



**ST. JOSEPH'S COLLEGE (AUTONOMOUS)**  
**POST GRADUATE DEPARTMENT OF MICROBIOLOGY**  
**SYLLABUS 2016-2018: CHOICE BASED CREDIT SYSTEM**

SEMESTER	PAPER CODE AND TITLE	NO. OF TEACHING HOURS	NO. OF CREDITS	TOTAL MARKS
<b>SEMESTER I</b>				
<u>THEORY</u>				
Paper I	<b>MB 7116:</b> Microbial Diversity	60	04	100
Paper II	<b>MB 7216:</b> Cell Biology	60	04	100
Paper III	<b>MB 7316:</b> Microbial Genetics	60	04	100
Paper IV	<b>MB 7416:</b> Microbiological Techniques	60	04	100
<u>PRACTICAL</u>				
Paper I	<b>MB 7P<sub>1</sub>:</b> Microbial Diversity and Cell Biology.	120	04	50
Paper II	<b>MB 7P<sub>2</sub>:</b> Microbial Genetics & Microbiological Techniques	120	04	50
<b>TOTAL</b>			<b>24</b>	<b>500</b>
<b>SEMESTER II</b>				
<u>THEORY</u>				
Paper I	<b>MB 8116:</b> Molecular biology	60	04	100
Paper II	<b>MB 8216:</b> Immunology	60	04	100
Paper III	<b>MB 8316:</b> Microbial Physiology	60	04	100
Paper IV	<b>MB 8416:</b> Food Microbiology	60	04	100
Paper V-A (DE)	<b>MBDE 8516:</b> Agricultural Microbiology	60	04	100
Paper V-B (DE)	<b>MBDE 8616:</b> Environmental Microbiology	60		
<b>Note: Students can choose one of the departmental elective from Paper V-A or V-B</b>				
<u>PRACTICAL</u>				
Paper I	<b>MB 8P<sub>1</sub>:</b> Immunology and Microbial Physiology	120	04	50
Paper II	<b>MB 8P<sub>2a</sub>:</b> Food & Agricultural Microbiology	120	04	50
	<b>MB 8P<sub>2b</sub>:</b> Food & Environmental Microbiology			
<b>TOTAL</b>			<b>28</b>	<b>600</b>

SEMESTER	PAPER CODE AND TITLE	NO. OF TEACHING HOURS	NO. OF CREDITS	TOTAL MARKS
<b>SEMESTER III</b>				
<u>THEORY</u>				
Paper I	<b>MB 9116:</b> Recombinant DNA Technology.	60	04	100
Paper II	<b>MB 9216:</b> Medical Microbiology.	60	04	100
Paper III	<b>MB 9316:</b> Industrial Microbiology.	60	04	100
Paper IV	<b>MB 9416:</b> Biostatistics And Bioinformatics.	60	04	100
<b>Paper V (OE)</b>	<b>MBOE 9516:</b> Microbes and Us	60	04	100
<b>Note: Students choose open elective from other departments.</b>				
<u>PRACTICAL</u>				
Paper I	<b>MB 9P<sub>1</sub>:</b> RDT and Medical Microbiology.	120	04	50
Paper II	<b>MB 9P<sub>2</sub>:</b> Industrial Microbiology.	120	04	50
		<b>TOTAL</b>	<b>28</b>	<b>600</b>
<b>SEMESTER IV</b>				
	<b>MB 0314:</b> Project Work	<b>360</b>	<b>12</b>	<b>300</b>
<b>KEY WORDS: DE – Departmental elective and OE – open elective</b>				

**SEMESTER I**  
**MB 7116: MICROBIAL DIVERSITY**

**Total: 60 Hours**

**UNIT I**

**EVOLUTION AND MICROBIAL TAXONOMY**

**18**

**Evolution of life on earth:** Theories of origin and evolution of life, Selection and types: r and K selection, Molecular clocks and Circadian rhythms. 2

**Microbial Taxonomy:**

Natural system of classification, binomial nomenclature. Concepts of taxon, species, strain. Criteria used for classification. Three domain classification, classification according to Bergey's manual of systematic bacteriology.

Recent trends in Microbial Taxonomy: **a)** Chemotaxonomy: cell wall components, lipid composition, isoprenoid-quinones, cytochrome composition. **b)** Molecular method: DNA homology, G + C ratio, rRNA sequencing **c)** Numerical taxonomy **d)** Genetic methods in taxonomy, Next Generation Sequencing **e)** Serological methods. Phylogenetic trees, methods for tree building, maximum likelihood, organizing data on a tree, evaluating phylogenies evolutionary models.

10

**Fungal classification** by Alexopolus and Mims (up to class level).

**Classification of viruses** by the Baltimore system.

1

**Extremophiles:**

5

Classification of microbes based on pH, temperature, pressure, salt concentration and their adaptations (Acidophilic, Thermophilic, Barophilic and Osmophilic microbes). Extraction of extremozymes, perspectives and applications.

**UNIT II**

**BACTERIOLOGY**

**13**

**Ultrastructure, Growth and Reproduction in Bacteria:**

11

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 and sporogenesis.

Reproduction by fission, budding, conjugation.

Cultivation of bacteria : Aerobic, anaerobic, batch and continuous, culture media.

Preservation of bacteria.

The domain Archaea, Archeal cell walls, membranes, RNA polymerase, their metabolism and major groups of Archaea. 2

### UNIT III

#### MYCOLOGY AND PHYCOLOGY

15

**Introduction to fungi:** General characteristics of fungi, morphology and thallus organization; fungal cell, hyphae, mycelium, tissue, hyphal modifications. 1

Ultrastructure of fungal cells: fungal cell wall, plasma membrane, cytoplasmic matrix, flagella, nuclear components. 2

**General aspects of fungal growth and reproduction:** Nutritional and environmental requirements, effect of environment on growth: pH, temperature, mechanism of growth in fungi, measurement and kinetics of growth; asexual, sexual and parasexual reproduction; heterothallism. 4

**Fungi and ecosystem:** Substrate group, saprophytic, parasitic, keratinophilic, coprophilous, epiphytic, endophytic, substrate successions, parasitism, mutualism with plants and animals. Economic importance of fungi. 2

**Salient features** of classes Ascomycetes, Zygomycetes, Basidiomycetes, Deuteromycetes. 4

**Introduction to algae:** general features, distribution, thallus construction, general mode of reproduction, Ultrastructure of typical cyanophycean cell. 2

### UNIT IV

#### VIROLOGY

14

**General virology:** Brief outline on discovery of viruses, morphology and ultrastructure : capsid and their arrangements, types of envelope and their composition, viral genome; theories of origin of viruses, distinctive properties of viruses (evolution and mutation in viruses and the quasi species concept), culturing of viruses; Virus related agents: viroid and prions. 4

**Bacterial viruses:** Bacteriophage structural organization, life cycle of lytic(T4) and lysogenic (lambda) phage, lytic lysogenic switch, one step growth curve. 4

**Plant viruses:** Classification, nomenclature, structure and life cycle, effect on plants : TMV, Cauliflower mosaic virus. 1

**Animal viruses:** Classification, nomenclature, structure and life cycle of RNA viruses: Paramyxoviridae (measles virus), Reoviridae (Rotavirus), Picornaviridae (Polio virus)  
DNA viruses: Poxviridae (vaccinia, small pox), Adenoviridae (HSV). 5

## **REFERENCES:**

1. Alexopolus, C.J. and Mims, C.W. Introduction to Mycology, Wiley.
2. Atlas and Bartha; Microbial Ecology.
3. Flint, Principles of Virology, ASM press.
4. J.W. Deacon, Modern Mycology, Wiley Press.
5. Leppard and Dimmock, Introduction to Modern Virology, Sixth Edition, Blackwell Publishing.
6. Nester *et al*, 2004, Microbiology a human perspective, Mac Graw Hill Higher education.
7. O.P Sharma, Introduction to Algae, McGraw Hill Publication.
8. Prescott, Harley & Klein's,(2008), Microbiology, Mac Graw Hill Higher education.
9. Stalley, Jerome, Microbial life 2<sup>nd</sup> edition (2007), Sinauer Associates inc, Massachusetts.

