




**M.Sc., Microbiology (CBCS)**

**Syllabus**

**(Implemented from 2018-19)**

**DEPARTMENT OF STUDIES IN MICROBIOLOGY**

**Shankaraghatta – 577451**

  
**KUVEMPU UNIVERSITY**  
**M.Sc., Microbiology (CBCS)**  
**Syllabus- I Semester**

Semester	Type	Paper Code	Paper Title	Hrs/ Week	Total Hrs	Credits	Marks		Total
							Internal Assessment	Examination	
I	<b>Hard Core</b>	Theory MB-1.1	Fundamentals of Microbiology	4	64	4	25	75	<b>100</b>
		Theory MB-1.2	Biochemistry and Biostatistics	4	64	4	25	75	<b>100</b>
		Theory MB-1.3	Microbial Physiology and Bioinformatics	4	64	4	25	75	<b>100</b>
		Practical MB-1.4	Fundamentals of Microbiology	4	64	2	-	50	<b>50</b>
		Practical MB-1.5	Biochemistry and Biostatistics	4	64	2	-	50	<b>50</b>
		Practical MB-1.6	Microbial Physiology and Bioinformatics	4	64	2	-	50	<b>50</b>
I	<b>Soft Core</b>	Theory MB-1.7	A) Mycology	4	64	4	25	75	<b>100</b>
			B) Principles of Genetics						
		Practical MB-1.8	A) Mycology	4	64	2	-	50	<b>50</b>
			B) Principles of Genetics						
<b>Total Credits</b>						<b>24</b>	<b>Total Marks</b>		<b>600</b>

**Additional Mandatory Credits:**

- 1. Communications Skills: 01 Credit**
- 2. Computer Applications: 01 Credit**
- 3. Personality Development: 01 Credit**




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**Syllabus- II Semester**

Semester	Type	Paper Code	Paper Title	Hrs/ Week	Total Hrs	Credits	Marks		Total
							IA	Examination	
II	<b>Hard Core</b>	Theory MB-2.1	Microbial Genetics and Molecular Biology	4	64	4	25	75	<b>100</b>
		Theory MB-2.2	Medical Microbiology	4	64	4	25	75	<b>100</b>
		Practical MB-2.3	Microbial Genetics and Molecular Biology	4	64	2	-	50	<b>50</b>
		Practical MB-2.4	Medical Microbiology	4	64	2	-	50	<b>50</b>
II	<b>Soft Core</b>	Theory MB-2.5	A) Plant-Microbe Interactions	4	64	4	25	75	<b>100</b>
			B) Microbial Enzymology						
		Practical MB-2.6	A) Plant-Microbe Interactions	4	64	2	-	50	<b>50</b>
			B) Microbial Enzymology						
II	<b>Elective</b>	Theory MB-2.7	A) Water Microbiology	2	32	2	10	40	<b>50</b>
			B) Agriculture Microbiology						
<b>Total Credits</b>						<b>20</b>	<b>Total Marks</b>		<b>500</b>



**KUVEMPU UNIVERSITY**  
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**Syllabus- III Semester**

Semester	Type	Paper Code	Paper Title	Hrs/Week	Total Hrs	Credits	Marks		Total
							Internal Assessment	Examination	
III	<b>Hard Core</b>	Theory MB-3.1	Agriculture Microbiology	4	64	4	25	75	<b>100</b>
		Theory MB-3.2	Immunology	4	64	4	25	75	<b>100</b>
		Practical MB-3.3	Agriculture Microbiology	4	64	2	-	50	<b>50</b>
		Practical MB-3.4	Immunology	4	64	2	-	50	<b>50</b>
III	<b>Soft Core</b>	Theory MB-3.5	A) Immunotechnology	4	64	4	25	75	<b>100</b>
			B) Fermentation Technology						
		Practical MB-3.6	A) Immunotechnology	4	64	2	-	50	<b>50</b>
			B) Fermentation technology						
III	<b>Elective</b>	Theory MB-3.7	A) Diagnostic Microbiology	2	32	2	10	40	<b>50</b>
			B) Industrial Microbiology						
<b>Total Credits</b>						<b>20</b>	<b>Total Marks</b>		<b>500</b>



**KUVEMPU UNIVERSITY**  
**M.Sc., Microbiology (CBCS)**  
**Syllabus- IV Semester**

Semester	Type	Paper Code	Paper Title	Hrs/ Week	Total Hrs	Credits	Marks		Total
							Internal Assessment	Examination	
IV	Hard Core	Theory MB-4.1	Food and Industrial Microbiology	4	64	4	25	75	100
		Theory MB-4.2	Microbial Biotechnology	4	64	4	25	75	100
		Theory MB-4.3	Environmental Microbiology	4	64	4	25	75	100
		Practical MB-4.4	Food and Industrial Microbiology	4	64	2	-	50	50
		Practical MB-4.5	Microbial Biotechnology	4	64	2	-	50	50
		Practical MB-4.6	Environmental Microbiology	4	64	2	-	50	50
		Theory MB.4.7	Project work	6	80	4	25	75	100
<b>Total Credits</b>						<b>22</b>	<b>Total Marks</b>		<b>550</b>

**1. Total Marks for the Course: 2150**

**2. Total Credits for the Course: 89**

1. Project work should be based on experimental/review work and valued by two examiners (one external and one internal). The Candidate is required to present the work in open Viva-Voce examination in presence of examiners.
2. Each candidate shall have to complete 01 Credit each in Communications Skills, Computer applications and Personality development within first two semesters.
3. Examination duration: 03 hrs for both theory and practical of each paper.

