ray, ArunBhunia. 2013. Fundamental Food Microbiology, Fifth Edition. CRC Press
4. Frazier W.C. and Westhoff C.D. 2008 Food Microbiology. Tata Mc Graw Hill Publishing Company Limited, New Delhi. Indian Edition.
5. Pitt, John I., Hocking, Ailsa D. 2009. Fungi and Food Spoilage 3rd Edition. Springer.
6. C Blackburn.2006. Food Spoilage Microorganisms. Woodhead Publishing.
7. Sperber, William H., Doyle, Michael P. (Eds.). 2010. Compendium of the Microbiological Spoilage of Foods and Beverages. Springer.
8. Pina M. Fratamico, Arun K. Bhunia, and James L. Smith. 2008. Foodborne Pathogens: Microbiology and Molecular Biology. Caister Academic Press.
9. Dongyou Liu. 2009. Molecular Detection of Foodborne Pathogens. CRC Press.
10. Adams M. R. and Moss M. O. 2007. Food Microbiology 3rd Edition. Royal Society of Chemistry. UK.
11. Ahmed E.Y. and Carlstrom C. 2003 Food Microbiology: A Laboratory Manual, John Wiley and Sons, Inc. New Jeresy.
12. Elmer H. Marth, James Steele. 2001. Applied Dairy Microbiology, Second Edition. CRC Press.
13. Marshall, Richard J. (Ed.). 2007. Food Safety. Springer.

MB 2.4: Softcore: SOIL MICROBIOLOGY

Course Outcome:

- Students will learn that the soil is an excellent habitat for multitude of microorganisms balancing the soil ecosystem.
- The knowledge acquired in Soil Microbiology will enhance the students' competency in the performance of their duties as future employees in the field of Agronomy/Soil Science.
- Attainment of course objectives will mean realization of the various beneficial effects of soil microorganisms on soil health, which is instrumental in the production of food and fiber. Conversely, students learned that some soil microbes are deleterious to agronomic crops
- Students will learn that some soil animals and what they eat are of ecological importance; thus, plant eating insects and mollusks may add organic matter to the soil; insects, arachnids, and worms that consume dung and plant litter mix it with soil and speed up its decay; and, plant parasitic nematodes reduce soil's productivity.

Course Pedagogy: Soil microbiology is the study of all microorganisms that exist in the soil, specifically the ways they function and affect soil properties. Our soils are pulsating with life, serving as excellent hosts for the growth and development of various organisms. In fact, there are more microbes in one teaspoon of soil than there are people on the planet. This collection of organisms consists of bacteria, fungi, and algae that serve many vital roles in the overall nourishment of soils.

Within just one handful of soil lives around 100 million bacteria. These bacteria are largely responsible for the process of nitrogen fixation; converting atmospheric nitrogen into compounds that can be used by plants. Although not as commonly abundant as bacteria, fungi also assist with extremely significant functions of soil health. While one of their main activities is decomposition of organic matter, fungi also perform necessary services related to water and nutrient cycling. Fungi are responsible for binding soil particles together, assembling a system to increase water filtration and water holding capacities. In a similar manner as fungi, earthworms also break down organic matter, such as dead leaves, and produce natural fertilizers. They too support soil fertility with the transportation of water throughout the soil, as well as air, by creating tunnels that allow the two to flow freely.

THEORY **32 Hours**

Unit I **4 Hours**

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

Unit II **4 Hours**

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

Unit III **4 Hours**

Biogeochemical Cycles: carbon, sulphur and iron cycle in soil.

UNIT IV **4 Hours**

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

Unit V **2 Hours**

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**

Soil-Borne Diseases and Human Health: *Clostridium tetani* (tetanus), Toxoplasmosisis, 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.
8. Metcalf, R.L. and Luckmann, W.H. 1994. Introduction to insect pest management 3ed edn. John Willey and Sons, Inc.
9. Motsara, I.M.R., Bhattacharyya, P. and Srivastava, B. 1995. Biofertilizer Technology, Marketing and usage-A source Book-cum- glossary- FDCO, New Delhi.
10. 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

Course Outcome:

- Describe common groups of bacteria and archaea in different ecosystems, and their role in biogeochemical key processes in these environments.
- Describe for cultivation-independent methods for studies of the composition of microbial communities and for the function and occurrence of individual groups.
- Describe genomic-based methods to study microbial diversity in nature and for the mechanisms behind it.
- describe important interactions within microbial communities and between microorganisms and plants and animals.
- Evaluate, synthesize and present scientific studies of genetic and functional microbial diversity in different ecosystems.
- Use bioinformatic tools and databases that are used to study microbial diversity.
- Has acquired a fairly good understanding of the Diversity of the microbes
- Has acquired a fairly good understanding of the activities/importance of microbes.
- Has acquired practical skills of handing microorganisms in the laboratory for study

Course Pedagogy: Microbial diversity is a sub discipline of microbiology focuses on the huge diversity of microbes, its interaction with the ecosystem. Such interactions are essential for ecosystem function and may relate to plant and animal health, biogeochemical cycles and numerous other processes.

Overall this course enables students to learn how the microbial world rules over the entire ecosystem focusing on their interactions which form the basis of survival. The study helps us improve our lives via the use of microbes in environmental restoration, food production, bio-engineering of useful products such as antibiotics, food supplements and chemicals.

The knowledge gained under this subject helps the students to work in laboratories like pharmacological industries, clinical health and diagnostic laboratories, environmental research fields, microbial research and any industry where microorganisms and involved. The need of the hour is to focus on the importance of conservation of microbial diversity mainly the role of culture centers in conservation.

THEORY **32 Hours**

UNIT I **8 hours**

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

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

UNIT II **8 hours**

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

UNIT III **8 hours**

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

UNIT IV **8 hours**

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

References

1. Alexopoulos, C. J. and Mims, C. W. 1979. Introductory Mycology. III edition, Wiley Eastern, New Delhi.
2. Dimmock, N. J., Easton, A. J. and Leppard, K. N. 2001. Introduction to Modern Vorology. 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.
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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. Wagner, E.K. and Hewlett, M.J. 1999. Basic Virology. Blackwell Science. Inc.CORE PAPER

SEMESTER III

MB 3.1 Hardcore: MOLECULAR BIOLOGY

Course Outcome:

- Is able to describe structure of DNA and RNA, organization of eukaryotic genome
- Is able to compare and contrast the mechanisms of bacterial and eukaryotic DNA replication, DNA repair, transcription
- Is able to explain concepts in DNA repair mechanisms, and recombination as a molecular biology tool
- Is able to explain various levels of gene regulation in both prokaryotic and eukaryotic organisms
- Is able to describe post-transcriptional processes, RNA editing, RNAi and miRNA
- Is able to describe translation mechanism in prokaryotes and eukaryotes, regulation of translation, and post-translational processing
- Is able to describe post-translational processes.

Course Pedagogy: Molecular biology is the root branch of biology which deals with biomolecules, it's modifications and other molecular level mechanisms occurring in the body of living organisms. This field is developed out of related fields like genetics, biochemistry, biophysics and microbiology. Molecular biology gives a wide information on basic concepts of DNA structure and replication, DNA damage and recombination, synthesis of proteins by transcription, translation and regulation of gene expression in bacteria, bacteriophage, eukaryotes. Each unit is well presented with basic descriptions of cellular mechanisms of both prokaryotes and eukaryotes. In this discipline the major interest is drawn towards the differences in the molecular mechanisms in prokaryotes and eukaryotes.

The students view is synchronized into the world of biomolecules for the better understanding of molecular mechanism, cell to cell interaction, cell replication, mutations. This discipline allows the students to understand the molecular mechanisms so that they can study the cause of evolutionary existence of life and also the various diseases that result due to the changes in the biomolecules.

THEORY **32 Hours**

UNIT I **8 hours**

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

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

UNIT II **8 hours**

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

UNIT III **8 hours**

Gene Expression: Structure of RNA- Classes of RNA, Chemistry of RNA. **Transcription:** Transcription in prokaryotes and eukaryotes, Eukaryotic transcription factors. RNA processing, Ribozymes, Antisense RNA, Inhibitors of transcription and their

mechanism of action.

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 post- translational events.

UNIT IV **8 hours**

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. Molecular Cell Biology, W.H. Freeman and Company, New York.

MB 3.2 Hardcore: GENETIC ENGINEERING

Course Outcome:

- Students will become familiar with the tools and techniques of genetic engineering DNA manipulation enzymes, genome and transcriptome analysis and manipulation tools, gene expression regulation, production and characterization of recombinant proteins.
- This course exposes students to the applications of genetic engineering in biological research.
- Students will be able to perform basic genetic engineering experiments at the end of course.
- Students will acquire knowledge of advances in biotechnology- healthcare, agriculture and environment cleanup via recombinant DNA technology.
- Given the impact of genetic engineering in modern society, the students should be endowed with strong theoretical knowledge of this technology. In conjunction with the practicals in molecular biology & genetic engineering, the students should be able to take up biological research as well as placement in the relevant biotech industry

Course pedagogy: Genetic Engineering is an inter-disciplinary subject of biology which focuses on gene manipulation techniques using living systems and the applications of manipulated genes. This course helps students learning the components, techniques of gene manipulation in organisms and use of these techniques to create novel products(vaccines, enzymes GMOs).

The contents of the course are divided into four units. Each unit focuses on tools, techniques used in gene manipulation, applications of recombinant DNA, ethics concerned with gene manipulation and bioinformatics. Overall, this course teaches students the importance and scope of genetic engineering in the current world.