# MB 7216: CELL BIOLOGY

**Total: 60 hours**

## UNIT I

**EMERGENCE OF CELL BIOLOGY** 1

## UNIT II

**ORGANIZATION OF PROKARYOTIC AND EUKARYOTIC CELL** 31

<b>Structural organization of:</b> Cell membrane- fluid mosaic model, bi-lipid layer	2
<b>Endomembrane system:</b> Endoplasmic reticulum, golgi apparatus, lysosome, peroxisomes, vacuoles, mitochondria, chloroplast and nuclear components	5
<b>Cytoskeleton:</b> Components and structural functions, types of filament: microtubules, intermediate filaments, microfilaments– assembly and disassembly, molecular motors and sarcomere regulation, cell motility	6
<b>Transport across membrane:</b> Transmembrane transport of small molecules; endocytosis and exocytosis	
Protein trafficking; vesicular trafficking	
Prokaryotic type I, II, III secretion systems	6
<b>Cell division:</b> Bacterial- FtsZ division protein, MinCDE proteins, Bacterial aging	
Eukaryotic- mitosis	3
<b>Cell cycle:</b> Events in cell cycle, regulation of cell cycle and cancer, cancer stem cells, apoptosis, role of mitochondria in apoptosis	7
<b>Integrating cells into tissues:</b> Cell junctions and adhesions (cell-cell and cell-matrix), extracellular matrix	2

## UNIT III

**HOST PATHOGEN INTERACTIONS** 5

**Infection:** Bacterial adhesion to host cells-basic principles of microbial adhesion, pathogenicity islands, molecular mechanisms of adhesion, bacterial structures involved in adhesion, effect of adhesion on host cells. Invasion of epithelial cells- actin rearrangements (eg. *Salmonella*, *Mycobacterium*); Invasion of endothelial cells (eg. *E.coli*, *Streptococcus pneumonia*)

## UNIT IV

**CELL SIGNALING AND COMMUNICATION AMONG CELLS** 23

<b>Signal transduction in prokaryotes:</b> Two component systems, chemotaxis, receptor structure and function, secondary messengers, extra cellular messengers and their receptors.	5
Quorum sensing in gram positive and gram negative bacteria, bioluminescence, Biofilms- organization, signals involved in their formation and dispersal, quorum sensing in Myxobacteria.	6

<b>Signal transduction in eukaryotes:</b> Overview of extracellular signalling- major classes of receptors, secondary messengers, common intracellular signalling proteins- GTPase switch proteins, protein kinases, adaptor proteins	3
G-protein coupled receptors and their effectors.	2
Receptor tyrosine kinases and Ras-MAP kinase pathway, JAK-STAT pathway	4
Intercellular receptor pathway- Ca as messenger	2
Intracellular receptor pathway- NO as messenger	1

## REFERENCES:

1. Bruce Alberts, 4<sup>th</sup> edition, Molecular Biology of the cell, Garland Science.
2. Fredrich Marks *et.al* (2009), Cellular signalling processing, Garland Science Taylor & Francis Group.
3. Gerald Karp 6<sup>th</sup> edition, Cell Biology, Wiley
4. Henderson *et. al* (2000), Cellular microbiology, John Wiley & Sons Ltd.
5. Lehninger (2010), Principles of Biochemistry, Worth Publishers, Inc.
6. Lodish, Berk, Baltimore, (2000), Molecular Biology, 4<sup>th</sup> Edition, W.H. Freeman & co.

# MB 7316: MICROBIAL GENETICS

**Total: 60 hours**

## UNIT I

### NUCLEIC ACIDS

15

- a. Historical Perspective:** DNA as the source of genetic information in bacteria and viruses (i) Griffith's experiment (ii) Avery's experiment (iii) Hershey and Chase experiment; RNA as the source of genetic information of TMV- Frankel-Conrat's experiment. **3**
- b. Organization and Molecular structure:** DNA structure, forms of DNA, DNA topology, DNA supercoiling, VNTRs, mini and micro genomes, Satellite DNA, Structure of RNA and Genome organization. **9**
- c. Properties of DNA:** Denaturation, Renaturation (Filter binding assay and concentration dependent renaturation) and DNA heteroduplexes.
- d. DNA constancy and C-value paradox.** **3**

## UNIT II

### DNA REPLICATION IN PROKARYOTES

8

DNA replication in Prokaryotes: Origin of replication, replication fork, leading and lagging strand, semi conservative replication, rolling circle replication, enzymes involved in prokaryotic replication and DNA proof reading.

## UNIT III

### MUTATION AND REPAIR

11

- a. Gene mutation:** Genes as unit of mutation, Molecular basis of spontaneous and induced mutations and their role in evolution, mutagens, types of mutation, transposon mutagenesis, site-directed mutagenesis, Mutational hot spots, environmental mutagenesis and toxicity testing – AME's test. **6**
- b. Reversion:** Same type revertant, Second site revertants, Second type revertants of frameshift mutations, intergenic reversion. **2**
- c. Repair:** Biological indication of repair, Biochemical mechanisms for repair of thymine dimmers-Photoreactivation, Excision repair, Recombination repair, SOS repair. **3**

## UNIT IV

### RECOMBINATION

7

- a. Recombination:** Holliday Model; Double Strand Break Repair Model; Role of RecA, Rec BCD, RuvAB and RuvC in recombination. **3**
- b. Site-Specific Recombination:** Types: Conservative site-specific recombination - recombination by serine recombinase; (ii) Transpositional recombination- Definition and mechanism of (a) DNA transposons-cut and paste mechanism, replicative mechanism; (b) viral-like retrotransposons- use of RNA intermediate and (iii) polyA retrospoons – reverse splicing mechanism. **4**



**UNIT V**  
**GENE TRANSFER MECHANISMS AND MAPPING**

**6**

Mechanism and Applications of bacterial transformation, Transduction, Conjugation, Complementation and Transfection. Transformation mapping, Mapping through interrupted mating, Transduction Mapping.

**UNIT VI**  
**PLASMIDS**

**4**

General features, Types of natural plasmids, F-factors- description and their used in genetic analysis, Colicins and Col factors. Plasmid DNA replication.

**UNIT VII**  
**TRANSPOSABLE ELEMENTS**

**5**

Overview of transposable elements in bacteria (IS elements, composite transposons and non composite transposons) and eukaryotes (yeast Ty elements, FB elements of *Drosophila*); Transposon mutagenesis, gene conversion.

**UNIT VIII**  
**BACTERIOPHAGE**

**4**

Life cycle of bacteriophages and their uses in microbial genetics: T7, P1, M13 and  $\phi$ X174.

**REFERENCES:**

1. Jocelyn E.Krebs, Elliott S. Goldstein and Stephen T. Kilpatrick (2011), Lewin's Genes X, 10<sup>th</sup> Edition; Jones and Bartlett Publishers, Canada.
2. Eldon John Gardner, Michael J. Simmons and Peter Snustad. S (2007), Principles of Genetics, 8<sup>th</sup> Edition, Wiley & Sons.(Asia) Pvt. Ltd, Singapore.
3. David Freifelder (2008), Molecular Biology, 2<sup>nd</sup> Edition, Narosa Publishing House Pvt. Ltd, New Delhi.
4. Benjamin A. Pierce (2008), Genetics-A conceptual Approach, 4<sup>th</sup> Edition, Kate Ahr Parker, W.H.Freeman and Company, England.
5. D.Peter Snustad and Michael J. Simmkons (2010) Principles of Genetics, , 5<sup>th</sup> Edition, John Wiley & Sons (Asia) Pvt. Ltd, Singapore.
6. James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine and Richard Losick (2004), Molecular Biology of the gene, 5<sup>th</sup> Edition, Pearson Education, Inc. an Dorling Kindersley Publishing, Inc, California.
7. William S. Klug, Michael R. Cummings, Charlotte A. Spencer and Michael A. Palladino (2012) Concepts of Genetics, 10<sup>th</sup> Edition, Pearson Education, Inc, California.
8. Robert J. Brooker (1999), Genetics-Analysis and Principles, Addison Wesley Longman, Inc, Canada.

# **MB 7416: MICROBIOLOGICAL TECHNIQUES**

**Total: 60 Hours**

## **UNIT I**

### **PROPERTIES OF WATER**

Structure and interactions, water as a solvent, Proton mobility, Ionization of water

### **ACIDS- BASES AND BUFFERS**

Acid-base reactions (titration curve), Buffers (Henderson-Hasselbach equation), Biological buffers (Phosphate and Bi carbonate buffer) **7**

## **UNIT II**

### **MICROSCOPY AND STAINING**

a. Principles of Microscopy (Properties of light)

b. Light Microscopy

Bright Field Microscope, Phase Contrast Microscope, Dark Field Microscope, Fluorescence Microscope

Preparation and staining of specimen (simple, differential and structural staining)

c. Electron Microscopy

Transmission Electron Microscope, Scanning Electron Microscope

d. Newer techniques in Microscopy

Scanning Tunneling Microscope, Confocal Microscope, Atomic Force Microscope **15**

## **UNIT III**

### **STERILIZATION TECHNIQUES**

a. Control of microorganisms by physical agents

Fundamentals of control, Physical agents (high temperature, low temperature, desiccation, osmotic pressure, radiation, surface tension and interfacial tension, filtration)

b. Control of microorganisms by chemical agents

Characteristics of an ideal antimicrobial chemical agent, Major groups of antimicrobial agents (phenol and phenolic compounds, alcohols, halogens, heavy metals, dyes, detergent, quaternary ammonium compounds, aldehydes, gaseous agents), Evaluation of antimicrobial chemical agents( tube dilution and agar plate techniques, phenol coefficient method)

### **BIOASSAYS**

Introduction to Bioassays, Antimicrobial assays, antiviral and anticancer assays, Microbiological assay of antibiotics, microbial susceptibility to chemotherapeutic agents **15**

## **UNIT IV**

### **SEPARATION TECHNIQUES (PRINCIPLES, METHODS AND APPLICATIONS)**

a. Chromatography (Thin layer chromatography, Ion exchange, Size exclusion, Affinity, gas and HPLC chromatography)

b. Centrifugation (Preparative and Analytical)

c. Electrophoresis (Horizontal and Vertical)

**SPECTROSCOPY TECHNIQUES  
(PRINCIPLES, METHODS AND APPLICATIONS)**

Ultraviolet and Visible light spectroscopy, Fluorescence spectroscopy, Circular dichroism **15**

**UNIT V**

**MOLECULAR METHODS OF MICROBIAL COMMUNITY ANALYSES**

Phospholipids fatty acid analysis, nucleic acid techniques (DGGE/TGGE, RISA, SSCP, RAPD, PCR), fluorescent in situ hybridization (FISH). **8**