**Internal Assessment for Papers:**

1. Two Session tests : 10 marks
2. Seminar/Tutorial /Group discussion : 05 marks
3. Assignment/Field work/Submission of specimen : 05 marks
4. Regularity and Attendance : 05 marks

**Total: 25 Marks**

## **MB 1.1: Fundamentals of Microbiology**

**64h**

### **Unit I.**

**12h**

**Introduction to Microbiology:** The discovery of Microorganisms, theory of spontaneous generation, Biogenesis, Relationship between microorganisms and diseases, Koch's postulates. **The Study of Microbial Structure: Microscopy and Specimen preparation;** Lenses and the Bending of Light, Magnification, Resolution, Numerical aperture, Types of Microscopes: Bright-Field, Dark-Field, Phase-Contrast, Fluorescence and Confocal Microscope, Electron Microscope: Transmission Electron Microscope (TEM), Scanning Electron Microscope (SEM). **Preparation and staining of Specimens:** Fixation, Dyes and simple staining, basic dyes, acidic dyes, differential staining, Gram's staining, Acid fast staining, staining specific Structures, Capsule staining, Negative staining, Endospore staining.

### **Unit II**

**12h**

**Cell Biology: An overview of Prokaryotic cell structure;** Shape, arrangement and size, prokaryotic cell organization, Prokaryotic cell membranes, Bacterial membranes, Archaeal membranes, Fluid mosaic model of membrane structure, Cytoplasmic matrix, Ribosomes, Nucleoid, Plasmids, Bacterial cell wall, Gram-Positive and Gram-Negative cell walls, Mechanism of Gram staining, Archaeal cell walls, Components external to the cell wall; Capsules, Slime layers and S-Layers, Pili and fimbriae, flagella and motility, Chemotaxis, Bacterial Endospore.

**An overview of Eukaryotic cell structure:** Structure of Plasma membrane, Cytoplasmic matrix, Microfilaments, intermediate filaments and Microtubules, **Cell organelles;** Golgi apparatus, Lysosomes, Biosynthetic- Secretory pathway, Endocytic pathway, Ribosomes, Mitochondria, Chloroplasts, Nucleus, Cilia and Flagella. Comparison of Prokaryotic and Eukaryotic Cells.

### **Unit III. Nutrition and Growth of Microorganisms**

**10h**

**Microbial Nutrition:** Nutritional requirements, Nutritional types of Microorganisms, Growth factors, Uptake of Nutrients by the cell; Passive and facilitated diffusion, Active transport, Group translocation, Iron uptake. **Culture Media:** Synthetic or Defined media, Complex media, Supportive media, Enriched media, Selective media. **Isolation of Pure cultures:** Spread plate, Streak plate and Pour plate methods. **Microbial Growth:** Prokaryotic cell cycle; Chromosome replication and Partitioning, Cytokinesis. Growth curve; Lag phase, Exponential or Log phase, Stationary phase, Decline or Death phase.

**Measurements of Microbial Growth:** Measurement of cell Numbers, Measurement of cell mass. Continuous Culture; Chemostat, Turbidostat. Factors influencing on Growth; Solutes and water activity, pH, Temperature, Oxygen concentration, Pressure and Radiation.

## Unit IV

10h

**Control of Microorganisms by Physical and Chemical Agents:** Sterilization, Disinfection, Sanitization, Antisepsis, Bactericide, Fungicide, Viricide, Bacteriostatic, Fungistatic. Conditions Influencing the effectiveness of Antimicrobial agents. **Physical methods of Sterilization:** Dry heat and Wet heat, Pasteurization, TDP and TDT, Filtration, Radiation. **Chemical methods of Sterilization:** Phenolics, Alcohols, Halogens, Heavy metals, Quaternary ammonium compounds, Aldehydes, Gases, Phenol coefficient test, Culture preservation techniques.

## Unit V

10h

**Microbial Classification and Taxonomy: Taxonomy:** Nomenclature, Identification, Natural classification of Carolus Linnaeus, Phenetic classification, Phylogenetic classification, Genotypic classification, Numerical Taxonomy, Taxonomic ranks. Techniques used for Microbial Taxonomy and Phylogeny: Classical characteristics; Morphological, Physiological and metabolic, Ecological and Genetic analysis. Molecular characteristics; Nucleic acid base composition, Nucleic acid hybridization, Phylogenetic trees. **Major Divisions of Life:** Haeckel's three kingdom classification, Whittaker's five kingdom classification, Three domain concept of Carl Woese.