The lecture will impart knowledge of using these techniques in various fields such as agriculture to create transgenic plants, in therapeutics or medicine to create vaccines, to

cure genetic diseases. In industries to increase efficiency of production of various microbial products, in forensic science to identify suspects, paternity issues etc.., this subject has wide scope and great significance in the world.

THEORY **32 Hours**

UNIT I **8 hours**

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.

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, Adenoviruses, Retroviruses, Synthetic construction of vectors, Ti cloning vector

UNIT II **8 hours**

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**

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.

Microbial genome sequencing projects: DOE microbial genome programme, TIGR microbial database. Analysis of genome sequences, DNA chips: studying gene expression using DNA microarrays. Nest Generation sequence.

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.

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 BiotechnologyFundamentals 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.
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Cambridge Univ. Press. Cambridge
8. Maheshwari, D.K., Dubey, R.C. and Kang, S.C.(2006) Biotechnological Applications of Microorganisms. I.K. International Publishing House. New Delhi.
9. P. K. Gupta. (2008) Molecular Biology and Genetic Engineering. Deep and Deep Publications. India.
10. VK Gupta, MSchmoll, M Maki, MTuohy, MAMazutti. (2013) Applications of Microbial Engineering. CRC Press.

MB 3.3 Hardcore: INDUSTRIAL MICROBIOLOGY

Course Outcome:

- Get equipped with a theoretical and practical understanding of industrial microbiology
- Appreciate how microbiology is applied in manufacture of industrial products
- Know how to source for microorganisms of industrial importance from the environment
- Know about design of bioreactors, factors affecting growth and production, heat transfer, oxygen transfer
- Understand the rationale in medium formulation & design for microbial fermentation, sterilization of medium and air
- Appreciate the different types of fermentation processes
- Understand the biochemistry of various fermentations
- Identify techniques applicable for Improvement of microorganisms based on known biochemical pathways and regulatory mechanisms
- Comprehend the techniques and the underlying principles in downstream processing.

Course Pedagogy; Industrial microbiology is a branch of applied microbiology. Which deals with the microorganisms and fermentation technology used for production of high value added products such as therapeutic agents, fuels, food items, chemicals, sweeteners, detergents, beverages, enzymes, vitamins, and proteins. The course imparts detailed fundamental principles and of industrial microbial processes.

The course contained four units and focuses on basic industrial equipment's, isolation and screening of microorganisms, media formulation, production and key factors for optimum maintenance, recovery process and production economics, commercial value and their applications. The course provides the basic knowledge of the industrial processes and biosynthesis of potent microbial agents.

This course makes the students as entrepreneurs and gives so many jobs for the people. From this knowledge nation can be stand as independent from other countries for their energy source.

This course helps the students to work in the pharmaceutical, chemical, food technological, beverages and dairy industries and biotechnological sectors includes biomedical, bio prospecting and biomass industries.

THEORY **32 Hours**

UNIT I **8 hour**

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.

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 **8 hours**

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

Downstream processing: Steps in recovery and purification of fermented products.

UNIT III **8 hours**

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.

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. Production of proteases: Alkaline proteases, Neutral proteases and acid proteases.

UNIT IV **8 hours**

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 B_{12}, and Riboflavin. Alcoholic beverages (Beer, Wine, Brandy, Rum)

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

Course Outcome:

- This course provides learning opportunities in the basic principles of medical microbiology and infectious disease.
- It covers mechanisms of infectious disease transmission, principles of aseptic practice, and the role of the human body's normal microflora.
- The course provides the conceptual basis for understanding pathogenic microorganisms and the mechanisms by which they cause disease in the human body.
- It also provides opportunities to develop informatics and diagnostic skills, including the use and interpretation of laboratory tests in the diagnosis of infectious diseases.
- To understand the importance of pathogenic bacteria in human disease with respect to infections of the respiratory tract, gastrointestinal tract, urinary tract, skin and soft tissue.
- Helps to understand the use of lab animals in medical field.
- Recall the relationship of this infection to symptoms, relapse and the accompanying pathology.
- Explain the methods of microorganism's control, e.g. chemotherapy & vaccines. Solve problems in the context of this understanding.

Course Pedagogy: Medical microbiology, the large subset of microbiology that is applied to medicine, is a branch of medical science concerned with the prevention, diagnosis and treatment of infectious diseases. In addition, this field of science studies various clinical applications of microbes for the improvement of health.
Medical microbiology, also known as "'clinical microbiology'", is the study of microbes, such as bacteria, viruses, fungi and parasites, which cause human illness and their role in the disease..

Clinical microbiology laboratories perform aerobic and anaerobic bacteriology, parasitology, mycobacteriology, mycology, and virology. Clinical microbiology is also a rather complex discipline because it utilizes many different types of methodologies and constantly undergoes changes in testing methods. There is significant overlap in methods used to diagnose microbial diseases, and the microbiology laboratory may comprise several disciplines (e.g., classical culture methods, antigen detection methods, molecular methods, and serological methods are often performed under the purview of microbiology). The wide variety of pathogens and testing methods that are available makes microbiological testing challenging, and thus error detection and

correction are important components of quality laboratory testing. Errors may occur at all stages of testing (pre-analytical, analytical, and post-analytical), and an error in one stage of testing is likely to overlap with or lead to errors in other stages (e.g., incorrect specimen collection can lead to culture, identification, and reporting of organisms that are not involved in the disease process, and incorrect or unnecessary therapy as a result). In the clinical microbiology laboratory, as in every other discipline, the frequency of analytical errors has been reduced considerably with the implementation of quality control and quality assurance programs. Despite the improvements in microbiological testing, microorganisms remain a constant challenge, and errors do occasionally occur. Clinical microbiology is somewhat unique among the laboratory disciplines in that it remains heavily reliant on manual testing and interpretive/subjective skills, and it is somewhat subjective. Despite improvements, analytical errors can occur in the clinical microbiology laboratory. Common sources of error and methods to prevent them are discussed as general concepts relevant to clinical microbiology, followed by specific examples grouped by specimen or testing method.

THEORY: **32 Hours**

UNIT I **8 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.

UNIT II **8 hours**

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.

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**

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

UNIT IV **8 hours**

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

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

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

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
8. Marjorie Kelly Cowan (2012) Microbiology Fundamentals: A Clinical Approach; McGraw- Hill Science/Engineering/Math
9. Connie R. Mahon , Donald C. Lehman , George Manuselis Jr. (2010) Textbook of Diagnostic Microbiology ; Saunders
10. Ananthanarayan ,Paniker(2009)Textbook of Microbiology , 8th Edition; University Press
11. Jawetz (2010)Medical Microbiology ,25th Edition; Tata McGraw - Hill Education

MB 3.5 Softcore: CLINICAL & DIAGNOSTIC MICROBIOLOGY

Course Outcome:

- Various bacterial, viral, fungal and protozoal disease their causative agent, mode of infection, epidemiology, treatment, lab diagnosis, prophylaxsis.
- students will develop skill regarding Isolate and identify microorganism form laboratory sample,
- Antibiotics senstitivity and resistance test
- Detection of parasite
- Handling of blood and body fluids

Course Pedagogy: Clinical and Diagnostic Microbiology is a specialty within the sciences which focuses on applying microbiology to medical application. Similarly to being concerned with the identification of a disorder-inflicting organism, diagnostic microbiology can also be a part of modifying a treatment plan. Microbes including bacteria, protozoans, and fungi play a vital factor in many disease processes. The various laboratory techniques like microscopy, immunological assessments, radiology, biomarker tests, ELISA, serology checks, vaccines vectors are the primary diagnostic tests which are currently in use. Many microbes have developed resistance to medications. Hence, it's far essential for the scientists to give smarter methods of diagnosing those microbes and their pathogenic mechanisms

THEORY **32 Hours**

UNIT I **8 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 **8 hours**

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

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

UNIT III **8 hours**

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

UNIT IV **8 hours**

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

Reference

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,
6. Alberto M. Marchevsky and Mark Wick. (2011). Evidence Based Pathology and Laboratory Medicine. Springer publication.
7. David E. Bruns; Edward R. Ashwood; Carl A. Burtis; Barbara G. Sawyer (2007). Fundamentals of Molecular Diagnostics St. Louis, Mo. : Saunders Elsevier
8. 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.
9. Huw Llewelyn , Hock Aun Ang, Keir E Lewis and Anees Al-Abdullah (2009). Oxford Handbook of Clinical Diagnosis. Oxford publications.
10. Peter Hu Madhuri Hegde and Patrick Alan Lennon (2012). Modern Clinical Molecular Techniques. Springer publications.

11. Henrik Winther and Jan T. Jorgensen (2010). Molecular Diagnostics. Springer publications.
12. 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

Course Outcome:

- To acquire knowledge on food product analysis
- To enable them to know about preservation of pharmaceutical products
- Learn to assess the microbial quality of marine foods Outcome
- Acquire Knowledge on food product analysis
- Impart knowledge of preservation technology.
- Knowledge on quality analysis of marine food products

Course Pedagogy: It is a sub-discipline of Microbiology which focuses on microbiological techniques or methods used for the study of microbes, including bacteria, fungi and protists. This course helps students learning fundamental procedures and safety guidelines followed in the microbiology laboratory.

This course teaches students the basic skills necessary to be successful in the laboratory as well as provides easy to follow, step-by-step, directions on how to perform each technique based in microbiology. Along with clear instructions, pictures are provided, so that the student can visually see how to proceed through the technique to minimize errors. Also, at the end of each unit, the student will be able to recognize and interpret the results of the technique based on the pictures and information provided in the unit lecture. Each technique is well presented with clear illustrations for every step, followed by safety measures and tips for troubleshooting. This course to all biology, allied health and microbiology students.