**REFERENCES:**

1. David L. Nelson and Michael M. Cox; Lehninger Principles of Biochemistry, W. H. Freeman.
2. Donald Voet and Judith G. Voet; Biochemistry, Wiley, 4<sup>th</sup> edition
3. Jacquelyn G. Black; Microbiology: Principles and Explorations, Wiley; 7 edition
4. James T. Staley, Robert P. Gunsalus, Stephen Lory and Jerome J. Perry; Microbial Life, Sinauer Associates, Inc.; 2nd edition
5. Joanne Willey, Linda Sherwood and Chris Woolverton; Prescott, Harley, and Klein's Microbiology, McGraw-Hill Higher Education, 7<sup>th</sup> edition
6. Keith Wilson and John Walker; Principles and techniques of Biochemistry and Molecular Biology, Cambridge University Press.
7. Michael J. Pelczar, Roger D. Reid and Eddie Chin Sun Chan; Microbiology, Tata McGraw Hill Education
8. R R.Colwell and R Grigorova; Current methods for classification and identification of microorganisms, Academic Press
9. Roger Y. Stanier; General Microbiology, Macmillan
10. Ronald M. Atlas; Principles of Microbiology, McGraw-Hill Higher Education
11. Atta-ur-Rahman, M.Iqbal Choudhary and William J.Thomson; Bioassays techniques for drug development, Harwood academic publishers

## PRACTICALS

### MB7P<sub>1</sub>: MICROBIAL DIVERSITY AND CELL BIOLOGY

**Total: 120 Hours**

#### **MICROBIAL DIVERSITY**

##### **BACTERIOLOGY:**

1. Isolation of bacteria.
2. Identification of bacteria.
3. Staining techniques: Gram's, Negative, Endospore, Capsule and Cell Wall.
4. Cultural characteristics of bacteria on NA.
5. Pure culture techniques (Types of streaking).
6. Biochemical characterization :  
IMViC, Carbohydrate fermentation test, Mannitol motility test, Gelatin liquefaction test, Urease test, TSI test, Nitrate reduction test, Catalase test, Oxidase test, Starch hydrolysis, Casein hydrolysis.
7. Isolation of cellulolytic and anaerobic sulphate reducing bacteria using a Winogradsky column.
8. Isolation and characterization of acidophilic, alkalophilic and halophilic bacteria.

##### **MYCOLOGY:**

1. Isolation of different fungi: Saprophytic, Coprophilous, Keratinophilic.
2. Identification of fungi by lactophenol cotton blue method.

##### **PHYCOLOGY:**

1. Type study of algae and Cyanobacteria – *Scytonema*, *Spirullina*, *Anabaena*, *Nostoc*.

##### **VIROLOGY:**

1. Isolation of bacteriophages from sewage.

##### **CELL BIOLOGY**

1. Isolation of chloroplast from spinach leaves by sucrose density gradient centrifugation.
2. Study of Mitosis.
3. Detection of chemoreceptor mediated chemotaxis using Chemical Gradient Motility Agar.
4. Production and quantification of biofilm by using microorganisms.

##### **REFERENCES:**

1. James G. Cappuccino and Natalie Sherman. Microbiology: A Laboratory Manual.
2. Kanika Sharma. Manual of Microbiology: Tools and Techniques.
3. Robert S. Burlage, Ronald Atlas, David Stahl, Gill Geesey, Gary Sayler, 1998. Techniques in Microbial Ecology, Oxford University Press. N.Y.
4. Samuel Singer, 2001. Experiments in Applied Microbiology, Academic Press.

## **MB7P<sub>2</sub> : MICROBIAL GENETICS AND MICROBIOLOGICAL TECHNIQUES**

**Total :120 Hours**

### **MICROBIAL GENETICS**

1. Mutagenesis- By physical and Chemical agents.
2. Ames Test.
2. Isolation of genomic DNA and analysis by agarose gel electrophoresis.
3. Isolation of plasmid DNA and analysis by agarose gel electrophoresis.
4. Conjugation in *E.coli*.

### **MICROBIOLOGICAL TECHNIQUES**

1. Buffer preparation and titration.
2. Staining techniques: simple and differential (gram's staining).
3. Micrometry.
4. Haemocytometry.
5. Phenol Coefficient method to test the efficacy of disinfectants.
6. Effect of antibiotics and heavy metals on bacteria and fungi.
7. Production and separation of aflatoxin using paper chromatography.

### **REFERENCES:**

1. Bloom, Freyer, Meckler, 1996. Laboratory DNA Science, The Benjamin/Cummings Pub.
2. Experiments with gene fusions 1994, T. Slave, Cold Spring Harbour Lab. Press.
3. James G. Cappuccino and Natalie Sherman. Microbiology: A Laboratory Manual.
4. S. Sadashivam, A. Manickam. Biochemical methods.
5. Short course in genetics, J.H. Miller 1992, CSH Laboratories.
6. Ted R. Johnson and Christine L Case, 2001. Laboratory Experiments in Microbiology.

## **SEMESTER II**

### **MB 8116: MOLECULAR BIOLOGY**

**Total: 60 Hours**

#### **UNIT I**

Structure of eukaryotic chromosome (Chromatin- Nucleosome model and 5 packaging).

##### **REPLICATION IN EUKARYOTES :**

Pre replicative complex, DNA polymerase and enzymes involved in replication, Process of replication, End replication problem and telomerase.

Inhibitors of DNA replication.

#### **UNIT II**

##### **TRANSCRIPTION IN PROKARYOTES AND EUKARYOTES: 15**

RNA polymerase – structure, properties and functions

Initiation – promoters – upstream & downstream sequence, Sigma and Transcription factors.

Elongation

Termination – Rho dependent and Rho independent.

Structure and function of mRNA and tRNA

Post transcriptional modifications of RNA (rRNA, tRNA and mRNA)

Inhibitors of transcription.

Reverse transcription – Reverse transcriptase.

#### **UNIT III**

##### **TRANSLATION: 15**

Genetic code: Elucidation of Triplet code, code characteristics, codon dictionary.

Structure of Ribosomes and its constituents in prokaryotes and eukaryotes.

Amino acyl tRNA synthetase function and proof reading.

Process of translation in prokaryotes and eukaryotes.

Initiation – Initiation factors, Initiator tRNA, Amino acid activation, Shine-Dalgarno sequences, Initiation site.

Elongation – Elongation factors and Translocation.

Termination – Termination codons and releasing factors

Inhibitors of translation and control of translation in eukaryotes (SsrA rescue system, nonsense and nonstop mediated decay).

#### **UNIT IV**

##### **PROTEIN SORTING: 8**

Signal hypothesis

Transport between nucleus, transport into mitochondria, chloroplast and ER.

Overview of the path of secretory protein (brief).

Post Translational modification and folding.

## UNIT V

### **A) REGULATION OF GENE EXPRESSION IN PROKARYOTES- 9**

Operon concept – positive and negative mechanisms of control (general concepts).  
Lactose system – Coordinate regulation, Lac operon, Positive and negative regulation, Catabolite repression, lac mutant (problems on phenotype and genotype variation)

Tryptophan operon, Attenuation.

Arabinose operon and its regulation.

Role of sigma factor in regulation, antitermination and riboswitches.

### **B) EUKARYOTIC GENE EXPRESSION REGULATION –**

Britten Davidson model of gene regulation(concept).

Chromatin remodeling (HAT and HDAC), DNA methylation, Hormonal regulation, regulatory proteins, Alternate splicing, RNA editing, Gene silencing. 8

### **REFERENCES:**

1. Benjamin A Pierce, Genetics- A conceptual approach, 4<sup>th</sup> edn., W H Freeman and Company ,New York.
2. Benjamin Lewin, 2004, Genes VIII, Oxford University Press, New York.
3. Bruce Alberts et al, Molecular biology of the cell, 4<sup>th</sup> edn., Garland Science.
4. Freifelder, D., 2000, Molecular Biology, second edition, Naros Publishing House, New Delhi.
5. James D Watson, Tania Baker: Molecular biology of the gene, 5<sup>th</sup> Edn, Pearson Education.
6. Lehninger, 2010, Principles of Biochemistry, 5<sup>th</sup> edn., by Nelson & Cox, W.H. Freeman and Co., New York.
7. Lodish, Berk, Matsudiara, Kaiser; Molecular Cell Biology; 7<sup>th</sup> Edition; W H Freeman and Co, Macmillan Higher Education.
8. Snustad and Simmons, Principles of genetics, 6<sup>th</sup> edn., John Wiley and sons.
9. Turner, P.C., A.G. Mel.ennan., A.D. Bates and M.R. H. White, 1999, Instant Notes in Molecular Biology, Viva Books Ltd., New Delhi.
10. Voet, D., Voet, J.G. and Pratt, W.C., 2006, Fundamentals of Biochemistry, John Wiley and Sons.

## **MB 8216: IMMUNOLOGY**

**Total: 60 Hours**

### **UNIT I**

Types of immunity: Definition, innate, acquired- active and passive with examples.

Factors affecting immunity: age, hormonal influence, nutrition.

Mechanisms of innate immunity: Anatomical, Physiological, Phagocytotic and Inflammatory response.

Hematopoiesis: Hematopoietic growth factors, genes that regulate hematopoiesis, regulation of hematopoiesis, programmed cell death, ontogeny, development and functions of cells in innate and adaptive immunity

Cells of the immune system (T-cells, B-cells, Natural Killer cells, Macrophages, Antigen presenting cells, Neutrophils, Eosinophils, Basophils, Mast cells and Dendritic cells).

Organs of the Immune system: Structure and function of Primary and Secondary Organs

**15**

### **UNIT II**

Antigens: characteristics, types, cross reactivity, hapten, adjuvant, immunogenicity and antigenicity.

Immunoglobulins: types, structure and functions, Molecular biology of immunoglobulin synthesis, antibody diversity, isotype switching.