## Unit VI

10h

**Diversity of Microorganisms: Viruses;** General structural properties of Viruses, viral envelopes and enzymes, Virus reproduction. Overview of Viral classification based on structure, Nucleic acid and host. **Bacteria:** General characteristics, Morphological types, reserve food materials, Reproduction, Classification of Bacteria according to Bergey's manual of Systematic Bacteriology to the level of Classes. **Fungi:** Distribution, Importance, Structure, Nutrition and metabolism, Reproduction, heterothallism. Classification of Fungi to the level of Classes. **Protozoa:** Distribution, Nutrition, Morphology, Encystment and Excystment, Reproduction, Classification of Protozoa to the level of orders. **Algae:** General characteristics, Morphological types, Reproduction, Classification of Microalgae to the level of Divisions.

### References;

1. Alcamo, I.E. 1997. Fundamentals of Microbiology, 5<sup>th</sup> edition, An imprint of Addison Wesley Longman, New York.
2. Batzing, B.L. 2002. Microbiology (An Introduction), Brooks/Cole Thomson Learning, Canada.
3. Bauman, R. 2007. Microbiology (With diseases by Taxonomy), 2<sup>nd</sup> edition, Pearson Benjamin Cummings Publishers, San Francisco.
4. Cappacino, J.G. and Sherman, N. 2005. Microbiology, A Laboratory Manual, 7<sup>th</sup> edition, Pearson Education INC. Delhi, India
5. Cooper, G.M and Hausman, R.2009. The Cell A molecular Approach, 5<sup>th</sup> edition, ASM Press, Washington, D.C.
6. Willey, J.M., Sherwood, L.M and Woolverton, C.J.2008. Prescott, Harley, and
7. Klein's Microbiology, 7<sup>th</sup> edition, McGraw-Hill, New York.

## MB-1.2: Biochemistry and Biostatistics

64h

### Unit I

16h

#### Biochemistry

**Water:** Properties of water, weak interaction in aqueous systems, ionization of water, pH, weak acids and weak bases, buffers, types of buffers and their importance. **Carbohydrates:** Definition, classification, structural properties and importance of sucrose, lactose, maltose, starch, cellulose, agar. **Amino acids, peptides and proteins:** Definition, classification, structure, general properties, assay methods of proteins. **Lipids and fats:** Definition, classification, structure and importance of lipids and fats.

### Unit II

16h

**Nucleotides:** Structure and properties of nucleotides and nucleosides. **Vitamins:** Definition, classification, structure and importance. **Porphyryns:** Definition, structure, properties and importance of chlorophyll, cytochrome and hemoglobin. **Enzymes:** Classification, nomenclature, general properties, activation energy, transition state, binding energy, turnover number, enzyme kinetics and Michaelis-Menten Equation, Importance of  $K_m$  and  $V_{max}$ , coenzymes, activators, inhibitors, isoenzymes, multi-enzyme complex, allosteric enzymes, mechanism of enzyme action.

### Unit III

16h

#### Biochemical Techniques

**Centrifugation techniques:** Basic principles of sedimentation. Methods and applications of density-gradient centrifugation, ultracentrifugation. **Chromatographic techniques:** General principles, Methods and applications of Paper chromatography, Thin-layer chromatography, Exclusion chromatography, Affinity chromatography, Ion-exchange chromatography, HPLC, Gas-liquid chromatography. **Electrophoretic techniques:** General principles and application of electrophoresis and isoelectric focusing. **Spectroscopic techniques:** General principles and laws of radiation, colorimetry, Ultraviolet-Visible spectrophotometry. **Radioisotopic techniques:** General principles, nature of radio activity, detection and measurement of radioactivity, applications of radioisotopes in biological investigation.

### Unit IV

16h

#### Biostatistics:

**Importance and applications:** Scope, sample and population concepts, sampling techniques, collection and organization of data, graphical presentation of data-frequency distribution, polygon, histogram, bar graph, pie diagram. **Measures of central tendency and dispersion:** Mean, Median, Mode, Range, mean deviation, variance, standard deviation. **Probability distributions:** Concepts of probability, Binomial, Poisson and Normal distribution. **Tests of significance:** Student's 't' test, Chi-square test, F-test, Analysis of Variance-one way and two way ANOVA.



## References;

1. Cazes, J.2005. Ewing's Analytical Instrumentation Handbook, 3<sup>rd</sup> edition, Marcel Dekker.Inc., USA
2. Miller, J.M.2005. Chromatography concepts and contrasts, 2<sup>nd</sup> edition, John Wiley & Sons.Inc Publication, Canada
3. Mohan, J. 2003. Organic Analytical Chemistry (Theory and Practice), Narosa Publishing House, New Delhi.
4. Williard, Merritt, Deal and Settle. 1986. Instrumental methods of Analysis, 7<sup>th</sup> edition, CBS Publishers, New Delhi.
5. Wilson, K and Walker, J. 2000. Practical Biochemistry (Principles in Techniques), 5<sup>th</sup> edition, Cambridge University Press, UK.
6. Devlin, J.M. 2011. Text book of Biochemistry with clinical correlations, 7<sup>th</sup> edition, John wiley and sons, Inc. USA.
7. Voet, D.J., Voet, J.G. and Pratt, C.W. 2008. Principles of Biochemistry, 3<sup>rd</sup> edition, John wiley and sons.
8. Elliott, W.H and Elliott, D.C. 2009.Biochemistry and molecular biology, 4<sup>th</sup> edition, Oxford university press, New york.
9. Prasad, S. 2004. Elements of Biostatistics, Rastogi publications.