The lecture will impart the students with knowledge and skills about how to culture, stain, identify, preserve and control of microorganisms. The skills and knowledge gained about techniques in microbiology helps the students to work in the laboratories like food and dairy industries, pharmacological industries, clinical, health and diagnostics laboratories, and any industries where microorganisms are used.

THEORY **32 Hours**

UNIT I **8 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, limitations. Preparation of specimens for electron microscopic studies (Ultra thin sectioning, negative staining, shadow casting and freeze etching).

UNIT II **8 hours**

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

UNIT III **8 hours**

Culture media for Microbes Types of media- general purpose media, special purpose 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 cathode rays).

UNIT IV **8 hours**

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

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

References:

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2. Aneja, K.R. 1993. Experiments in Microbiology, Plant Pathology. Rastogi and Company, Meerut. Cappuccino, J. G. and Sherman, N. 1999. MICROBIOLOGY A Laboratory Manual 4th Edn. Addison – Wesley.
3. Becker, W. M., Kleinsmith, L.J. and Hardin, J. 2000. The world of the Cell. IVth Edition. Benjamin/Cummings.
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14. Talaro, K and Talaro, A.1996. Foundations in Microbiology, II edition, WCB publishers.
15. 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

Course Outcome:

Approaches used in agriculture to control disease in plant

- Microbial ecology and microbial interaction
- Pathogenic interactions with plant
- Microbial biocontrol agents

Course Pedagogy: Agricultural microbiology is a branch of microbiology dealing with plant associated microbes. It also deals with microbiology of soil fertility, such as microbial degradation of organic matter and soil nutrient transformations. It aims to address problem in agricultural practices usually caused by lack of biodiversity in microbial communities.

An understanding of microbial strains relevant to agricultural applications is useful in the enhancement of factors such as soil nutrient, plant pathogen resistance, crops robustness fertilization uptake effectively. The many symbiotic relationship between plant and microbes can ultimate be exploited for greater food production necessary to feed expanding new population safer to minimize the ecological disruption. The microbes are also used as bio fertilizers, bio pesticides, and fungicides.

Agricultural microbiology also explains about the plant pathogen and the control measures against these plant pathogens. The use of techniques for the proper harvest and storage of the crops and its prevention from the contamination by microorganisms. The loss caused by damage or spoilage of stored crops will impact on the economy.

The syllabus includes four disciplines which deal with the introduction to agricultural microbiology, the plant pathology, parasitism and disease development, the defense mechanism of plant, plant disease and their management, the microbes and plant interaction and the bio pesticides. It also deals with production and application of *Rhizobium, Azospirillum, Azotobacter*. The toxins produced by Bacillus *thuringiensis, Psuedomonas, Beauveria, Cephalosporium* and *Trichoderma* also covered.

The advanced studies on the agriculture and microorganisms related to agriculture have been proved to enhance the production of good quality and high yield crops. The production of drought and disease resistant plants has been taking place by applying the concepts of biotechnology and use of microorganisms.

The concept of sustainable agriculture is a response to the decline in the quality of the resources based associated with modern agriculture. The relationship between agricultural, the global environment and social system suggest that agricultural development results for the complex interactions of a multitude of factors.

This course makes knowledge about agricultural cultivation and products. Which makes environmental friendly and costless for the farmers.

THEORY **32 Hours**

UNIT I **8 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, Kochs' rules;

UNIT II **8 hours**

Parasitism and Disease Development Parasitism and pathogenecity, Host range of pathogens, Disease triangle, Diseases cycle / Infection cycle, Relationship between disease cycles and epidemics;

Pathogens Attack Plants – Mechanical forces, Microbial enzymes and toxins, Growth regulators. Effect on physiology of Host – Photosynthesis, Translocation and transpiration, Respiration, Permeability, Transcription and translation. Environment and Plant Disease– Effect of Temperature, Moisture, Wind, Light, Soil, pH and structure, Nutrition and Herbicides.

Defense Mechanisms of Plant: Disease Pre-existing structural and chemical defenses, Induced structural and biochemical defenses.

UNIT III **8 hours**

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

UNIT IV **8 hours**

Microbes and Plant interaction-Mycorrhizae-Biology and their applications, Biofertilizers - microbial inoculants. Production and application of *Rhizobium, Azospirillum, Azotobacter,* phospho 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:

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2. Mehrotra. R.S. and Ashok Aggarwal (2002), Plant pathology, Tata MC Graw-Hill publishers, 2nd edition, 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, 2nd edition, 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.
7. Roger Hull (2013).Plant virology, Elsevier academic press, 1th edition, U.K.
8. Hermann H. Prell, Peter R. Day. (2001). Plant-Fungal Pathogen Interaction: A Classical and Molecular View, 1st edition, Springer-Verlag Berlin Heidelberg, Germany.
9. Geoffrey Clough Ainsworth (1981). Introduction to the History of Plant Pathology 1st edition, Cambridge university press, U.K.
10. Vidhyasekaran, P. (2007). Fungal Pathogenesis in Plants and Crops: Molecular Biology and Host Defense Mechanisms, 2nd edition, APS press, U.S.A.

MB 4.2 Softcore: ENVIRONMENTAL MICROBIOLOGY

Course Outcome:

- Will have an overview of the till date developments in the field of environmental microbiology with special emphasis on the role of microbes in mitigating environment pollution.
- Will have become acquainted with various cultural, biochemical and molecular techniques used in understanding microbial diversity.
- Will be knowledgeable about the diversity, adaptations and biotechnological applications of microbes of extreme environment.
- Is able to describe the role of microbes in solid and liquid waste management, gaining knowledge of various methods employed in sewage treatment and solid waste treatment.

- Understands the role of microbes in bioremediation of environmental pollutants like petroleum hydrocarbons, pesticides, plastic and electronic waste; also understands utility of microbes in mineral and oil recovery.

Course Pedagogy: Microbial communities control nutrient cycles and biogeochemical transformations in natural, managed and engineered ecosystems. Microorganisms recycle organic matter, transform contaminants, and maintain ecosystem health. Understanding the ecology of natural microbial communities will deepen our understanding of how ecosystems function. Since microbial communities are critical for ecosystem function, microbial ecology can also assist the development of models to predict how ecosystems will respond to future environmental conditions.

Environmental Microbiology introduces students to the diversity of microbial populations and their important roles in environmental processes in air, water, soils, and sediments. Microbial community ecology and interactions with plants and animals will also be discussed. Students will learn how microbial activities sustain natural ecosystems and contribute to environmental quality, and also how these functions are harnessed to support managed and artificial systems. Techniques for characterizing microorganisms and investigating microbial processes will also be discussed.

Student preparation: Prior experience in environmental science, microbiology, and biochemistry is helpful; however, introductory lectures review basic principles of microbiology and biochemistry, providing a minimum background for the remainder of the course.

This helps to utilize bio wastes from industrial field and agricultural fields. This recycling of bio wastes leads to costless and environment clean .Students can teaches how to maintain the environment condition to others and build the nation strong by learning this course.

THEORY **32 Hours**

UNIT I **8 hours**

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 II **8 hours**

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 III **8 hours**

Microbes in extreme environment: Microbes of extreme environments, Thermophiles, 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 **8 hours**

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.

References:

1. Raina M. Maier, Ian L. Pepper. (2009).Environmental Microbiology. 2nd edition, Academic press, U.S.A.
2. Paulsen, Ian T., Holmes, Andrew J. (2014). Environmental Microbiology. 2nd edition, Springer-Verlag Berlin Heidelberg, Germany.
3. Singh, Ajay, Ward, Owen P. (2004). Biodegradation and Bioremediation. Springer-Verlag Berlin Heidelberg, Germany.
4. Surajit Das. (2014). Microbial Biodegradation and Bioremediation. Elsevier academic press, 1st edition, U.K.
5. Gabriel Bitton. (2005). Waste water Microbiology. John Wiley & Sons publishers, U.K.
6. Pradipta K. Mohapatra . (2008). Textbook of Environmental Microbiology. I K International Publishing House Pvt. Ltd, New Delhi.
7. Frederic P. Miller, Agnes F. Vandome, McBrewster John. (2010). Bioleaching. VDM Publishing house, Mauritius.
8. Martin Alexander. (1999). Biodegradation and Bioremediation. Academic press, U.S.A.
9. Shree Nath Singh. (2011). Microbial Degradation of Xenobiotics. Springer Heidelberg Dordrecht, London, U.K.
10. Nicholas P. Cheremisinof. (2002). Handbook of Water and Wastewater Treatment Technologies. Butterworth-Heinemann publishers, U.S.A.

MB 4.3 Softcore*:* GENOMICS AND PROTEOMICS

Course Outcome:

- The aim of this course is to teach genomics, transcriptomics, proteomics, metabolomics and phonemics using model organisms representing plants and animals.
- The course will cover recent developments in genomics, gene expression and small RNAs, synthetic biology, epigenetics, proteomics, fast-forward genetics and next-generation mapping.
- An objective of the course is to develop skills in experimental design within the context of learning about biology including: regulation of transcription and translation, stress response, signal transduction and the engineering and regulation of metabolic pathways.

Course Pedagogy: Genomics is the study of entire genomes, including the complete set of genes, their nucleotide sequence and organization, and their interactions within a species and with other species. The advances in genomics have been made possible by DNA sequencing technology. Genomic information is used to create similar maps of the DNA of different organisms. *Proteomics* generally refers to the large-scale experimental analysis of proteins and proteomes

Bioinformatics helps the students to understand Genomics and proteomics which uses the computational knowledge in helps in extracting the knowledge from biological data. This helps in data analysis, visualization, prediction, primer designing, data storage etc., through web based tools like NCBI.