Immunotechnology: Production of monoclonal antibodies, Applications of Mab –Diagnostic, therapeutic and immunopurification. Antigen antibody interactions: Principles and methods of Precipitations, Agglutinations, ELISA, RIA, Immunofluorescence, Complement fixation and Flow cytometry.

Mechanism of antigen recognition and activation by T and B cells.

**20**

### **UNIT III**

Immune response: Humoral, primary and secondary responses, factors influencing antibody production and Cellular immune response.

Mechanisms of Immunological Tolerance: T and B cell tolerance.

Immune effector mechanisms: Cytokines properties and functions.

Complement System: General Properties, components, complement activation, Classical, alternate pathway. Regulations of the complement system, biological consequences of complement activation, and complement deficiencies.

Hypersensitivity: Anaphylaxis, cytotoxic, immune complex deposition and cell mediated.

**15**

### **UNIT IV**

Immunity to infectious diseases: Bacterial, viral

Auto immunity: Classification and mechanisms of autoimmune diseases.

Structure and functions of class I and class II MHC molecules and HLA typing

Transplantation immunology: Graft versus host reactions, Principles of tumor immunology:

Tumor antigens, immune response to tumor, and immunotherapy of malignancy.

Vaccines: classification, identification and analysis of vaccines: inactivated, live attenuated, subunit, synthetic, DNA and plant vaccine.

**15**



## **REFERENCES:**

1. Abbas A.K., A.H. Lichtman and J.S. Pober 2000. Cellular and molecular Immunology IV edition V.B. Saunders Company, London.
2. Cellular and Molecular Immunology. 3rd Edition by Abbas.
3. Coleman, R.M., Lombard, M.F., and R.E. Sicard, 1992, Fundamental immunology, second edition, Wm.C. Brown Publishers, USA.
4. Cruse, J.M. and R. Lewis, 1999 Atlas of Immunology, CRC Press, New York.
5. Eli Benjamini, Sunshine G, and Lespeowitz 2000. Immunology – a short course, fourth edition, Wiley – Liss, New York.
6. Janeway, Jr.C.A. and P.Travers 2001 Immunobiology, fifth edition Garland Publishing, London.
7. Kubey J., 2000, Immunology, fourth edition W.H. Freeman and Company, New York.
8. Immunobiology: The Immune System in Health and Disease. 3rd Edition by Travers.
9. Manual of Clinical Laboratory and Immunology 6th Edition. 2002 by Noel R. Rose, Chief Editor: Robert G. Hamilton and Barbara Detrick (Eds.) , ASM Publications
10. Immunobiology: The Immune System in Health and Disease. 3rd Edition by Travers.
11. Pathak and Pathak
12. Roit, L, Brostall J. and Male D. 2001 Immunology VI edition, Mosby, London.
13. Talwar G. P. (1983) Handbook of Immunology, Vikas Publishing Pvt. Ltd. New Delhi

# MB 8316: MICROBIAL PHYSIOLOGY

**Total: 60 hours**

## UNIT I

### **MICROBIAL NUTRITION AND TRANSPORT**

**6**

- a. **Nutritional types of microorganisms-** Autotrophs, heterotrophs, phototrophs, chemotrophs.
- b. **Metabolite transport-** Facilitated diffusion, mechanosensitive channels, ATP-binding cassette transporter family, chemiosmotic-driven transport, establishing ion gradients. Specific transport systems- ATP-linked ion motive pumps, histidinepermease, iron, phosphotransferase system
- c. **Microbial stress responses-** Osmotic stress, oxidative stress, thermal stress and heat shock response, nutrient stress and starvation stress response.

## UNIT II

### **BIOMOLECULES AND BIENERGETICS**

**20**

- a. **Carbohydrates:** Structure(mono, di and polysaccharides).
- b. **Amino acids and proteins:** Structure, classification and properties of amino acids. Structural organizations of proteins (primary, secondary, tertiary and quaternary structure).
- c. **Lipids:** Structure, classification, physical and chemical properties.
- d. **Nucleotides and nucleic acids:** Structure
- e. **Bioenergetics:** Laws of thermodynamics, Applications to biological system, high energy compounds-ATP, NAD, FAD, FMN, CoA.  
**Energy production:** Oxidation-reduction reactions, Substrate level phosphorylation

## UNIT III

### **METABOLISM**

**20**

- a. **Carbohydrate metabolism:** Glycogenolysis, Glycolysis, TCA cycle, Electron transport and Oxidative phosphorylation. Pentose phosphate pathway, Glyoxylate cycle, Glucuneogenesis, Biosynthesis of peptidoglycan, Entner-Duodroff pathway.  
**Fermentation-** Fermentation balances, Lactic acid fermentation, Alcoholic fermentation, acetic acid, butyric acid, mixed acid and propionic acid fermentation.
- b. **Amino acid metabolism:** General aspects of amino acid metabolism (Transamination, deamination, decarboxylation), urea cycle, uric acid biosynthesis.
- c. **Lipid metabolism:** Oxidation of saturated fatty acids –  $\beta$  oxidation pathway, Biosynthesis of straight chain even carbon saturated fatty acid (palmitic acid)
- d. **Nucleic acid metabolism:** Biosynthesis and degradation of purine and pyrimidine nucleotides.

## UNIT IV

### **ENZYMES**

- a. Introduction, Classification
- b. **Enzymes kinetics:** Michaelis-Menten equation for simple enzymes, Multisubstrate kinetics, Kinetics of allosteric enzymes. Factors affecting enzyme kinetics.
- c. **Mechanism of enzyme action:** Active site and allosteric site. Lock and key theory, induced fit theory, acid-base catalysis, covalent catalysis, metal ion exchange.

**10**

- d. **Regulation of enzyme action:** Enzyme inhibition: Reversible, Irreversible, Competitive, Uncompetitive and Non-competitive.
- e. Isozymes, Ribozymes and abzyme.

## UNIT V

### PHOTOSYNTHESIS

4

- a. **Properties of photosynthetic and accessory pigments:** chlorophyll, bacterial chlorophyll, rhodopsin (bacteriorhodopsin, halorhodopsin, channelrhodopsin), carotenoids and phycobiliproteins.
- b. **Mechanism of photosynthesis:** Oxygenic and anoxygenic photosynthesis. Fixation of CO<sub>2</sub> – Calvin cycle (C<sub>3</sub> pathway) and C<sub>4</sub> pathway.

### REFERENCES:

1. Arora, D.K. and Gupta, S. (1996). Bacterial Physiology. Anmol Publications. New Delhi.
2. Branden, C., and Tooze, J. Introduction to Protein Structure. 2<sup>nd</sup>edn.
3. Brun, Y.V., and Shimkets, L.J. (2000). Prokaryotic Development. ASM Press.
4. Caldwell, D.R. (1995). Microbial Physiology and metabolism. Brown Publishers.
5. Creighton, T. E. (1993). Proteins. Structure and molecular properties. 2<sup>nd</sup>edn. W.H Freeman and Co., New York.
6. Garrett, R. H., and Grisham, C. M. (1999). Biochemistry. 2<sup>nd</sup>edn. Saunders College Publishing.
7. Gottschalk, G. (1985). Bacterial Metabolism. Springer Series in Microbiology
8. Lehninger, 2010, Principles of Biochemistry, 5<sup>th</sup> edn., by Nelson & Cox, W.H. Freeman and Co., New York.
9. Madigan, *et al.* Brock Biology of Microorganisms, 12<sup>th</sup>edn. Benjamin Cummings.
10. Moat, A.G. & Foster, J.W. (1999). Microbial physiology, Wiley-Liss.
11. Palmer, T. (2001). Enzymes: Biochemistry, Biotechnology and Clinical Chemistry, Horwood Publishing Chichester.
12. Price, N.C., and Stevens, L. (2006). Fundamentals of Enzymology, 3<sup>rd</sup>edn. Oxford University Press.
13. Roger, L.P. *et al.* (1992). The Biochemistry of the Nucleic Acids. 11<sup>th</sup> edn. Chapman and Hall.
14. Simpson, R. J. (2005). Proteins and Proteomics: A Laboratory Manual. I.K. International Publishing House Ltd. New Delhi.
15. Stainer, R.Y. *et al.* (1986). General Microbiology. Macmillan Education Ltd. London.
16. Voet, D., Voet, J.G. and Pratt, W.C., 2006, Fundamentals of Biochemistry, John Wiley and Sons.
17. White, D., and Hegeman, G. D. (2006). The Physiology and Biochemistry of Prokaryotes, Third Edition. Oxford University Press.
18. Wink, M. (2006). An Introduction to Molecular Biotechnology: Molecular Fundamentals, Methods and Applications in Modern Biotechnology. Springer Publishing Company.

# **MB 8416: FOOD MICROBIOLOGY**

**Total: 60 Hours**

## **UNIT I**

### **INTRODUCTION TO FOOD MICROBIOLOGY:**

Definition, concepts and scope. Food as substrate for microbes. Factors influencing microbial growth in food-Extrinsic and intrinsic factors.

### **CONTAMINATION AND FOOD SPOILAGE:**

Sources of food contamination. Principles of food spoilage; Cereals, sugar products, vegetables, fruits, meat and meat products, sea foods, poultry; spoilage of canned foods.

**10**

## **UNIT II**

### **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 of fermented milk and milk products, nutraceuticals, probiotics, Microbiological standards for milk and milk products.