## **MB-1.3: Microbial Physiology and Bioinformatics** **64h**

### **Unit I**

**16h**

**Metabolic Pathways: Bioenergetics;** The laws of thermodynamics and concept of entropy; First and Second law of thermodynamics, Gibb's Free energy, free energy changes in chemical reactions, free energy changes in metabolic reactions, coupling endergonic and exergonic reactions.

**Metabolism of carbohydrates:** Overview of metabolism, Glycolysis and ATP formation, gluconeogenesis, Glyoxylate cycle, Tricarboxylic acid cycle, Pentose phosphate pathway, Hexose monophosphate pathway, Entner-Doudoroff pathway, electron transport chain and oxidative phosphorylation, substrate level phosphorylation. Anaerobic oxidation of pyruvate: the process of fermentation.

### **Unit II**

**16h**

**Photosynthesis:** Overview of Photosynthetic metabolism, absorption of light, Photosynthetic pigments, light reactions; cyclic and non-cyclic photophosphorylation in eukaryotes, cyanobacteria, green and purple bacteria, Carbon dioxide fixation and synthesis of carbohydrates. **Metabolism of lipids:** Biosynthesis of lipids, Catabolism of lipids by beta-oxidation, yield of ATP for Stearic acid and Linoleic acid, Biosynthesis of cholesterol and ergo sterol. **Metabolism of nitrogenous compounds:** Transamination,

oxidative deamination, decarboxylation, urea cycle. General biosynthetic pathways of amino acids, biosynthesis of purines and pyrimidines and their regulation.

### Unit III

16h

**Fungal and bacterial secondary metabolism:** Secondary metabolites and regulation of secondary metabolism. **Antibiotics:** Definition, Discovery, classification, structure and mode of action. Biosynthesis of secondary metabolites -beta-lactum antibiotics, patulin, Aflatoxin, ergot alkaloids. **Fungal toxins:** Types of toxins, aromatic and phenolic toxins, terpenoid toxins, polysaccharides and glycoproteins. **Bacterial toxins:** Exo and endotoxins, enterotoxins. **Pigments:** Melanin, carotenoids. **Fungal hormones:** Sirenin (*Allomyces*) Sterols (*Achlya*). Trisporic acid (Ascomycetes), peptide hormones (Basidiomycetes). Bioluminescence in microorganisms: Mechanism and significance.

### Unit IV

16h

**Bioinformatics:** An overview, introduction and scope of bioinformatics. **Biological databases:** Types of databases (Entrez, SRS or Sequence Retrieval system. PIR or protein identification resource, GENE BANK, SWISS-PROT and other databases). Major bioinformatics databases and data analysis. Sequence analysis: Models for sequence analysis, methods for alignment (data matrices), method for optimal alignment (gap penalties and scoring matrices). Tools for sequence alignment- FASTA, BLASTA, PSI-Blast. Phylogenetic analysis: Phylogenetic trees, Methods of phylogenetic evaluation.

#### References;

1. Batzing, B.L. 2002. Microbiology (An Introduction), Brooks/Cole Thomson Learning, Canada.
2. Cooper, G.M and Hausman, R.2009. The Cell A molecular Approach, 5<sup>th</sup> edition, ASM Press, Washington, D.C.
3. Moat, A.G., Foster, J.W and Spector, M.P. Microbial Physiology, 4<sup>th</sup> edition, A John Wiley & Sons, Inc., Publication.
4. Ratledge, C and Kristiansen, B. 2001. Basic Biotechnology, 2<sup>nd</sup> edition, Cambridge University Press, USA.
5. Willey, J.M., Sherwood, L.M and Woolverton, C.J.2008. Prescott, Harley, and Klein's Microbiology, McGraw-Hill, New York.
6. Rastogi,S.C., Menndiratta,N. and Rastogi, P. 2007. Bioinformatics methods and applications, 2<sup>nd</sup> edition, Printice-hall of India. Pvt.Ltd. New Delhi.
7. Rajan,S.S and Balaji, R. 2002. Introduction to bioinformatics, Himalaya Publishing house, Mumbai.

## MB-1.7: (A)-Mycology

64h

### Unit I

16h

Introduction to fungi, developmental milestones in the field of mycology, development of mycology in India, Significance of fungi to humans. **Ecology of fungi:** Distribution of fungi in nature, factors influencing fungal distribution. Characteristics of fungi- Morphological, structural and ultrastructural details of fungi, chemistry of the fungal cell and cell organelles.

## Unit II

16h

**Fungal biodiversity and systematics:** Diversity of fungi, systematic position of fungi, parameters for fungal systematics, classification of fungi to the level of Order (with suitable examples). **Reproduction in fungi:** Asexual and sexual reproduction methods, reproductive structures and organs in different fungi, heterokaryosis, parasexuality and heterothallism.