Students are able to understand and use the knowledge of bioinformatics and do Insilco analysis to verify and test their hypothesis before they start their wet lab experiments. Bioinformatics helps in drug discovery and students will be placed in pharmaceutical and drug companies

THEORY **32 Hours**

UNIT I **8 hours**

Genome - Overview Of Genome; Sequence Of Genome Acqusition 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.

UNIT III **8 hours**

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**

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**

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.

References

1. Lynn Jorde , Peter Little , Mike Dunn and Shankar Subramaniam (2014). Encyclopedia of Genetics, Genomics, Proteomics and Bioinformatics. Wiley Publication. UK
2. Suhai, Sándor (2002). Genomics and Proteomics. Springer publications.
3. Nawin Mishra (2010). Applications of Proteomics I: Proteomics, Human Disease, and Medicine. Wiley publication. UK
4. Ganapathy Subramanian and Nawin Mishra (2012). Science of Proteomics: Historical Perspectives and Possible Role in Human Healthcare. Wiley Publications. UK
5. Ferenc Darvas, András Guttman, György Dormán (2013). Chemical Genomics and Proteomics (2nd Ed). CRC Press.
6. Ruchi Singh (2014). BIOINFORMATICS: GENOMICS AND PROTEOMICS. Vikas Publications. Newdelhi.
7. Metin Akay (2007). Genomics and Proteomics Engineering in Medicine and Biology. Wiley Publications. UK.
8. Devarajan Thangadurai and Jeybalan Sangeetha (2015). Genomics and Proteomics Principles, Technologies, and Applications. Apple Academic Press.
9. A. Malcolm Campbell, Laurie J. Heyer (2003). Discovering genomics, proteomics and bioinformatics. Benjamin Cummings publications.
10. Nachimuthu Saraswathy and Ponnusamy Ramalingam (2011). Concepts and Techniques in Genomics and Proteomics . Woodhead Publishing groups.
11. 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.* Estimation of total phenols in diseased and healthy

plant tissues. Seed health testing by SBM.

4. 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.
5. Isolation and identification sewage micro flora.
6. Isolation and identification soil micro flora.
7. Isolation and Identification of airborne microbes– indoor and outdoor.
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. Effect of high salt concentration on microbial growth.
12. Degradation of cellulose by *Chaetomium globosum.*
13. Bacterial examination of drinking water by membrane filters technique.
14. Study of associated soil microorganisms with plants, Actinorhiza, Mycorrhiza.
15. Study of important microbes in the degradation of wastes.

UNIVERSITY OF MYSORE

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

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

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 Outcome

Microbiology is a subject where, students' study about different bacteria, archaea, fungi, algae and viruses. They isolate bacteria, fungi and viruses from different sources like soil, water, air, sewage, different food samples and characterize and identify them based on their cultural and biochemical characteristics. Microbiology involves the study about concepts, mechanism and applications in the field of genetics, physiology, immunology, medical microbiology, molecular biology, industrial microbiology and genetic engineering which makes them to learn about genome organization, metabolism, manipulation of genes, molecular basis of microbes, production of antibiotics, enzymes. 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.

Microbiologists have various opening in fields like pharmacy, diary, food industry, clinical research, water industry, agriculture, chemical technology, nanotechnology, agrochemistry biotechnology, biorefinery, environment, pollution control and bioremediation, pathology labs or they can find career in hospitals apart from research. In the field of agriculture, microbiologists act as environmental and health specialists to study the role of microbes in plant disease, pest control, nutrition and soil fertility. In the field of medicine and health care, the work is usually associated with diagnosis, prevention and treatment of illnesses associated with microbes.

They can also be entrepreneurs starting up small-scale industry for production of SCP (Single cell protein), production of bio-fertilizers etc. A microbiologist can innovate new diagnostic kits, discover new drugs, Student with PG in microbiology, he/she can work in microbiology-based industries like pharmacy, dairy, breweries, distilleries, enzyme, etc. and you also can pursue PhD. On completion of Ph.D. they can take up teaching at the universities and PG colleges. They can also take up a post-doctoral research.

Program Pedagogy

The seminar presentation will improve the oration skills of students and group discussion will kindle their logical ability to analyse 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.

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 2018-2019

Semester-I Credits: 20

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

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

Semester-II Credits: 20

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

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

M. Sc. Microbiology

Credit Based Choice Based Continuous Evaluation Pattern System

Proposed Semester-wise distribution of the course structure

Semester-III Credits: 20

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

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

Semester-IV Credits: 16

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

HC= 01; SC=02; PW=01

Grand Total Credits: 76

SEMESTER I
MB 1.1 Hardcore: VIROLOGY

Course Outcome: Upon successful completion of the course, the student:

- Is able to describe classification of viruses
- Is able to describe tools for studying virus structure, process of virus attachment and entry, virus assembly and release
- Is able to describe steps in replication of genome of RNA viruses, retroviruses, and DNA viruses
- Is able to describe steps in virus infection, transmission, patterns of infection, virus virulence, and host defense against virus infection
- Is able to describe methods of making virus vaccines and anti-viral drugs, drivers of virus evolution, and emerging viruses
- Is able to describe unusual infectious agents, virus mediated cellular transformation and oncogenesis
- Is able to describe evasion strategies used by viruses, and learn to apply their knowledge to investigate virus outbreak

Course pedagogy: Virology is a sub-discipline of Microbiology which focuses on the basic knowledge of viruses, their reproduction and pathogenesis within a host cell.
The contents of the course are divided into four units. This course will emphasize basic concepts of viruses, their diversity (structural, host range and genetic), various methods employed in virus studies, replication strategies, host virus interactions, emerging viral diseases, antiviral strategies in prevention and control of viral diseases and their applications, evolution and future prospective. These concepts are taught across thirty two hours, which include lectures in which students are provided information and illustrations of various virus aspects, and tutorials in which students present seminars of the topics assigned.
The lecture will impart students with knowledge and make them understand how viruses are built, replicate and evolve, cause disease, prevention of infection and their applications. The knowledge gained about viruses helps the students to develop interest in this field and helps the students to work in laboratories that are interested in isolation of viruses from various ecological niche, molecular pathogenesis, vaccines, antiviral drugs, applications such as virus vectors development and in health and diagnostic laboratories.

THEORY **32hours**

UNIT I **8 hours**

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.
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 **8 hours**

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.
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 **8 hours**

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

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 **8 hours**

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

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 1.2 HardCore: BACTERIOLOGY

Course Outcome: Upon successful completion of the course, the student:

- Will be able to describe the morphological features, cell arrangement and structural components of bacterial cell in detail. Is able to differentiate between Gram-positive and Gram-negative bacteria.
- Will have gained knowledge about cell wall structure and extracellular appendages in different bacteria and will be acquainted with current methodologies available for production of protoplasts and L-forms
- Can enlist the characteristics of archaea that differentiate it from eubacteria, and will have learnt key features of some model archaeal organisms.
- Will have gained in-depth knowledge about density based signal transduction in bacteria and its significance in competence, sporulation and antibiotic resistance. Will know about quorum quenching and its uses

Teaching and Learning Activity:

- Detailed discussion on the general morphology of bacteria and the basic differences in gram-positive and gram-negative cell structure and the detailed structure of gram-negative and gram-positive bacterial cell walls and extracellular appendages through diagrammatic representations.
- Employing video lectures and interactive diagrams of the secretion systems that exist in bacteria for enabling students to differentiate between the Sec, SRP and Tat secretion pathway. Acquainting students with bacterial sortases.

Course Pedagogy: Bacteriology is the sub-disciplinary course of Microbiology. Bacteriology is the study of bacteria and their importance in medicinal and other areas such as agriculture, industries. Bacteria are single celled microorganisms which can live as independent organisms or dependently as

parasites. Superficially bacteria appear to be relatively simple forms of life; in fact they are sophisticated and highly adaptable.

The discipline of bacteriology evolved from the need of physicians to test and apply the germ theory of disease and from economic concern relating to the spoilage of food and wine. The contents of this course are divided into various units and each unit focuses on various aspects of bacteriology such as serial dilution technique, microscopy, staining technique, classification and taxonomy and economic importance of bacteria.

Under this subject we are studying scope and history, economic importance of bacteria, cell structure and microscopy. Growth, cultivation and control of bacteria. Salient features of some major groups of bacteria.

Bergey's manual- the primary purpose of the 4 volumes was to provide detailed information on bacterial classification and detailed characteristics of taxa and species. We are still following Bergey's manual as a standard to classify bacteria.

In beginning bacteriology parallel to the development of microscope. Microscopes are used to study the microbes and their cells, crystalline structure and the molecular structure, mainly scanning and transmission electron microscope. The staining makes the procedure of visualization easier as microbes appear colored against a white background. Cells may be stained to highlight metabolic processes or to differentiate between live and dead cells in a sample. Different staining techniques are used to differentiate different stages of bacteria.

Bacteria have its economic importance in various fields like industries, pharmaceuticals, agriculture, food industries. Bacteria have both beneficial and harmful effects. Certain bacteria cause diseases in humans such as Cholera, Salmonellosis, Tuberculosis, Typhoid and Diphtheria. Hence there is a need to study these disease causing bacteria and we can prevent these diseases.

The knowledge gained under this subject helps the student to work in laboratories, pharmacological industries, and in any industries where microorganisms are used as chief source.

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. Non-culturable methods for the identification of pathogenic microorganisms.