**8**

## **UNIT III**

### **FOOD PRESERVATION TECHNIQUES:**

Principles of food preservation- Chemical preservatives and Food additives, asepsis, High temperature (D, F, Z values), Low temperature, Drying, Radiation, Canning and Packaging of foods- Types of packaging materials, properties and benefits.

**6**

## **UNIT IV**

### **FERMENTED AND MICROBIAL FOODS:**

Lactic starter cultures, Cheese, Yoghurt, Saeurkraut, Olives, Soy sauce, Sausages, Cocoa, SCP and SCO.

Effect of food on normal gut flora.

Processed food, foods for space.

**10**

## **UNIT V**

### **FOOD BORNE ILLNESS:**

Food borne diseases caused by *Listeria*, *Salmomella*, *Shigella*, *Campylobacter jejuni*, *Clostridium botulinum*, Mycotoxins and food borne viruses.

**10**

## UNIT VI

### **INDICATORS OF FOOD MICROBIAL QUALITY:**

Coliforms, Enterococci, Bifidobacteria, Coliphages and Enteroviruses.

6

## UNIT VII

### **MICROBIAL DETECTION AND FOOD SAFETY:**

Quantitative methods for microbial enumeration in foods. Test and detection of toxins in foods. Biosensors in pathogen detection.

10

### **FOOD SANITATION AND CONTROL:**

GMP, Good Hygienic Practices, Hazard Analysis and Critical Control points. (HACCP), Food control Agencies - AGMARK, BIS, ISO 9000, ISO 22000, PFA.

### **REFERENCES:**

1. Adams M. R., Mass, M. O. (1996). Food Microbiology. New Age International (P) Limited Publishers, New Delhi
2. Biochemical Engineering and Biotechnology Handbook, Atkinson, Grove's Dictionaries
3. Casida, J.F. 1968. Industrial Microbiology, Wiley Eastern Ltd., New Delhi.
4. Cruger, W. and Crueger, A. 2000. Biotechnology: A Text Book of Industrial Microbiology, Second Edition, Panima Publishing Corporation, New Delhi.
5. E-books -Hayes, P. R. Food Microbiology and Hygiene (1995). Published by Chapman & Hall, 2-6 Boundary Row, London SE 1 BHN.
6. E-books-Montrille T. J., Matthews, K. R. (2005). Food Microbiology, ASM Press, 175 2 S2 NW Washington, USA.
7. Encyclopedia of Bioprocess Technology, Fermentation, Biocatalysis and Bioseparation, Volumes 1 - 5, Flickinger and Drew, Wiley
8. Fermentation and Biochemical Engineering Handbook - Principles, Process Design, and Equipment, Vogel and Tadaro, William Andrew Publishing
9. Frazier, W. C., Westhoff, D. C. (1988). Food Microbiology, M. C. Graw-Hill Companies, Inc., New York.
10. Jay, M. J., Loessner, M. J., Golden, D.A. (2005). Modern Food Microbiology, Springer Science + Business Media Inc., New York.33
- Journal articles.
11. Manual of Industrial Microbiology and Biotechnology, Demain et al., Wiley
12. Principles of Fermentation Technology, Stanbury et al., Butterworth-Heinemann

# **MBDE 8516: AGRICULTURAL MICROBIOLOGY**

**Total : 60 Hours**

## **UNIT I**

**20**

### **MICROBIAL INTERACTIONS**

**Nitrogen cycle:** Fixation of atmospheric nitrogen, ammonification, nitrification, and denitrification. Symbiotic and non-symbiotic nitrogen fixation, Nif genes, Nitrogenase enzyme.

**Interaction between plants and microbes:** Siderophores, Rhizosphere, Rhizoplane, Phyllosphere and Phylloplane. Taxonomy of Mycorrhizas and Actinorhiza, host fungus specificity, functional compatibility and the importance of mycorrhizae in agriculture, horticulture and forestry.

Characteristics of carrier based inoculants and strain selections. *Rhizobium*, *Azotobacter*, *Azospirillum*, Mycorrhiza, Phosphate solubilising microorganisms, Cyanobacteria, and Azolla. Production technology and application.

Mushroom cultivation and biogas production.

## **UNIT II**

### **HOST PARASITE INTERACTIONS:**

**10**

Role of host exudates; process of pathogen entry; role of enzymes, hormones and toxins produced by pathogens in pathogenesis; deranged host metabolism.

### **HOST RESISTANCE:**

Passive and induced resistance; Phytotoxins and Phytoalexins; Hypersensitivity reaction.

## **UNIT III**

### **CONTROL OF PLANT DISEASES:**

**10**

Protection, Plant quarantine, Eradication, Chemical control-Systemic fungicides, Antibiotics. Acquired resistance of fungicides, Biological Control of pathogens, Genetic methods for crop improvement and Integrated Pest Management.

## **UNIT IV**

### **ETIOLOGY, SYMPTOMS AND CONTROL MEASURES OF PLANT DISEASES - 10**

- a. Bacterial blight of rice (*Xanthomonas oryzae*)
- b. Citrus canker (*Xanthomonas citrii*)
- c. Crown gall Disease (*Agrobacterium tumefaciens*)
- d. Damping off (*Pythium* spp.)
- e. Late blight of potato (*Phytophthora infestans*)
- f. Downy mildew of crucifers (*Peronospora*)
- g. Downy mildew of grapes (*Plasmopara viticola*)
- h. White rust of crucifers (*Albugo candida*)

- i. Wheat Rust (*Puccinia graminis*)
- j. Tikka disease of groundnut (*Cercospora* spp.)
- k. Red rot of sugar cane (*Colletotrichum falcatum*)
- l. Early Blight of tomato (*Alternaria lycopersici*)
- m. Ergot of rye (*Claviceps purpurea*)
- n. Sandal spike
- o. Little leaf of brinjal
- p. Tobacco mosaic disease
- q. Citrus exocortis

## UNIT V

### **MICROBIAL INSECTICIDE:**

**10**

Definition, selection, mode of action, methods of mass culture and production, advantages, limitation and quality control. Eg. *Bauveria bassiana*, NPV, CPV, GPV and *Bacillus thuringensis*. Applications of Genetic Engineering in Agricultural Microbiology: Antisense RNA technology.

### **REFERENCES:**

1. Mehrotra, R.S. 1983, Plant Pathology, Tata McGraw Hill publishing company Ltd., New Delhi.
2. Pandey, B.P., 1997, Plant Pathology (Pathogen and Plant Disease), S.Chand and Company Ltd., New Delhi.
3. Ray Chadhuri, S.P., 1977, A manual of Virus Diseases of Tropical Plants, Macmillan Company of India Ltd., Delhi.
4. Rengaswami, G and S.Rajagopalan, 1973, Bacterial Plant Pathology – Tamil Nadu Agriculture University, Coimbatore.
5. Subba Rao, N.S., 1995, Soil Microorganisms and Plant Growth, third edition, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

## **MBDE 8616: ENVIRONMENTAL MICROBIOLOGY**

**Total: 60 Hours**

### **UNIT I**

Microbial transformations of C, N, P, S and their Biogeochemical cycles **5**

### **UNIT II**

**AIR MICROBIOLOGY:** **15**

Air borne microorganisms – diseases and control measures – monitoring of airborne microbes – culture media. Microbial indicators of air pollution – sick building syndrome.

**Aeroallergens-** Allergy due to inhaled microbes and pollens – Mechanism of Type-I hypersensitivity reaction – testing and therapy of allergy.

**Air samplers-** Anderson's sampler, Cascade Impactor, Hirst trap, Burkard sampler, Rotorod, vertical cylinder trap, types of impingers, identification of pollen and spores – pollen calendar.

### **UNIT III**

**AQUATIC AND SANITARY MICROBIOLOGY:** **20**

Aquatic habitats- surface, subsurface and marine habitats, zonation of water ecosystems and food chain in aquatic ecosystems. Effect of acid rain on microbial processes in natural waters. Ground water contamination and remedial measures.

**Role of microbes in** 1. Sewage treatment: Primary, Secondary and Tertiary treatment.  
2. Biological Treatment of Industrial effluents.

**Water borne diseases and control measures-** Indicator microbes of water pollution, testing procedure- BIS for commercial mineral water, ISI standard for potable water, water purification.

### **UNIT IV**

**SOLID WASTE DISPOSAL:** **10**

Composting, vermicomposting and sanitary landfill.

**BIODEGRADATION OF PESTICIDES:**

2, 4-D, DDT and heptachlor. Metallophilic bacteria, Bioaccumulation.

**BIODEGRADATION OF XENOBIOTICS:**

PCBs, plastics. Biodeterioration of paper and textiles. Biobleaching of ore and metal corrosion.

### **UNIT V**

**BIOREMEDIATION:** **10**

Testing for biodegradability- Biosensors, efficacy testing, side effect testing. Approaches to bioremediation. Environmental modification for bioremediation- Bioengineering approaches. Bioremediation of various ecosystems- contaminated soil



and aquifers, oil spills- super bug, bioremediation of air pollution.

**REFERENCES:**

1. Agashe, S.N. 1994. Aerobiology, Oxford & IBH Publishing Company, New Delhi.
2. Atlas, R.M. and Bastha, R. 2000, Microbial Ecology Fundamentals and Applications 4<sup>th</sup> Edition, Addison Wesley Longman, Inc. New York.
3. Bitton, G, 1994. Wastewater Microbiology, Wiley-Liss Inc. New York.
4. Duggal, K.N. 1985, Elements of Public Health Engineering S. Chand & Co., Ltd., New Delhi.
5. Hurst, C.J., Krudsen, G.R., McInerney, M.J., Stetzenbach, L.D. and Watter, M.V., 1997. Manual of Environmental Microbiology, ASM Press, Washington, D.C.
6. Mitchell, R. 1992. Environmental Microbiology, Wiley-Liss, Inc. New York.