## Unit III

16h

**Physiology of fungi:** Fungal growth, nutritional requirements, assessment of fungal growth, effect of environmental factors on growth, primary and secondary metabolism; fungal enzymes, mycotoxins. **Mycological techniques:** Isolation, culturing and maintenance of fungi. Mycological media and methods, culture collections.

## Unit IV

16h

**Application of fungi:** Usefulness of fungi and their metabolites in different fields. **Biology and significance of the following genera:** *Aspergillus*, *Penicillium*, *Neurospora*, *Saccharomyces*, *Erysiphae*, *Xylaria*, *Polyporus*, *Peziza*, *Lycoperdon*, *Agaricus*, *Puccinia*, *Ustilago*, *Colletotrichum*, *Fusarium*, *Alternaria*, *Drechslera*, *Sclerotium*, *Saprolegnia*, *Phytophthora*, *Rhizopus*, *Trichoderma*.

## References;

1. Alexopoulos, C.J., Mims, C.W and Blackwell, M.2002. Introductory Mycology, 4<sup>th</sup> edition, John Willey & Sons (ASIA) Pte Ltd, Singapore.
2. Bhatnagar, D., Lillehej, E.B. and Arora, D.K., 1992. Hand Book of Applied Mycology, Mycotoxins in Ecological Systems. Vol. 5, Marcel Dekker, Inc. New York.
3. Bilgrami, K.S. and Verma, R.N.1997. Physiology of Fungi. Vikas publishing house Pvt. Ltd.
4. Carlile, M.G., Watkinson, S.C and Gooday, G.W. 1994. The Fungi, Academic Press, UK.
5. Gow, N.A.R and Gadd, G.M. 1996. The growing fungus, Chapman and Hall Publishers, London.
6. Griffin, D. 1993. Fungal Physiology, 2<sup>nd</sup> edition, Willy-Less Publisher, New York.
7. Mukadam, D.S. 2004. Modern Topic In Fungi, Saraswati Printing Press, Aurangabad, India.

8. Sharma, P.D. 2005. Fungi and Allied organisms. Narosa publishing house. New Delhi.

9. Vaughan, H.C.I.G. 2006. Fungi, 2<sup>nd</sup> edition, Biotech Books, Delhi.

## **MB-1.7: (B); Principles of Genetics** **64h**

### **Unit I** **10h**

**The science of Genetics:** Overview of Genetics; genetics in medicine, modern agriculture and society. Prokaryotic and eukaryotic cells, chromosome, cell cycle, mitosis, meiosis, spermatogenesis, oogenesis, union of gametes, gamete formation in plants. Life cycles of model organisms, *Neurospora*, *Yeast*, *Drosophila*.

### **Unit II** **10h**

**Mendelism and extension of Mendelism:** Mendel study of heredity: concept of phenotype and genotype, monohybrid (law of dominance and segregation), dihybrid (law of independent assortment). Applications of Mendel principles; punnet square, forked line. Testing genetic hypothesis: chi-square test, pedigree analysis. Allelic variation and gene function; incomplete dominance, co dominance, multiple alleles. Gene action; environmental effects on the expression of Human genes, penetrance and expressivity. Gene interactions; epistasis, pleiotropy.

### **Unit III** **10h**

**The chromosomal basis of Mendelism:** Chromosomes; chromosomal number, sex chromosomes, chromosome theory of heredity. Chromosomes as arrays of genes, non-disjunction, the chromosomal basis of Mendel principles of segregation and independent assortment. Sex linked genes; hemophilia, blood clotting disorders, colorblindness. Sex determination in Human beings and *Drosophila*.

### **Unit IV** **10h**

**Variation in chromosome number and structure:** Cytological techniques; analysis of mitotic chromosomes, the Human karyotype. Cytogenetic variation; polyploidy (sterile, fertile, tissue specific polyploidy and polyteny). Aneuploidy; monosomy, trisomy, deletions and duplications of chromosome segments.

### **Unit V** **10h**

**Linkage, crossing over and chromosome mapping in Eukaryotes:** Exceptions to the Mendelian principle of independent assortment, frequency of recombination and linkage intensity. Gene mapping using the frequency of crossing over, recombination by two

point and three-point test cross, and chiasma formation. Tetrad analysis in Yeast and Neurospora. Linkage analysis in humans; detection of linked loci by pedigree analysis.

## **Unit VI**

**14h**

**Quantitative and population genetics:** Complex pattern of inheritance, analysis of quantitative traits, threshold traits, the multiple factor hypothesis, partitioning the phenotypic variance, broad sense heritability, narrow sense heritability, predicting phenotypes, artificial selection. Inbreeding; the effects of inbreeding and its analysis.

Darwin's theory of evolution, theory of allelic frequency; estimating allelic frequencies, relating genotype frequencies to allele frequencies. The Hardy-Weinberg principle and exceptions. Natural selection at the level of the gene, and phenotypes. Random genetic drifts; random changes in allele frequencies, the effects of population size, populations in genetic equilibrium.