UNIT III **8 hours**

Growth, Cultivation and control of Bacteria: Nutrient requirements, nutritional types of bacteria, culture media, classification of media. Growth: Nutritional uptake, Growth kinetics, generation time, growth curve, factors affecting growth. Methods for measurement of microbial growth – direct microscopy, viable count estimates, turbidometry, and biomass. Aerobic, anaerobic, batch, continuous and synchronous cultures. Methods of pure culture isolation, Enrichment culturing techniques, single cell isolation, and pure culture development. Preservation and Maintenance of Microbial cultures: Repeated sub culturing, preservation at low temperature, sterile soil preservation, mineral oil

preservation, deep freezing and liquid nitrogen preservation, lyophilization. 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

Course outcome:

- In mycology classes they understand the world of fungi and lichens,
- Appreciate the adaptive strategies of the fungi and lichens,
- understand the economic and pathological importance of fungi, and Identify common plant diseases and device control measures
- In tutorial classes they do group discussions on use full and pathogenesis of different fungi involved in daily life.
- In practical classes they mount the fungi, learn microscopic views and the key characteristics to identify different species of fungi.

Course Pedagogy: Mycology is the sub-branch of Microbiology, which is concerned with the study of fungi. It includes the study of taxonomic classification, fungal genetics, and biochemical properties. Fungi are fundamental for life as symbionts, also takes part in biodegradation process. They are socially and economically important as they are capable of causing diseases in plants, animals and human beings.

Study of fungi is highly important as it plays major role in production of food supplements like SCP, fermentation industries, vitamins, enzymes, organic acids. Another notable element is production of secondary metabolites like antibiotics which acts against other microbes. In agriculture, knowledge pertaining to fungi should be maximum as it causes plant diseases leading to economic loss. Fungal infections have more devastating effects on human health and hence clinical significance of fungi has gained more attention, due to its wide applications and effects, the study of fungi is highly recommended.

THEORY **32 Hours**

UNIT I **8 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 **8 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 **8 hours**

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

UNIT IV **8 hours**

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

Course outcome:

- Can discuss the importance of mutation analysis, can analyze mutations by complementation and recombination tests, and can design a strategy to create gene replacement in bacteria
- Is able to explain how plasmid copy number is regulated, can differentiate between Hfrstrains and strains carrying F plasmid, and can construct a genetic map of bacterial genome using conjugation-based method
- Is able to compare and contrast generalized versus specialized transduction, knows how to construct genetic linkage maps using two-factor and three factor cross, is able to discuss the basis of natural competence in bacteria.
- Is able to list the events in the lytic and lysogenic phases of lambda phage life cycle and the regulatory factors and events involved.
- Can list the outcomes of transposition events, can design strategies to mutagenize bacteria using transposons, can explain the construction of conditional knockouts
- Can differentiate between positive and negative regulation of gene expression, inducible and repressible systems. Can describe the regulation of the lac, trp, gal,ara and tol operons.
- Will have learnt about the model organisms used in biological studies.

Course Pedagogy: Microbial genetics deals with the transmission of hereditary characters in microorganisms like bacteria, viruses and algae which play a unique role in developing field of molecular and cell biology and plays wide role in applications in the field of medicine, agriculture, food and pharmaceutical industry. The benefits of microbial genetics in the field of agriculture are increased in crop yields which reduce the cost for food or drug production, reduce need for pesticide and medical benefits to the worlds growing population by recombinant DNA technology and as vectors.
The importance of genetics study involves; To understand the gene function of microorganisms. Microbes provide relatively simple system for studying genetic phenomenon and thus useful to other higher organisms. Microorganisms are used for isolation and multiplication of specific genes of higher organisms which is referred as gene cloning. Microbes provide many values added products like antibiotics, growth hormones etc. Microbial genetics will be helpful to increase these products productivity by microbial technology. Understanding the genetics of disease-causing microorganisms especially virus, will be crystal to control disease. Gene transfer among the prokaryotes play major role in the spread of the genes in a particular environment. Microbial genetics will be useful to study the gene transfer from one organism to another.

THEORY **32 Hours**

UNIT I **8 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 **8 hours**

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

Fungal Genetics: *Neurospora*- Tetrad analysis and linkage detection - 2 point and 3 point crosses, chromatid and chiasma interference, Mitotic recombination in *Neurospora* and *Aspergillus*.
Algal Genetics: *Chlamydomonas* - unordered tetrad analysis - Recombination and Mapping, Nucleocytoplasmic interactions and gene expression in *Acetabularia*. Extra nuclear (Cytoplasmic) inheritance.

UNIT IV **8 hours**

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

References:

1. 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

Course Outcome:

- To understand the ubiquitous nature of microbes.
- To provide knowledge on characteristics of Microbes Outcome
- Students able to differentiate various groups of Microbes
- Get knowledge on adaptability of extremophiles
- Knowledge about microbial taxonomy.
- To create awareness on evolutionary relationship of ecosystem
- To learn about individual ecosystem and its interactions.
- To understand the concepts of community ecology Outcome
- Better understanding of evolutionary relationship of ecosystem
- Get more knowledge on individual ecology
- Able to understand the role of microbes in ecology

Course Pedagogy: Microbial ecology and diversity is a sub discipline of microbiology (environmental Microbiology) which focuses on the huge diversity of microbes, its interaction among themselves and the ecosystem. Microbes embody the vast diversity of life on earth. In their natural environments, microbes interact with each other, with plants and animals. Such interactions are essential for ecosystem function and may relate to plant and animal health, biogeochemical cycles and numerous other processes.

Overall this course enables students to learn how the microbial world rules over the entire ecosystem focusing on their interactions which form the basis of survival. The study helps us improve our lives via the use of microbes in environmental restoration, food production, bio-engineering of useful products such as antibiotics, food supplements and chemicals. This course is for all biology, allied heath, environmentalists and microbiology students.

The knowledge gained under this subject helps the students to work in laboratories like pharmacological industries, clinical health and diagnostic laboratories, environmental research fields, microbial research and any industry where microorganisms and involved. The need of the hour is to focus on the importance of conservation of microbial diversity mainly the role of culture centers in conservation.

THEORY **32 Hours**

UNIT I **8 hours**

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

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

UNIT II **8 hours**

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

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

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

UNIT III **8 hours**

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

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

UNIT IV **8 hours**

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

References

1. 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: Practical's 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

Course Outcome:

- Will be acquainted with methods of measuring microbial growth, calculating growth kinetic parameters with understanding of steady state and continuous growth.
- Will have gained an in-depth knowledge of primary, secondary and group translocation transport systems existing in bacteria, simultaneously learning membrane transport proteins and kinetics of solute transport.
- Will have learnt central metabolic pathways for carbon metabolism in bacteria enlisting differences with eukaryotic systems and their regulation in diverse physiological conditions. This allows students to apply the acquired knowledge in engineering metabolic pathways for developing industrially useful strains.
- Will have gathered understanding of inorganic and organic nitrogen assimilation and its regulation. Also knows role of glutathione in cellular redox regulation and biochemistry of glutamate overproducing strains.
- Will have learnt basic concepts of enzyme biochemistry, its kinetics and regulation.
- Will understand details of lipid and nucleotide metabolism in E. coli and its regulation along with biochemical basis of lipid accumulation in yeasts.
- Is conversant with intracellular signaling in bacteria in response to various nutritional and physiological stresses.

Course Pedagogy: Microbial physiology is defined as the study of microbial cell functions which includes the study of microbial growth, microbial metabolism and microbial cell structures. Microbial physiology is important in the field of metabolic engineering and also functional genomics. Study of microbial structures, functions and response of microbial activity to environmental stress, metabolism, genetic composition of microbes. The contents of the course are divided into four main chapters or units those are: A) Microbial physiology, B) Carbohydrate metabolism, C) lipid metabolism, D) Microbial photosynthesis and each unit focuses on various aspects of microbial physiology. A changing environment creates conditions that can be stressful for microorganisms, and they are neither immortal, nor impervious to stress. Microbes must have physiological acclimation mechanisms to survive and remain active in the face of stress or they will die. However, those adaptation and acclimation strategies create physiological costs at the organism level and can alter the composition of the active microbial community, creating shifts in ecosystem-level C, energy, and nutrient flows. Microbial physiology is an important research field, not only in fundamental research on microbial species but also in all applied aspects of microbiology i.e, Industrial Microbiology, Environmental Microbiology and Medical Microbiology. Microbial physiology is an important research field, not only in fundamental research on microbial species but also in all applied aspects of microbiology i.e, Industrial Microbiology, Environmental Microbiology and Medical Microbiology. The microbial physiology group studies the physiology of the aerobic microorganisms and anaerobic microbial communities that play an important role in environmental biotechnological processes, such as waste water treatment, soil remediation, production of chemicals and biofuels and recovery of metals. The microbial physiology group studies the physiology of the aerobic microorganisms and anaerobic microbial communities that play an important role in environmental biotechnological processes, such as waste water treatment, soil remediation, production of chemicals and biofuels and recovery of metals.

THEORY **32 Hours**

UNIT I **8 hours**

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**

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**

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**

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.

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

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

Course Outcome:

- Will be able to understand the fundamental bases of immune system and immune response
- Will be able to gather information about the structure and organization of various components of the immune system
- Will be able to understand the genetic organization of the genes meant for expression of immune cell receptors and the bases of the generation of their diversity
- Will be able to understand the operation and the mechanisms which underlie the immune response
- Will be able to apply the knowledge gained to understand the phenomena like host defense, hypersensitivity (allergy), organ transplantation and certain immunological diseases

Course Pedagogy: Immunology is the branch of biology which deals with various aspects that forms an integrated network of cells, molecules, and organs within the immune system. This course helps students to learn and understand basic concepts as well as its application in various fields of biology.

The content of the course consist of four units where each unit focuses on basic aspects of immunology and its application. The course begins with the brief introduction regarding overview of immune system followed by the mechanism of immunological reactions, immunotechniques, immunodiagnosis and its

application in the field of medicine. At the end of each unit a student is able to understand how the immune system develops, how the body defends itself against disease, and what happens when it all goes wrong.