**PRACTICALS**  
**MB 8P<sub>1</sub>: IMMUNOLOGY AND MICROBIAL PHYSIOLOGY**

**Total :120 Hours**

**IMMUNOLOGY**

1. Agglutination test- Blood grouping and WIDAL.
2. Precipitation tests (RIEP, CCIIEP).
3. Identification of *Staphylococcus aureus* by coagulase test.
4. ELISA
5. Determination of nonspecific resistance to bacteria.
6. Determination of bactericidal activity of normal serum.

**MICROBIAL PHYSIOLOGY**

1. Determination of Growth – Growth curve and generation time.
2. Estimation of DNA by Diphenylamine method.
3. Estimation of RNA by Orcinol method.
4. Estimation of Proteins by Lowry's method.
5. Estimation of amylase activity.
6. Determination of  $K_m$  and  $V_{max}$ .
7. Saponification value of fat.
8. Iodine number of fatty acids.
9. Estimation of Phosphatase and Catalase activity.

**REFERENCES**

1. Alcamo, I.E. 2001, Laboratory Fundamentals of Microbiology, Jones and Barlett.
2. Alexander J. Ninfa, 1998. Fundamental Laboratory approaches for Biochemistry and Biotechnology Fitzgerald Science Press, Inc., Bethesda, Maryland.
3. Bloom, Freyer, Meckler, 1996. Laboratory DNA Science, The Benjamin/Cummings Pub.
4. David T Plummer, 1996. An Introduction to Practical Biochemistry, 3 ed. Tata
5. Experiments with gene fusions 1994, T. Slave, Cold Spring Harbour Lab. Press.
6. Hudson, L and Hay, F.C. Tical Immunology, Blackwell Scientific Publications. McGraw-Hill.
7. Parkinson D, (1994) Methods in soil analysis, Part 2, Microbiology and Biochemical properties, SSSA book seriesm No.5 Soil Sciences Society of America, Madison, Wise, USA.
8. Short course in genetics, J.H. Miller 1992, CSH Laboratories.
9. Ted R. Johnson and Christine L Case, 2001. Laboratory Experiments in Microbiology.

## **MB 8P<sub>2a</sub>: FOOD AND AGRICULTURAL MICROBIOLOGY**

**Total: 120 Hours**

### **FOOD MICROBIOLOGY**

1. Rapid platform tests, DMC and SPC.
2. Production of milk products from starter cultures. (Yoghurt and acidophilus milk)
3. Food preservation by salt, sugar, sodium benzoate.
4. Role of Yeast in Bread making.
5. Production and detection of aflatoxins from spoilt food.

### **AGRICULTURAL MICROBIOLOGY**

1. Isolation of *Azotobacter* and *Azospirillum* from soil.
2. Isolation of phosphate solubilizing bacteria.
3. Isolation of *Rhizobium* spp., and study of root nodules of legumes
4. Staining and identification of VAM
5. Mushroom cultivation
6. Study of plant pathogens
7. Screening of siderophore producing bacteria.

### **REFERENCES:**

1. James G. Cappuccino and Natalie Sherman. Microbiology: A Laboratory Manual.
2. Kanika Sharma. Manual of Microbiology: Tools and Techniques.
3. Robert S. Burlage, Ronald Atlas, David Stahl, Gill Geesey, Gary Sayler, 1998. Techniques in Microbial Ecology, Oxford University Press. N.Y.

## **MB 8P<sub>2b</sub>: FOOD AND ENVIRONMENTAL MICROBIOLOGY**

**Total: 120 Hours**

### **FOOD MICROBIOLOGY**

1. Rapid platform tests, DMC and SPC.
2. Production of milk products from starter cultures. (Yoghurt and acidophilus milk)
3. Food preservation by salt, sugar, sodium benzoate.
4. Role of Yeast in Bread making.
5. Production and detection of aflatoxins from spoilt food.

### **ENVIRONMENTAL MICROBIOLOGY**

1. Study of air samplers and airborne microorganisms.
2. Determination of biological oxygen demand.
3. Determination of COD.
4. Bacteriological examination of water.
5. Isolation of microorganisms from sewage samples.
6. Isolation of methanogens.

### **REFERENCES**

4. James G. Cappuccino and Natalie Sherman. Microbiology: A Laboratory Manual.
5. Kanika Sharma. Manual of Microbiology: Tools and Techniques.
6. Robert S. Burlage, Ronald Atlas, David Stahl, Gill Geesey, Gary Sayler, 1998. Techniques in Microbial Ecology, Oxford University Press. N.Y.

# **MB 9116: RECOMBINANT DNA TECHNOLOGY**

**Total: 60 Hours**

## **UNIT I**

- a. Introduction to genetic engineering 2
- b. Tools in genetic engineering:
  - DNA manipulative enzymes: 5
  - Restriction endonucleases – Nomenclature, classification, enzyme catalysis and applications.
  - DNA Ligase - Types, enzyme catalysis and ligation strategies.
  - DNA modifying enzyme: Polynucleotidyl kinase, alkaline phosphatase and terminal nucleotidyltransferase. 1
- c. Cloning vectors: 12
  - Plasmids (pBR322, pUC-8, pGEM3Z and Ti plasmid)
  - Bacteriophage ( $\lambda$  phage and M13 vectors)
  - Cosmids, phagemids, expression vectors, shuttle vectors, BACs and YACs, Excretion Vectors and Animal viral vectors (Adeno virus and retro virus).
  - Cloning and expression in bacteria and yeast.

## **UNIT II**

- a. Basic principles of gene cloning strategies. 2
- b. Transformation techniques:  $\text{CaCl}_2$  mediated Transformation, Micro projectile 5  
Bombardment, Microinjections, Electroporation, Liposome mediated transfer, and Agrobacterium mediated transfer.

## **UNIT III**

- Genomic and cDNA library construction and their applications. 4

## **UNIT IV**

- Analysis of gene and gene products:** 8
  - Direct methods – Selection by Complementation or Nonsense separation and marker inactivation techniques.
  - Indirect methods – Restriction enzyme cleavage pattern, Hybridization techniques (Colony and Plaque hybridization), Blotting techniques, Chromosome walking, Detection of specific protein by invitro translation techniques, Immunological methods, Protein synthesis in mini cells and Maxi cells.

## **UNIT V**

- a. DNA finger printing and its applications 2
- b. PCR – Gene amplification, Primer designing, optimization, variation in the PCR, 4  
types of PCR.
- c. DNA sequencing – Sanger, Coulsen's method, Maxam Gilbert's method, 3

- automated sequencing.
- d. DNA Microarrays – Types , features and their application in the study of gene expression **3**
- e. Chemical synthesis of oligonucleotides : Phosphodiester, Phosphotriester, Phosphitetriester approaches, enzymatic synthesis of DNA and applications of synthetic oligonucleotides. **3**

## UNIT VI

- a. Applications of gene cloning and Ethics in Genetic Engineering: **4**  
Applications of gene cloning in Medicine (Gene therapy), Agriculture (Transgenic plants – Insecticide resistant and herbicide resistant).
- b. Safety of recombinant DNA technology : **2**  
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. 2000, Gene Cloning, fourth edition, Chapman and Hall Publication, USA.
2. Lewin B., 2000, Genes VII, Oxford University Press, Oxford, U.K.
3. Old R.W. and Primrose S.B., 1996, Principles of Gene Manipulations, Blackwell Science Publications, London.
4. SandhyaMitra, 1996, Genetic Engineering, Mac Millar India Ltd., New Delhi.
5. Symonds N., A. Toussaint, P. Van De Putte, M.M. Howe, 1987, Phage Mu. Cold Spring harbor Laboratory.
6. Watson, J.D., N.H.Hopkins, J.W. Roberts, J.A. Steitz and A.M. Weiner, 1998, Molecular Biology of the Gene, fourth edition, The Benjamin/Cummings Publishing Company Inc., Tokyo.
7. Winnaker E.L., 1987, From Gene to Clone: Introduction to Gene Technology, VCH Publications, Weinbem Federal Republic German.

## MB 9216: MEDICAL MICROBIOLOGY

**Total: 60 hours**

### UNIT I

Introduction to Normal human flora. **12**  
Laboratory Management:- Safety in a microbiology laboratory.  
Quality control in microbiology: - External and internal  
Nosocomial infections :- Microbiology of hospital infections, common type of infections, diagnosis and control of infections, biomedical waste management quantity and types of biomedical waste and waste treatment.  
Factors responsible for Microbial pathogenesis.

### UNIT II

General characters, culture, antigenic structure, pathogenesis, laboratory diagnosis, **15**  
epidemiology, treatment, management and control of important groups of pathogenic microorganisms  
**BACTERIAL:** *Staphylococci, Streptococci, Pneumococcus, Gonococci, Clostridia, Haemophilus, Vibrio, Shigella, Salmonella, M. tuberculosis, Pseudomonas, Leptospira, Treponema pallidum*

### UNIT III

#### **MEDICAL MYCOLOGY:**

Classification of medically important fungi. **15**  
Surface infections:-*Tinea versicolor, Tinea nigra* and *T. piedra*.  
Cutaneous infections:-*Dermatophytes*.  
Systemic:- Yeast – *Cryptococcus neoformans*  
Yeast like fungi – *Candida sp.*  
Filamentous fungi – *Aspergillus, Penicillium*  
Dimorphic fungi – *Blastomyces dermatidis, Histoplasma capsulatum*  
**Parasitology:** *Giardia, Plasmodium, Entamoeba histolytica,*  
Parasitic hookworms:-*Toxoplasma, Taenia.*

### UNIT IV

#### **VIRUSES**

DNA viruses – Herpes virus – HSV-1 and HSV-II, Hepatitis B virus. **12**  
RNA viruses – Dengue, Chikungunya, Ebola, H1N1, HIV  
Viral zoonoses – Japanese encephalitis, rabies,  
Oncogenic Viruses:-Properties of cells transformed by viruses, list of Oncogenic viruses, oncogenes and mechanism of viral oncogenesis.