### **References;**

1. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. 2008. Introduction to Genetic Analysis. W.H. Freeman and Company, New York.
2. Hartt, D and Jones, E.N.2005. Genetics (Analysis of genes and genomes), 6<sup>th</sup> edition, Jones and Barlett Publishers.
3. Pierce, B.A. 2006. Genetics (A Conceptual Approach), 2<sup>nd</sup> edition, W.H. Freeman and Company, New York.
4. Russel, P.J. and Cumming, P.B. 2008. Genetics (A Molecular Approach), 2<sup>nd</sup> edition, Pearson Benjamin cummings Publishers, New York.
5. Strickberger, M.W.2006. Genetics, 3<sup>rd</sup> edition, Prentice-Hall of India Private Limited, New Delhi

## **MB-2.1: Microbial Genetics and Molecular Biology**

**64h.**

### **Unit I**

**10h**

**Structure of nucleic acids:** Structure and types of DNA, Watson-Crick model of DNA, Organization of DNA in cells, melting temperature of DNA, structure and types of RNA. Historical developments of DNA as a genetic material: Griffith experiment of transformation, enzymatic approach by Avery, MacLeod and McCarty. Hershey and Chase Experiment with Phage virus.

### **Unit II**

**10h**

**DNA replication:** Semiconservative, Rolling model, Replication machinery, Enzymes in DNA replication, events at the replication fork, termination. **Transcription (RNA synthesis) in bacteria:** Initiation, Elongation and termination of Transcription, post transcriptional modifications. **Genetic code:** Properties of Genetic code, identifying the codons, organization of Genetic code, Triplet codon, arrangement of initiation and termination codons.

### Unit III

10h

**Translation (Protein synthesis):** Role of mRNA, role of ribosomes and role of tRNA in translation. Activation of Amino acids, Initiation, Elongation and termination of translation, post translational modifications of proteins. **Regulation of Bacterial gene expression:** Principles of regulation, mechanism to control transcription. The *lac* operon, effect of lactose and glucose on the control of lac operon. Tryp-operon.

### Unit IV

10h

**Mutation and Repair mechanisms:** Spontaneous mutations, induced mutations, types of mutations, silent mutation, missense mutation, nonsense mutation, frame shift mutations, Mutagenesis – physical and chemical mutagens, base and nucleoside analog, alkylating agents, interchelating agents, ionizing radiation. **Repair mechanisms of damaged DNA:** Excision repair, Mis-match repair, Recombinational repair, SOS response. Auxotrophs and Prototrophs, selection of mutants, testing of chemicals for their cancer causing ability by Ames test.

### Unit V

10h

**Recombination in fungi:** Linkage detection, linkage mapping in two and three point crosses in *Neurospora*. **Recombination in bacteria: Bacterial conjugation;** Mechanism of bacterial conjugation, F<sup>+</sup>x F<sup>-</sup> conjugation, Hfr conjugation, F' conjugation, Gene mapping by conjugation. **Bacterial transformation:** Natural and artificial transformation. **Transduction:** Types and mechanisms of generalized and specialized transduction. **Recombination in viruses:** Phage phenotypes, phenotype mixing, recombination.

### Unit VI

14h

**Recombinant DNA technology:** Historical Perspectives, Restriction enzymes, classification and functions; General features of DNA polymerases, RNA polymerases, reverse transcriptase and ligases, Oligonucleotides as probes and primers. **Vectors:** General characteristics of vectors, Plasmids, Ori site, selectable markers, multi-cloning sites, Phage vectors, Construction of genomic Library and cDNA library, Expression vectors and their importance. **Transfer of recombinant DNA into host cells:** Genetic transformation of bacteria, yeast, animal and plant cells. Plating, screening and selection of recombinants. General principles and applications of DNA sequencing, DNA finger printing (RFLP), PCR, Southern and Northern blotting.

## References;

1. Friedberg, E.C., Walker, G.C., Siede, W., Wood, R.D., Schultz, R.A. and Ellenberger, T. 2006. DNA Repair and Mutagenesis, 2<sup>nd</sup> edition, ASM Press, Washington, D.C.
2. Nelson, D and Cox, M.M.2000. Lehninger Principles of Biochemistry, 3<sup>rd</sup> edition, Worth Publishers, USA.
3. Strickberger, M.W.2006. Genetics, 3<sup>rd</sup> edition, Prentice-Hall of India Private Limited, New Delhi.
4. Tropp, B.E. 2008. Molecular Biology (Genes to Proteins), 3<sup>rd</sup> editions, Jones and Barlett Publishers, London.
5. Watson, Baker, Bell, Gall, Levina and Lorick. 2008. Molecular Biology of the Gene, 6<sup>th</sup> edition, Pearson Benjamin Cummings Publishers, Cold Spring Harbor Laboratory Press, New York,

## MB2.2: Medical Microbiology

64h

### Unit I

16h

Historical development of Medical microbiology, Host parasite relationships; Symbiosis, parasites, pathogenicity, Lethal dose 50 (LD<sub>50</sub>). **Pathogenesis of Viral Diseases:** Maintaining a reservoir, contact, entry, and primary replication, vectors, release from host cells, viral spread and cell Tropism, virus-host interactions, recovery from infection, virus shedding.