Studying this subject will equip students with basic practical skills to work in vast fields like pathology, pharma industries, diagnostics and hospitals.

THEORY **32 Hours**

UNIT I **8 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.

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**

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

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

UNIT III **8 hours**

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

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

UNIT IV **8 hours**

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

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

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

References:

1. Abul K. Abbas (2014)Cellular and Molecular Immunology, ; Saunders
2. 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

Course Outcome:

- Will know about production and evaluation of the quality of starter cultures and fermented milk products and understands the use and production of probiotics, prebiotics and nutraceuticals.
- Is aware of fermentation protocols for production of microbial biomass such as edible yeasts, mushrooms, single cell proteins and single cell oils. The student also learns about production of microbial carotenoid pigments such as lycopene and β-carotene.
- Gathers information regarding microbes causing food intoxications and food-borne infections.
- Knows traditional food preservation techniques including drying, salting, pickling, refrigeration, freezing, oxidation, vacuum packaging, canning/bottling, smoking, sugaring, chemical preservation and irradiation.
- Is able to utilize modern techniques viz. high-pressure processing (HHP), bacteriocins, manosonication (MS) and pulsed electric field (PEF) for effective food preservation. The student can also calculate kinetics of inactivation, process and product parameters.
- Gains knowledge about conventional methods for food quality analysis and is able to use the most recent and non-invasive techniques of quantification and detection of food borne microbes and pathogens such asESS and various new imaging techniques.
- Understands the relevance of microbial standards for food safety, quality assurance programs that revolutionize food safety.

Course Pedagogy: Food microbiology is a sub-discipline of Microbiology which focuses on the study of the microorganisms that ferment, inhibit or contaminate food. It also includes the study of microorganisms that cause food spoilage and those with other useful roles.

The course emphasizes basic concepts of food microbiology, contamination and food spoilage, dairy microbiology, food poisoning and intoxication, food produced by microbes, detection of food borne microorganisms and microbial indicators of food safety quality control, food law and legislation.

Dairy industry is an excellent example where bacteria, yeasts, molds and viruses are very important in determining the quality of final product. They are also used to produce fermented foods such as cheese, yogurt, bread, beverages, and those with other useful roles such as producing probiotics, single cell proteins and mushroom cultivation.

Food Microbiology is important to study food borne diseases of microbial origin, microbial food spoilage, beneficial uses of microbes in food, control of microbial growth in foods, destruction of microbes in foods, microbial food fermentation, pro-biotic bacteria, regulatory aspects to ensure consumers related to microbial hazards in food.

The lecture will impart students with knowledge, how microorganisms are useful to produce food, how they contaminate, spoil and cause diseases and how to detect their presence in the food. The knowledge gained about food microbiology helps the students to develop interest in this field and helps the students to work in the food industries that are interested in isolation, detection of food borne pathogens and production of food products from microorganisms.

THEORY **32 Hours**

UNIT I **8 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 **8 hours**

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

Dairy Microbiology: Microbiology of raw milk, Milk as a vehicle of pathogens, Prevention of

contamination of raw milk, Microbiology of processed milk, Spoilage and defects fermented milk and milk products, Microbiological standards for milk and milk products. Cream and butter bacteriology.

UNIT III **8 hours**

Food poisoning and intoxication: Significance of food borne diseases, 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.

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**

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

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

References:

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MB 2.4: Softcore: SOIL MICROBIOLOGY

Course Outcome:

- Students will learn that the soil is an excellent habitat for multitude of microorganisms balancing the soil ecosystem.
- The knowledge acquired in Soil Microbiology will enhance the students' competency in the performance of their duties as future employees in the field of Agronomy/Soil Science.
- Attainment of course objectives will mean realization of the various beneficial effects of soil microorganisms on soil health, which is instrumental in the production of food and fiber. Conversely, students learned that some soil microbes are deleterious to agronomic crops
- Students will learn that some soil animals and what they eat are of ecological importance; thus, plant eating insects and mollusks may add organic matter to the soil; insects, arachnids, and worms that

consume dung and plant litter mix it with soil and speed up its decay; and, plant parasitic nematodes reduce soil's productivity.

Course Pedagogy: Soil microbiology is the study of all microorganisms that exist in the soil, specifically the ways they function and affect soil properties. Our soils are pulsating with life, serving as excellent hosts for the growth and development of various organisms. In fact, there are more microbes in one teaspoon of soil than there are people on the planet. This collection of organisms consists of bacteria, fungi, and algae that serve many vital roles in the overall nourishment of soils.

Within just one handful of soil lives around 100 million bacteria. These bacteria are largely responsible for the process of nitrogen fixation; converting atmospheric nitrogen into compounds that can be used by plants. Although not as commonly abundant as bacteria, fungi also assist with extremely significant functions of soil health. While one of their main activities is decomposition of organic matter, fungi also perform necessary services related to water and nutrient cycling. Fungi are responsible for binding soil particles together, assembling a system to increase water filtration and water holding capacities. In a similar manner as fungi, earthworms also break down organic matter, such as dead leaves, and produce natural fertilizers. They too support soil fertility with the transportation of water throughout the soil, as well as air, by creating tunnels that allow the two to flow freely.

THEORY **32 Hours**

Unit I **4 Hours**

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

Unit II **4 Hours**

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

Unit III **4 Hours**

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

UNIT-IV **4 Hours**

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**

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**

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:

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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.
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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.
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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

Course Outcome:

- Describe common groups of bacteria and archaea in different ecosystems, and their role in biogeochemical key processes in these environments.
- Describe for cultivation-independent methods for studies of the composition of microbial communities and for the function and occurrence of individual groups.
- Describe genomic-based methods to study microbial diversity in nature and for the mechanisms behind it.
- describe important interactions within microbial communities and between microorganisms and plants and animals.
- Evaluate, synthesize and present scientific studies of genetic and functional microbial diversity in different ecosystems.
- Use bioinformatic tools and databases that are used to study microbial diversity.
- Has acquired a fairly good understanding of the Diversity of the microbes
- Has acquired a fairly good understanding of the activities/importance of microbes.
- Has acquired practical skills of handing microorganisms in the laboratory for study

Course Pedagogy: Microbial diversity is a sub discipline of microbiology focuses on the huge diversity of microbes, its interaction with the ecosystem. Such interactions are essential for ecosystem function and may relate to plant and animal health, biogeochemical cycles and numerous other processes.
Overall this course enables students to learn how the microbial world rules over the entire ecosystem focusing on their interactions which form the basis of survival. The study helps us improve our lives via the use of microbes in environmental restoration, food production, bio-engineering of useful products such as antibiotics, food supplements and chemicals.
The knowledge gained under this subject helps the students to work in laboratories like pharmacological industries, clinical health and diagnostic laboratories, environmental research fields, microbial research and any industry where microorganisms and involved. The need of the hour is to focus on the importance of conservation of microbial diversity mainly the role of culture centers in conservation.

THEORY **32 Hours**

UNIT I **8 hours**

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

UNIT II **8 hours**

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

UNIT III **8 hours**

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

UNIT IV **8 hours**

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

References

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3. Ghosh, A. 2003. Natural Resource Conservation and Environment Management. Aph Publishing Corp. Calcutta.
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SEMESTER III
MB 3.1 Hardcore: MOLECULAR BIOLOGY

Course Outcome:

- Is able to describe structure of DNA and RNA, organization of eukaryotic genome
- Is able to compare and contrast the mechanisms of bacterial and eukaryotic DNA replication, DNA repair, transcription
- Is able to explain concepts in DNA repair mechanisms, and recombination as a molecular biology tool
- Is able to explain various levels of gene regulation in both prokaryotic and eukaryotic organisms
- Is able to describe post-transcriptional processes, RNA editing, RNAi and miRNA
- Is able to describe translation mechanism in prokaryotes and eukaryotes, regulation of translation, and post-translational processing
- Is able to describe post-translational processes.

Course Pedagogy: Molecular biology is the root branch of biology which deals with biomolecules, it's modifications and other molecular level mechanisms occurring in the body of living organisms. This field is developed out of related fields like genetics, biochemistry, biophysics and microbiology. Molecular biology gives a wide information on basic concepts of DNA structure and replication, DNA damage and recombination, synthesis of proteins by transcription, translation and regulation of gene expression in bacteria, bacteriophage, eukaryotes. Each unit is well presented with basic descriptions of cellular mechanisms of both prokaryotes and eukaryotes. In this discipline the major interest is drawn towards the differences in the molecular mechanisms in prokaryotes and eukaryotes.
The students view is synchronized into the world of biomolecules for the better understanding of molecular mechanism, cell to cell interaction, cell replication, mutations. This discipline allows the students to understand the molecular mechanisms so that they can study the cause of evolutionary existence of life and also the various diseases that result due to the changes in the biomolecules.

THEORY **32 Hours**

UNIT I **8 hours**

Concepts in Molecular Biology: Microbes in molecular biology.
Organization of Genomes: Prokaryotic genome- Genetic and Physical organization of bacterial genome, Eukaryotic genome – Genetic and Physical organization of nuclear genome
DNA structure and Replication: DNA as Genetic material, Chemistry of DNA, Modes of DNA Replication, Enzymes of DNA replication, Molecular mechanism of DNA replication, Differences in prokaryotic and eukaryotic DNA replication.