### UNIT V

Classification and mechanism of action of antimicrobial agents: bacteria, viruses, fungi **6**  
and parasites). Methods of testing drug sensitivity.

## REFERENCES:

1. Ananthanarayanan and Jeyaram Paniker C.K. Text Book of Microbiology, 8<sup>th</sup> edition Orient Longman, Chennai.
2. Chakraborty P., 1995 A Text Book of Microbiology, New Central Book Agency (P) Ltd., Calcutta.
3. Collee, J.G., A.G.Eraser, B.P. Marmion, A Simmons, 1996 Mackie and McCartney, Practical Medical Microbiology, fortieth edition, Churchill Livingstone.
4. Davis, B.D., R.Dulbecco, H.N. Eisen, H.S. Ginsberg 1990. Microbiology 4<sup>th</sup> edition Harper & Now publishers, Singapore.
5. Franklin T. J. and Snow G. A., (1975), Biochemistry of Antimicrobial Action, Chapman and Hall, London, 1-22 and 160- 174
6. Gale E. F., Cundliffe E., Reynolds P. E., Richmond M. H. and Waring M. J., (1972), The molecular basis of antibiotic action, John Wiley and Sons, London
7. Goldstein A., Aronow L., and Kalman S. M. (1969) Principles of Drug Action, The Basis of Pharmacology, Harper international edition New York 11.
8. Jawetz E, J.C. Melnic and E.A. Adelberg, 2001, Review of Medical Microbiology, Prentice Hall International Inc, USA.
9. Jawetz E, J.C. Melnic and E.A. Adelberg, Medical Microbiology, 24<sup>th</sup> edition, The McGraw- Hill companies.
10. Lorian V., (1986), Antibiotics in laboratory medicine, 2nd Ed, Williams & Wilkins Publication 5
11. Leslie Collier, Balows A. and Sussman M. 2000 Topley & Wilson's Microbiology and Microbial infection vol. 1-5 Arnold Publishers, London.
12. Mandell, Douglas and Bennett's Principle and Practice of Infectious diseases 2000 vol. 1 & 2 Churchill Livingstone.
13. Villanova, PA; NCCLS: 2002. National Committee for Clinical Laboratory Standards (now Clinical and Laboratory standards Institute, CLSI). Performance standards for antimicrobial susceptibility testing; 12th information supplement (M100-S1).
14. Villanova, PA: NCCLS, 1997. National Committee for Clinical Laboratory Standards (now Clinical and Laboratory Standards Institute, CLSI). Methods for dilution antimicrobial susceptibility testing for bacteria that grows aerobically. Approved Standards M7-A4.



# **MB 9316: INDUSTRIAL MICROBIOLOGY**

**Total: 60 Hours**

## **UNIT- I**

Concepts and scope of fermentation technology **1**

## **UNIT-II**

- a. Basic design and function of a fermenter. **7**
- b. Types of fermenters: stirred tank fermenters, tubular fermenters, tower fermenters, air-lift fermenters, membrane bioreactors, photo bioreactors, disposable fermenters, fluidized bed fermenters.
- c. Solid state fermenters: tray fermenters, drum fermenters.

## **UNIT-III**

- a. Media sterilization, sterilization of fermenter, sterilization of air supply. **11**
- b. Aseptic inoculation methods, sampling methods, monitoring and control devices.
- c. Fermentation media: media formulations, sources of carbon, nitrogen, vitamins and minerals.
- d. Role of buffers, precursors, inhibitors, inducers and antifoam agents.
- e. Development of inoculum for bacterial, fungal and actinomycetes.
- f. Substrate for solid state fermentation
- g. Power requirement, Oxygen transfer kinetics, Concepts of Newtonian and non Newtonian fluids, plastic fluids, apparent viscosities

## **UNIT-IV**

Microbial growth kinetics: Batch, Continuous and Fed Batch culture. **6**

## **UNIT-V**

- a. Isolation, preservation and improvement of industrial microorganisms: **11**  
Isolation methods, screening methods, preservation techniques, strain improvement, protoplast fusion, parasexual cycle and recombinant DNA techniques.
- b. Immobilization of enzymes and cells: methods, advantages and applications

## **UNIT-VI**

- a. Scale up of fermentation process: parameters used in scale up and **8**  
problems associated with scale up.
- b. Downstream processing: objectives and criteria, foam separation, precipitation methods, filtration devices and filter aids.
- c. Industrial scale centrifugation and cell disruption methods, liquid-liquid extraction, solvent recovery, chromatography, microfiltration, ultrafiltration, drying devices, crystallization and whole broth processing.

## UNIT VII

### **MICROBIAL TECHNOLOGY**

- a. Production of: alcohol-beer and ethanol; Organic acids- citric acid; **16**  
Amino acids- glutamic acid; Antibiotics- penicillin; Vitamins- Vitamin B12;  
Enzymes- protease; Biopolymers-: xanthan gum
- b. Production of recombinant proteins- human insulin, interferon; Recombinant vaccine production - Hepatitis B vaccine; melanin biosynthesis in *E.coli*; Chymosin production in *E.coli* and yeast.

### **REFERENCES:**

1. Casida, J.F. (1968). Industrial Microbiology. Wiley Eastern Ltd.
2. Cruger, W. and Crueger, A. (2000). Second Edition, Biotechnology: A Text Book of Industrial microbiology., Panima Publishing Corporation, New Delhi.
3. Flickinger, M.C. and Drew, S.W. (1999). Encyclopedia of Bioprocess Technology, Biocatalysts and Bioseparation. Vol. V., John Wiley and Sons Publications.
4. Pepper, H.J. and Pearman, D. (1979). Microbial Technology. Vol.I Academic Press, New York.
5. Stanbury, P.F., Whitaker, A. and Hall, S.J. (1995). Second Edition, Principles of Fermentation Technology. Aditya Book (P) Ltd., New Delhi.

# **MB 9416: BIOSTATISTICS AND BIOINFORMATICS**

**Total: 60 Hours**

## **BIOSTATISTICS**

### **UNIT I**

Samples and Population, Variables in Biology **10**  
Sampling methods. Probability and non probability methods.  
Frequency distribution  
Graphic presentation of data-histogram, frequency curve and ogives  
Measures of Central tendency – mean, median and mode  
Measures of dispersion – range, mean deviation, standard deviation, standard error, variance.

### **UNIT II**

Probability – addition and multiplication rules. Hayes theorem **10**  
Probability distribution binomial, poisson and normal.  
Student “t” distribution.  
Point estimation and interval estimation.  
Estimating the population mean, known and unknown.  
Wilcoxon signed Rank test  
Null and alternate hypothesis  
Two tailed and one tailed test  
Chi-square test – test of independence, goodness of fit and homogeneity  
Statistics related to Epidemiology

### **UNIT III**

Correlation – definition, types and measurements of correlation. **10**  
Regression analysis – equation, estimation of unknown value from known value.  
ANOVA – one way and two way classification – Least significance difference (LSD)  
Randomization – different ways of randomization – randomized blocks – latin squares.  
Randomized blocks versus latin square.  
Problems biologically based.  
Software packages used in analyzing results. Graph pad prism , 2 way

## **REFERENCES:**

1. Baxevanis, A.D., and Ouellette, B.F.F., 2001, Bioinformatics A Practical Guide to the Analysis of Genes and Proteins, Wiley – Interscience Publication, New York.
2. Bhaskararao, T 2001 Methods of Biostatics Paras publications, Hyderabad.
3. Gibas, C., and Jambeck, P., 2001, An Introduction to Software tools to Biological Applications Developing Bioinformatics Computer Skills, Shroff Publishers & Distributors Pvt. Ltd., Mumbai.

4. Gupta, S.P., 1987, Statistical Methods (Sul-ton Chand and Sons Publishers, New Delhi).
5. Khan I.A and Khanum A. 1994 Fundamentals of Biostatistics (UkaazPublcation, New Delhi).
6. Rashidi, H.H., and Buchler, L.K. 2000, Bioinformation Basics. Applications in Biological Science and Medicine, CRC Press, USA.
7. Reza Hoshmand, A. 1988, Statistical Methods for Agricultural Sciences (Timber Press, Oregon)
8. Schefler W.C. 1980 Statistics for the Biological Sciences (Addison – Wesley Publishing Company, New York).
9. Sokal, R.R. and Rohif F.J. 1987 Introduction to biostatistics (W.H. Freeman and Company, New York)

# **BIOINFORMATICS**

## **UNIT I**

Databases: Introduction to data bases-Relational databases- Oracle, SQL, Database generation, Sequence databases- Resources- Human Genome Project (HGP), Microbial genomes, structural databases- protein data Bank (PDB), Organization of databases, Navigation through databases **8**

## **UNIT II**

Principles behind computational analysis, Sequence analysis, sequence alignment and phylogenetic analysis with reference to nucleic acids, identification of ORF'S, sequence analysis, sequence alignment, phylogenetic analysis with reference to proteins **7**

## **UNIT III**

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. **8**

## **UNIT IV**

Tools For Data Bank - Pairwise Alignment - Needleman And WunschAlgorithm – 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. **7**

## **REFERENCES:**

1. Bioinformatics 1998, baxavanis.
2. Bioinformatics 2000. Higgins & Taylor, OUP
3. Introduction to Bioinformatics-2002. Dhananjaya, [www.sd.bio.com.series](http://www.sd.bio.com.series)
4. Nucleic acid research, 2001. Jan. Genome Database issue
5. Taxali, R.K. 1991. dBase III Plus-Made Simple (Tata Mc-Graw-Hill Publishing Company Ltd., New Delhi).
6. Taxali, R.K., 2000, PC Software for Windows Made Simple (Tata McGraw-Hill Publishing Company Ltd., New Delhi).
7. Zar J.H. 1996. Biostatistical Analysis (Prentice-Hall International, USA).