**Pathogenesis of Bacterial diseases:** Maintaining a reservoir of the bacterial pathogen, transport of bacterial pathogen to the host, attachment and colonization of the pathogen, invasion of the host tissues, growth and multiplication of the bacterial pathogen, leaving the host, regulation of Bacterial virulence factors expression, pathogenicity islands.

**Toxicity: Exotoxins;** AB toxins, specific host site exotoxins, membrane disrupting exotoxins, superantigens, roles of exotoxins in diseases. Endotoxins.

### Unit II

16h

**Host defense against Microbial invasion:** Primary defenses, secondary defenses, factors influencing host defenses. Microbial mechanisms for escaping host defenses, evasion of host defenses by bacteria and viruses, evading the complement system, resisting phagocytosis, survival inside phagocytic cells, evading the specific immune response.

**Antimicrobial chemotherapy:** The development of chemotherapy, general characteristics of antimicrobial drugs, therapeutic index, narrow and broad spectrum drugs, cidal or static. **Determining the level of Antimicrobial activity;** Dilution susceptibility tests, Disc diffusion tests, Kirby-Bauer method, the Etest. **Antimicrobial drugs:** Inhibitors of cell wall synthesis (Penicillins, Cephalosporins), Protein synthesis inhibitors (Tetracyclines, Chloramphenicol), Metabolic antagonists (Sulfonamides, Trimethoprim), Nucleic acid synthesis inhibitors (Quinolones). **Factors influencing**

**Antimicrobial Drug Effectiveness: Drug resistance;** mechanism of drug resistance, origin and transmission of drug resistance, Antifungal drugs, Antiviral drugs, Antiprotozoan drugs.

### Unit III

16h

Pathogenesis, clinical conditions, laboratory diagnosis, epidemiology, chemotherapy and prevention of following infectious agents. **Bacteria:** *Staphylococcus, Streptococcus, Pneumococcus, Escherichia coli, Salmonella, Shigella, Neisseria, Vibrio, Clostridium, Haemophilus, Brucella, Mycobacterium, Mycoplasma, Chlamydia,*

### Unit IV

16h

**Virus:** Measles, Mumps, Influenza, Yellow fever, HIV, Common cold, Rabies, Hepatitis, Poliomyelitis, Dengue, Prions and Viroids. **Fungi:** Superficial mycosis, cutaneous mycosis, subcutaneous mycosis, systemic mycosis, opportunistic mycosis, **Protozoa:** Ameobiasis, Giardiasis, Malaria, Leishmaniasis, Trypanosomiasis. **Dental infections :** Dental plaque, dental caries, periodontal diseases. **Nosocomial infections:** Bacteremia, burn wounds, respiratory tract infections, surgical site infections, urinary tract infections, miscellaneous infections.

### References;

1. Ananthanarayan, R and Paniker, C.K.J.2009.Text book of Microbiology, 8<sup>th</sup> edition, Universities press Private Limited, Hyderabad, India
2. Black, J.G. 1996. Microbiology Principles and Applications, 3<sup>rd</sup> edition, Prentice Hall Publications, USA.
3. Coiw, R and Sunshine, G. Immunology (A short course), 6<sup>th</sup> edition, Wiley Blackwell.
4. Forbes, B., Sahm, D.F and Weissfeld, A.S.1998. Diagnostic Microbiology, 11<sup>th</sup> edition, Mosby, Inc.Missouri.
5. Janeway, Travers, Walport and Shlomchik.2005. Immunobiology (The immuno system in health and diseases), 6<sup>th</sup> editions, Garland Science Publishers, New York.
6. Kindt, T.J., Goldsby, R.A and Osborne, B.A.2007. Kuby Immunology, 6<sup>th</sup> edition, W.H. Freeman & Company, New York.
7. Male, D., Brostoff, J., Roth, D.B and Roitt, I.2006. Roitt Immunology, 7<sup>th</sup> edition, Mosby Elsevier Publishers.
8. Mims, C., Dockrell, H.M., Goering, R.V., Roitt, I., Wakelin, D. and Zucker, M. 2004. Medical Microbiology, 3<sup>rd</sup> edition, Elsevier Mosby, New York.
9. Prescott, Harley, and Kleins. Microbiology, 7<sup>th</sup> Edition, McGraw Hill Publication.



## **MB-2.5: (A) Plant-Microbe Interactions**

**64h**

### **Unit I**

**16h**

Introduction to microbial interactions with plants. Pre-penetration, Penetration and Post-penetration of microorganisms with plants. Nature of plant-microbe interaction: **Symbiotic relationship of microorganisms with plants:** *Rhizobium* and mycorrhizal fungi.

### **Unit II**

**16h**

**Plant-pathogen interactions:** Biology of *Agrobacterium*, *Peronospora*, *Alternaria* and TMV interactions with their hosts. Role of receptors, elicitors, lectins, cell wall surface components, suppressors, enzymes, toxins, PR-proteins and growth regulators in plant-microbe interactions.

### **Unit III**

**16h**

Molecular approaches in the study of plant-microbe interactions, genetic basis of pathogenicity and parasitism, signal transduction, compatibility and incompatibility, gene-for-gene concept. Plant interaction with endophytic bacteria and fungi, Use of Avirulent mutants in control of bacterial, fungal and viral disease of plants. Interactions of plants with soil pathogens and their antagonists in natural ecosystem.