UNIT II **8 hours**

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

UNIT III **8 hours**

Gene Expression: Structure of RNA- Classes of RNA, Chemistry of RNA.
Transcription: Transcription in prokaryotes and eukaryotes, Eukaryotic transcription factors. RNA processing, Ribozymes, Antisense RNA, Inhibitors of transcription and their mechanism of action.
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**

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:

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2. Brown, T. A. 1991. Essential Molecular Biology. A Practical Approach Vol-I & Vol.-II, Oxford Univ. Press. Oxford.
3. Flint, S.J., Enquist, L.W., Drug, R.M., Racaniello, V.R. and Skalka, A.M. 2000. Principles of Virology- Molecular Biology, Pathogenesis and Control. ASM Press, Washington, D.C.
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MB 3.1 Hardcore: GENETIC ENGINEERING

Course Outcome:

- Students will become familiar with the tools and techniques of genetic engineering DNA manipulation enzymes, genome and transcriptome analysis and manipulation tools, gene expression regulation, production and characterization of recombinant proteins.
- This course exposes students to the applications of genetic engineering in biological research.
- Students will be able to perform basic genetic engineering experiments at the end of course.
- Students will acquire knowledge of advances in biotechnology- healthcare, agriculture and environment cleanup via recombinant DNA technology.
- Given the impact of genetic engineering in modern society, the students should be endowed with strong theoretical knowledge of this technology. In conjunction with the practicals in molecular biology & genetic engineering, the students should be able to take up biological research as well as placement in the relevant biotech industry

Course pedagogy: Genetic Engineering is an inter-disciplinary subject of biology which focuses on gene manipulation techniques using living systems and the applications of manipulated genes. This course helps students learning the components, techniques of gene manipulation in organisms and use of these techniques to create novel products(vaccines, enzymes GMOs).

The contents of the course are divided into four units. Each unit focuses on tools, techniques used in gene manipulation, applications of recombinant DNA, ethics concerned with gene manipulation and bioinformatics. Overall, this course teaches students the importance and scope of genetic engineering in the current world.

The lecture will impart knowledge of using these techniques in various fields such as agriculture to create transgenic plants, in therapeutics or medicine to create vaccines, to cure genetic diseases. In industries to increase efficiency of production of various microbial products, in forensic science to identify suspects, paternity issues etc.., this subject has wide scope and great significance in the world.

THEORY **32 Hours**

UNIT I **8 hours**

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

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**

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**

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.

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.
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MB 3.3 Hard core INDUSTRIAL MICROBIOLOGY

Course Outcome:

- Get equipped with a theoretical and practical understanding of industrial microbiology
- Appreciate how microbiology is applied in manufacture of industrial products
- Know how to source for microorganisms of industrial importance from the environment
- Know about design of bioreactors, factors affecting growth and production, heat transfer, oxygen transfer
- Understand the rationale in medium formulation & design for microbial fermentation, sterilization of medium and air
- Appreciate the different types of fermentation processes
- Understand the biochemistry of various fermentations
- Identify techniques applicable for Improvement of microorganisms based on known biochemical pathways and regulatory mechanisms
- Comprehend the techniques and the underlying principles in downstream processing.

Course Pedagogy; Industrial microbiology is a branch of applied microbiology. Which deals with the microorganisms and fermentation technology used for production of high value added products such as therapeutic agents, fuels, food items, chemicals, sweeteners, detergents, beverages, enzymes, vitamins, and proteins. The course imparts detailed fundamental principles and of industrial microbial processes.
The course contained four units and focuses on basic industrial equipment's, isolation and screening of microorganisms, media formulation, production and key factors for optimum maintenance, recovery process and production economics, commercial value and their applications. The course provides the basic knowledge of the industrial processes and biosynthesis of potent microbial agents.
This course makes the students as entrepreneurs and gives so many jobs for the people. From this knowledge nation can be stand as independent from other countries for their energy source.
This course helps the students to work in the pharmaceutical, chemical, food technological, beverages and dairy industries and biotechnological sectors includes biomedical, bio prospecting and biomass industries.

THEORY **32 Hours**

UNIT I **8 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 o**f** industrially important microbes. Strain improvement- mutation, recombination- gene regulation and genetic manipulation. Preservation of industrially important microbes. Culture collection centers**.**

UNIT II **8 hours**

Media for Industrial Fermentations: Media formulation, growth factors, carbon, nitrogen, Energy and Mineral sources, buffers, inhibitors, precursors, inducers, Oxygen requirements Antifoam agents and others, Sterilization: Sterilization of bioreactor, media, air and exhaust air and filter sterilization
Downstream processing and fermentation economics: Steps in recovery and purification Methods of cell separation – filtration and centrifugation, cell disruption, liquid liquid extraction, chromatography, membrane processes. Fermentation economics- expenses for industrial organisms, strain improvement, media sterilization, heating, cooling, aeration and agitation. Cost of Plant and equipments, batch process cycle time, continuous culture, recovery and effluent treatment, cast recovery due to waste usages and recycling.

UNIT III **8 hours**

Industrial production of energy fuels: Industrial alcohol production: Biosynthesis, methods of production, recovery and applications of ethanol, acetone – butanol and glycerol through microbial process.
Industrial production of Organic acids and Enzymes: biosynthesis, media, production process, product recovery and application of citric acid and lactic acid, Enzymes: Fungal and Bacterial Amylase; Bacterial proteases.

UNIT IV **8 hours**

Industrial production of food additives: amino acid production, methods of production, product recovery of L-Glutamic acid and L-lysine. Commercial uses of Amino acids Vitamins: Commercial production of Vitamin B_{12}, and Riboflavin. Alcoholic beverages (Beer, Wine,)
Industrial production of health care product: Industrial production of β-lactum antibiotic (Penicillin): Biosynthesis, production and recovery. Streptomycin. Biosynthesis, production and recovery. Antitumor and anticholesterol agents, SCP and SCO, I P R: Patent Laws: Patent regulations of processes, products and microorganisms.

References:

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MB 3.4 Softcore: MEDICAL MICROBIOLOGY

Course Outcome:

- This course provides learning opportunities in the basic principles of medical microbiology and infectious disease.
- It covers mechanisms of infectious disease transmission, principles of aseptic practice, and the role of the human body's normal microflora.
- The course provides the conceptual basis for understanding pathogenic microorganisms and the mechanisms by which they cause disease in the human body.
- It also provides opportunities to develop informatics and diagnostic skills, including the use and interpretation of laboratory tests in the diagnosis of infectious diseases.
- To understand the importance of pathogenic bacteria in human disease with respect to infections of the respiratory tract, gastrointestinal tract, urinary tract, skin and soft tissue.
- Helps to understand the use of lab animals in medical field.
- Recall the relationship of this infection to symptoms, relapse and the accompanying pathology.
- Explain the methods of microorganism's control, e.g. chemotherapy & vaccines. Solve problems in the context of this understanding.

Course Pedagogy: Medical microbiology, the large subset of microbiology that is applied to medicine, is a branch of medical science concerned with the prevention, diagnosis and treatment of infectious diseases. In addition, this field of science studies various clinical applications of microbes for the improvement of health.

Medical microbiology, also known as '"clinical microbiology"', is the study of microbes, such as bacteria, viruses, fungi and parasites, which cause human illness and their role in the disease..

Clinical microbiology laboratories perform aerobic and anaerobic bacteriology, parasitology, mycobacteriology, mycology, and virology. Clinical microbiology is also a rather complex discipline because it utilizes many different types of methodologies and constantly undergoes changes in testing methods. There is significant overlap in methods used to diagnose microbial diseases, and the

microbiology laboratory may comprise several disciplines (e.g., classical culture methods, antigen detection methods, molecular methods, and serological methods are often performed under the purview of microbiology). The wide variety of pathogens and testing methods that are available makes microbiological testing challenging, and thus error detection and correction are important components of quality laboratory testing. Errors may occur at all stages of testing (pre-analytical, analytical, and post-analytical), and an error in one stage of testing is likely to overlap with or lead to errors in other stages (e.g., incorrect specimen collection can lead to culture, identification, and reporting of organisms that are not involved in the disease process, and incorrect or unnecessary therapy as a result). In the clinical microbiology laboratory, as in every other discipline, the frequency of analytical errors has been reduced considerably with the implementation of quality control and quality assurance programs. Despite the improvements in microbiological testing, microorganisms remain a constant challenge, and errors do occasionally occur. Clinical microbiology is somewhat unique among the laboratory disciplines in that it remains heavily reliant on manual testing and interpretive/subjective skills, and it is somewhat subjective. Despite improvements, analytical errors can occur in the clinical microbiology laboratory. Common sources of error and methods to prevent them are discussed as general concepts relevant to clinical microbiology, followed by specific examples grouped by specimen or testing method.

THEORY: **32 Hours**

UNIT I **8 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.

UNIT II **8 hours**

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.

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**

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

UNIT IV **8 hours**

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

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

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

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

References:

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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

Course Outcome:

- Various bacterial, viral, fungal and protozoal disease their causative agent, mode of infection, epidemiology, treatment, lab diagnosis, prophylaxsis.
- students will develop skill regarding Isolate and identify microorganism form laboratory sample,
- Antibiotics senstitivity and resistance test
- Detection of parasite
- Handling of blood and body fluids

Course Pedagogy: Clinical and Diagnostic Microbiology is a specialty within the sciences which focuses on applying microbiology to medical application. Similarly to being concerned with the identification of a disorder-inflicting organism, diagnostic microbiology can also be a part of modifying a treatment plan. Microbes including bacteria, protozoans, and fungi play a vital factor in many disease processes. The various laboratory techniques like microscopy, immunological assessments, radiology, biomarker tests, ELISA, serology checks, vaccines vectors are the primary diagnostic tests which are currently in use. Many microbes have developed resistance to medications. Hence, it's far essential for the scientists to give smarter methods of diagnosing those microbes and their pathogenic mechanisms.