# MBOE 9516: MICROBES AND US

**Total: 60 Hours**

## **Learning outcomes:**

**Microbes** are tiny organisms, too tiny to see without a microscope, yet they are abundant on Earth. They live everywhere: in air, soil, rock, and water. Some live happily in searing heat, while others thrive in freezing cold. Some **microbes** need oxygen to live, but others do not. Though microscopic, one can't overemphasize the importance of microbiology. Society benefits from microorganisms in many ways. They are necessary for the production of bread, cheese, beer, antibiotics, vaccines, vitamins, enzymes, and many other important products. Indeed, modern biotechnology rests upon a microbiological foundation. In contrary to those microorganisms also have harmed humans, animals, plants and so on, and disrupted society over the millennia. Microbial diseases undoubtedly played a major role.

This elective draws our relationship closer to microbes. This relationship involves not only the beneficial effects but also familiarize us with the harmful effects of certain microorganisms. Here we will bring to you the ways microbes affect our lives by causing diseases. We will also try and learn the measures to be taken to prevent the spread of microbial diseases and if affected to treat them. We will also examine the use of microbes in commercial and industrial applications to produce food, chemicals and drugs, to treat sewage, control pests and clean up pollutants.

## UNIT I

1. **MICROBIAL DIVERSITY** **2**  
Introduction to microbial biodiversity: distribution, abundance, ecological niche and types.
2. **MICROBIAL COMMUNITIES** **3**  
Important interactions within microbial communities: Between microorganisms and plants and animals.
3. **THE HUMAN MICROBIOME** **3**  
Human Microbiota, Gut Microflora, Maintaining and replenishing the Gut Microflora.

## UNIT II

4. **INFECTIOUS DISEASE & PREVENTION**
  - a. Definition of infection and disease. **1**
  - b. **Classification of infections:** localized, generalized, endemic, epidemic, sporadic and pandemic. Classification of diseases as communicable and non communicable with examples. **4**
  - c. **Sources of infection:** Air, humans, animals, insects, soil, water and food. **3**
  - d. **Methods of transmission of infection:** Contact, inhalation, ingestion. **2**  
inoculation ,insects, congenital, iatrogenic and laboratory infections.
  - e. **Causes, prevention and treatment of infections /disease:** **5**  
Dengue, HIV, Hepatitis, Tuberculosis, Typhoid and Candidiasis.

- f. Hospital acquired infection, prevention and control (CDC) 2
- g. Disinfection :- types of disinfection procedures 1
- h. Vaccines and Immunization schedule 2
- i. Chemotherapy - Use and abuse 4

### UNIT III

- 5. MICROBES IN THE ENVIRONMENT: 8**
- a. Definitions, biotic and abiotic environment. Water pollution and its control: Need for water management. Sources of water pollution. Measurement of water pollution.
  - b. Microbiology of wastewater and solid waste treatment.
  - c. Treatment schemes for effluents of dairy, distillery, tannery, sugar and antibiotic industries. (Types, microbes used, types of Effluent Treatment Plants).
  - d. Composting.
  - e. Biomining.

### UNIT IV

- 6. MICROBIAL PRODUCTS:**
- a. **Microbiology of fermented products and beverage fermentation. 6**  
Microbiology of fermented milk products (acidophilus milk, yoghurt and cheese), bread and sausages.  
Role of microorganisms in beverages – tea and coffee fermentations.
  - b. **Enzymes: 6** Microbial enzymes in food processing, textile, leather, wood industries and detergents. Enzymes in environmental analyses.
  - c. **Therapeutic compounds: 3**  $\beta$ -lactams, Insulin and Vitamin B12.
  - d. Bioplastic, Single cell protein, Biofertilizer, Transgenic plants and Biofuels. 5

### **REFERENCES:**

1. Robert S. Burlage, Ronald Atlas, David Stahl, Gill Geesey, Gary Sayler, 1998. Techniques in Microbial Ecology, Oxford University Press. N.Y.
2. Atlas and Bartha; Microbial Ecology.
3. Nester *et al*, 2004, Microbiology a human perspective, Mac Graw Hill Higher education.
4. Prescott, Harley & Klein's,(2008), Microbiology, Mac Graw Hill Higher education.
5. Stalley, Jerome, Microbial life 2<sup>nd</sup> edition (2007), Sinauer Associates inc, Massachusetts.
6. Casida, J.F. 1968. Industrial Microbiology, Wiley Eastern Ltd., New Delhi.
7. Cruger, W. and Crueger, A. 2000. Biotechnology: A Text Book of Industrial Microbiology, Second Edition, Panima Publishing Corporation, New Delhi.

## PRACTICALS

### MB 9P<sub>1</sub>: MOLECULAR BIOLOGY, RECOMBINANT DNA TECHNOLOGY AND MEDICAL MICROBIOLOGY

**Total: 120 Hours**

1. Collection and processing of clinical samples for microbiological examination
2. Antimicrobial susceptibility tests.
  - a. Kirby-Bauer disc diffusion test.
  - b. Dilution sensitivity test-MIC and MBC against Yeast and other fungi.
3. Differential Staining techniques: AFB, Leishman's, Giemsa, Capsule, granules spores.
4. Isolation and culture of medically important Anaerobes.
5. Isolation of plasmid DNA by column chromatography.
6. Extraction of total RNA.
7. Restriction digestion of isolated DNA (single and double digestion).
8. DNA ligation
9. DNA amplification by PCR.
10. Purification of IgG by affinity chromatography.
11. Western blotting
12. Southern blotting

### **REFERENCES:**

1. Ausubel, F.M., 1997, Short Protocols in Molecular Biology, second edition, John Wiley & Sons Harvard Medical School.
2. Ausubel, F.M., Roger Brent, Robert E. Kingston, David A Moore, Seidman J.G., John A.Smith, Kelvin Stunho, 1992, third edition, Sheet Protocols in Molecular Biology, John Wilsey& Sons Inc., New York.
3. Bailey and Scott Diagnostic Microbiology .
4. Berger, S.I., R. Kimmel, 1987, Guide to Molecular Cloning Techniques, academic Press Inc., New York.
5. Brown T.A. 1998, Lab – Molecular Biology Lab FAX – II Gene Analysis, second edition, Academic Press, UK.
6. Brown, T.A. 1998, Molecular Biology lab Fax II Gene Analysis, Academic Press, London.
7. Glover D.M. and B.D. Hames, 1995, DNA Cloning – A Practical Approach, Vol. – 4, IRC Press.
8. K.R.Aneja 2003,FourthEdition,Experiments in Microbiology ,Plant Pathology and Biotechnology.New age International (P) Ltd.
9. Rajamanekam.C Experimental protocols in basic molecular biology, Osho Scientific Publications, Madurai.
10. Sambrook, J., E.F. Fritsch, Maniatis, T., 1989, Molecular Cloning.. A Lab Manual Vol. III., second edition CSH Press, Cold Spring Harbour.
11. Sambrook, J., Fritsch, E.F., and Maniatis, T., 1989 second edition, Molecular Cloning 1, 2, 3 – A Laboratory Manual, Cold Spring Laboratory Press USA.



**PRACTICALS**  
**MB 9P<sub>2</sub> : INDUSTRIAL MICROBIOLOGY**

**Total: 120 Hours**

1. Screening and isolation of industrially important microorganisms (Enzyme - protease, and antibiotic - Penicillin) and their preservation.
2. Production of protease (SSF) and its estimation.
3. Production of antibiotic (SSF) and its assay.
4. Production and estimation of wine using different substrates by *Saccharomyces cerevisiae*.
5. Batch production and estimation of citric acid.
6. Immobilization of cells by alginate method.
7. Sterility testing of pharmaceutical products.
8. Isolation of protoplast and its fusion.
9. Preparation of banana juice using pectinase.
10. Production of any vitamin and its quantification by bioassay.
11. Visit to industries.

**REFERENCES:**

1. K.R.Aneja 2003,Fourth Edition,Experiments in Microbiology ,Plant Pathology and Biotechnology.New age International (P) Ltd
2. Manual of Industrial Microbiology and Biotechnology, Demain et al., Wiley
3. Biochemical Engineering and Biotechnology Handbook, Atkinson, Grove' Dictionaries
4. James G.Cappuccino and Natalie Sherman 2013 Seventh Edition. Microbiology a Laboratory Manual Pearson.
5. Microbiological Examination Methods of Food and Water: A Laboratory Manual, by Neusely da Silva, Marta Hirotomi Taniwaki, Valéria Christina Junqueira, Neliane Silveira (Author), Maristela da Silva do Nascimento (Author), Renato Abeilar Romeiro Gomes (Author).

**SEMESTER IV**

**MB 0314: PROJECT WORK**

**Total: 360 hours**

**Credits: 12**