THEORY **32 Hours**

UNIT I **8 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 **8 hours**

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

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

UNIT III **8 hours**

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

UNIT IV **8 hours**

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

Reference

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.
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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

Course Outcome:

- To acquire knowledge on food product analysis
- To enable them to know about preservation of pharmaceutical products
- Learn to assess the microbial quality of marine foods Outcome
- Acquire Knowledge on food product analysis
- Impart knowledge of preservation technology.
- Knowledge on quality analysis of marine food products

Course Pedagogy: It is a sub-discipline of Microbiology which focuses on microbiological techniques or methods used for the study of microbes, including bacteria, fungi and protists. This course helps students learning fundamental procedures and safety guidelines followed in the microbiology laboratory.

This course teaches students the basic skills necessary to be successful in the laboratory as well as provides easy to follow, step-by-step, directions on how to perform each technique based in microbiology. Along with clear instructions, pictures are provided, so that the student can visually see how to proceed through the technique to minimize errors. Also, at the end of each unit, the student will be able to recognize and interpret the results of the technique based on the pictures and information provided in the unit lecture. Each technique is well presented with clear illustrations for every step, followed by safety measures and tips for troubleshooting. This course to all biology, allied health and microbiology students.

The lecture will impart the students with knowledge and skills about how to culture, stain, identify, preserve and control of microorganisms. The skills and knowledge gained about techniques in microbiology helps the students to work in the laboratories like food and dairy industries, pharmacological industries, clinical, health and diagnostics laboratories, and any industries where microorganisms are used.

THEORY **32 Hours**

UNIT I **8 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, limitations. Preparation of specimens for electron microscopic studies (Ultra-thin sectioning, negative staining, shadow casting and freeze etching).

UNIT II **8 hours**

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

UNIT III **8 hours**

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

UNIT IV **8 hours**

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

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

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4. Becker, W. M., Kleinsmith, L.J. and Hardin, J. 2000. The world of the Cell. IVth Edition. Benjamin/Cummings.
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7. Pelczar, (Jr.) M. J., Chan, E. C. S. and Kreig, N. R.1993. Microbiology. McGraw Hill, NewYork
6. Perry, J.J. and Staley, J.T. 1997. Microbiology. Dynamics and Diversity. 4th edn. Wesley Longman pub. New York.
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9. Schaechter, M. Ingraham, J.L. and Neidhardt, F.C. 2006. Microbe. ASM Press, Washington.D.C.
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. 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 IV
MB 4.1 Hardcore: AGRICULTURAL MICROBIOLOGY

Course Outcome:
Approaches used in agriculture to control disease in plant
• Microbial ecology and microbial interaction
• Pathogenic interactions with plant
• Microbial biocontrol agents

Course Pedagogy: Agricultural microbiology is a branch of microbiology dealing with plant associated microbes. It also deals with microbiology of soil fertility, such as microbial degradation of organic matter and soil nutrient transformations. It aims to address problem in agricultural practices usually caused by lack of biodiversity in microbial communities.
An understanding of microbial strains relevant to agricultural applications is useful in the enhancement of factors such as soil nutrient, plant pathogen resistance, crops robustness fertilization uptake effectively. The many symbiotic relationship between plant and microbes can ultimate be exploited for greater food production necessary to feed expanding new population safer to minimize the ecological disruption. The microbes are also used as bio fertilizers, bio pesticides, and fungicides.
Agricultural microbiology also explains about the plant pathogen and the control measures against these plant pathogens. The use of techniques for the proper harvest and storage of the crops and its prevention from the contamination by microorganisms. The loss caused by damage or spoilage of stored crops will impact on the economy.
The syllabus includes four disciplines which deal with the introduction to agricultural microbiology, the plant pathology, parasitism and disease development, the defense mechanism of plant, plant disease and their management, the microbes and plant interaction and the bio pesticides. It also deals with production and application of *Rhizobium, Azospirillum, Azotobacter*. The toxins produced by Bacillus *thuringiensis, Psuedomonas, Beauveria, Cephalosporium* and *Trichoderma* also covered.
The advanced studies on the agriculture and microorganisms related to agriculture have been proved to enhance the production of good quality and high yield crops. The production of drought and disease resistant plants has been taking place by applying the concepts of biotechnology and use of microorganisms.
The concept of sustainable agriculture is a response to the decline in the quality of the resources based associated with modern agriculture. The relationship between agricultural, the global environment and social system suggest that agricultural development results for the complex interactions of a multitude of factors.
This course makes knowledge about agricultural cultivation and products. Which makes environmental friendly and costless for the farmers.

THEORY **32 Hours**

UNIT I **8 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, Kochs' rules;

UNIT II **8 hours**
Parasitism and Disease Development Parasitism and pathogenecity, Host range of pathogens, Disease triangle, Diseases cycle / Infection cycle, Relationship between disease cycles and epidemics; Pathogens Attack Plants – Mechanical forces, Microbial enzymes and toxins, Growth regulators. Effect on physiology of Host – Photosynthesis, Translocation and transpiration, Respiration, Permeability, Transcription and translation. Environment and Plant Disease– Effect of Temperature, Moisture, Wind, Light, Soil, pH and structure, Nutrition and Herbicides.
Defense Mechanisms of Plant: Disease Pre-existing structural and chemical defenses, Induced structural and biochemical defenses. Microbe mediated strategies for abiotic stress management.

UNIT III **8 hours**

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

UNIT IV **8 hours**

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

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

References:

1. George. N. Agrios (2005),Plant pathology, Elsevier academic press, 5th edition, U.K.
2. Mehrotra. R.S. and Ashok Aggarwal (2002), Plant pathology, Tata MC Graw-Hill publishers, 2nd edition, Delhi.
3. Kannaiyan. S. (2002), Biotechnology of Biofertilizers, Alpha science international, 1st edition.
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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, 1th 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 Softcore: ENVIRONMENTAL MICROBIOLOGY

Course Outcome:

- Will have an overview of the till date developments in the field of environmental microbiology with special emphasis on the role of microbes in mitigating environment pollution.
- Will have become acquainted with various cultural, biochemical and molecular techniques used in understanding microbial diversity.
- Will be knowledgeable about the diversity, adaptations and biotechnological applications of microbes of extreme environment.
- Is able to describe the role of microbes in solid and liquid waste management, gaining knowledge of various methods employed in sewage treatment and solid waste treatment.
- Understands the role of microbes in bioremediation of environmental pollutants like petroleum hydrocarbons, pesticides, plastic and electronic waste; also understands utility of microbes in mineral and oil recovery.

Course Pedagogy: Microbial communities control nutrient cycles and biogeochemical transformations in natural, managed and engineered ecosystems. Microorganisms recycle organic matter, transform contaminants, and maintain ecosystem health. Understanding the ecology of natural microbial communities will deepen our understanding of how ecosystems function. Since microbial communities are critical for ecosystem function, microbial ecology can also assist the development of models to predict how ecosystems will respond to future environmental conditions.

Environmental Microbiology introduces students to the diversity of microbial populations and their important roles in environmental processes in air, water, soils, and sediments. Microbial community

ecology and interactions with plants and animals will also be discussed. Students will learn how microbial activities sustain natural ecosystems and contribute to environmental quality, and also how these functions are harnessed to support managed and artificial systems. Techniques for characterizing microorganisms and investigating microbial processes will also be discussed.
Student preparation: Prior experience in environmental science, microbiology, and biochemistry is helpful; however, introductory lectures review basic principles of microbiology and biochemistry, providing a minimum background for the remainder of the course.
This helps to utilize bio wastes from industrial field and agricultural fields. This recycling of bio wastes leads to costless and environment clean .Students can teaches how to maintain the environment condition to others and build the nation strong by learning this course.

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 cycle. Detrimental effects of diverted biogeochemical cycles. Biological nitrogen fixation in detail: Symbiotic, asymbiotic and associated nitrogen fixation. Structure, function and genetic regulation of nitrogenases. Viable but nonculturable bacteria.

UNIT III **8 hours**

Microbes in extreme environment: Microbes of extreme environments, Thermophiles, 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 **8 hours**

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

MB 4.3 Softcore*:* GENOMICS AND PROTEOMICS

Course Outcome:

- The aim of this course is to teach genomics, transcriptomics, proteomics, metabolomics and phonemics using model organisms representing plants and animals.
- The course will cover recent developments in genomics, gene expression and small RNAs, synthetic biology, epigenetics, proteomics, fast-forward genetics and next-generation mapping.
- An objective of the course is to develop skills in experimental design within the context of learning about biology including: regulation of transcription and translation, stress response, signal transduction and the engineering and regulation of metabolic pathways.

Course Pedagogy: Genomics is the study of entire genomes, including the complete set of genes, their nucleotide sequence and organization, and their interactions within a species and with other species. The advances in genomics have been made possible by DNA sequencing technology. Genomic information is used to create similar maps of the DNA of different organisms. *Proteomics* generally refers to the large-scale experimental analysis of proteins and proteomes

Bioinformatics helps the students to understand Genomics and proteomics which uses the computational knowledge in helps in extracting the knowledge from biological data. This helps in data analysis, visualization, prediction, primer designing, data storage etc., through web based tools like NCBI.
Students are able to understand and use the knowledge of bioinformatics and do Insilco analysis to verify and test their hypothesis before they start their wet lab experiments. Bioinformatics helps in drug discovery and students will be placed in pharmaceutical and drug companies.

THEORY **32 Hours**

UNIT I **8 hours**

Genome - Overview Of Genome; Sequence Of Genome Acqusition 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.

UNIT III **8 hours**

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**

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.

UNIT V **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.

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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