### **Unit IV**

**16h**

Transgenic approaches for crop protection pathogen derived resistance, plantibodies, over expressing defence genes, use of cloned resistance genes, expression of vaccines in plants, engineering broad spectrum resistance. **Systemic acquired resistance in plants:** Hypersensitive response and associated defense reactions in plants, induced structural and biochemical defense mechanisms.

### **References;**

1. Agrios, G. 2005. Plant Pathology, 5<sup>th</sup> edition, Reed Elsevier India Private Limited, New Delhi, India.
2. Ayres, P.G. 1992. Pests and Pathogens (Plant Responses to foliar Attack), Bioscientific Publishers.
3. Ayres, P.G. 1992. Pests and Pathogens (Plant Responses to foliar Attack), Bioscientific Publishers.
4. Carlile, M.g., Watkinson, S.C and Gooday, G.W. 1994. The Fungi, Academic Press, UK.
5. Geger, M.J. and Stence, M.J. 2001. Biotic interactions in plant pathogen association. CAB-International, United Kingdom.
6. Gow, N.A.R and Gadd, G.M. 1996. The growing fungus, Chapman and Hall Publishers, London.

7. Mehrotra, R.S.1980. Plant Pathology, Tata McGraw-Hill publishing Company Limited, New Delhi.
8. Pelczar, M.J, Chan, E.C.S and Krieg, N.R. 1986. Microbiology, 5<sup>th</sup> edition, Tata McGraw-Hill Publishing Company Ltd, New Delhi.
9. Rangaswami, G and Bagyarai, D.J.2005. Agricultural Microbiology, 2<sup>nd</sup> edition, Prentice-Hall of India Private Limited, New Delhi.

## Soft Core: MB.2.5 (B)-Microbial Enzymology

64h

### Unit I

16h

**Bio energetics:** First and second law of thermodynamics; enthalpy, entropy, and Gibbs free energy. Enzyme nomenclature, classification, general properties of enzymes, factors affecting enzyme activity, activation energy, transition state, turnover number, enzyme co-factors. **Enzyme kinetics;** General kinetic principles; steady-state enzyme kinetics, Michelis-Menton equation, importance of Km and Vmax, linear transformation of MM-equation (LB Plot). **Enzyme inhibition studies;** Kinetics of competitive, noncompetitive, uncompetitive and mixed inhibitors.

### Unit II

16h

**Enzyme regulation:** Allosteric and cooperative effects, conquered model of Monod *et al*, and sequential model of Koshland *et al*, **Principles of metabolic regulations;** feedback regulations of multifunctional pathway. **Mechanism of enzyme action:** Acid base catalysis, covalent catalysis, chymotrypsin, pyruvate kinase, Multi enzyme complex, Fatty acid synthetase complex: biological significance of multi enzyme complex. **Coenzymes:** Structure and functions of different coenzymes.

### Unit III

16h

**Isolation and purification of enzymes:** Enzyme extraction –soluble enzymes, membrane bound enzymes, purification-precipitation methods, concentration of biomolecules: salting with ammonium sulphate precipitation, dialysis, lyophilisation, chromatographic methods, total activity and specific activity. **Assay techniques for microbial enzymes :** Amylases, proteases, cellulases, and lipases, Basic principles of cell and enzyme immobilization.

### Unit IV

16h

**Uses of enzymes in analysis** – Enzyme electrodes. Enzyme as biosensor, potentiometric biosensor, industrial applications of enzymes. **Commercial value:** steroidal conversions, penicillin and antibiotic conversion, immunosensor. Recent advances and future prospects of enzyme engineering; artificial enzymes. Enzymes in organic solvents, enzyme targeting using liposomes, isoenzymes.

**References;**

1. Palmer, T.2004. ENZYMES Biochemistry, Biotechnology, Clinical chemistry, East West press, New Delhi.
2. Palmer, T and Bonner, P.L.2008. ENZYMES Biochemistry, Biotechnology and Clinical chemistry, 2<sup>nd</sup> edition, East West press, New Delhi.
3. Singh, S. 2007. A text Book of Enzymes, Campus Books International, New Delhi.

**MB-2.7: (A) – Water Microbiology****32h****Unit I****16h**

Sources of Microbial contamination of water. Factors influencing microbial Contamination of water. Sampling of water for microbiological analyses. Types of water samples. Collection, transport and processing of samples. Detection of microbial populations in water – Phenotypic detection. Determination of microbial members: Direct count and viable count procedures

**Unit II****16h**

Detection methods for water-borne pathogens-multiple tube fermentation method, membrane filter method, P-A technique, rapid detection of coliforms. Detection of indicators of pathogenic bacteria-enterococci, bacteriophages. Water disinfection methods. Safe limits for drinking water. Water Quality standards.

**References;**

1. Alcamo, I.E. 1997. Fundamentals of Microbiology, 5<sup>th</sup> edition, An imprint of Addison Wesley Longman, New York.
2. Batzing, B.L. 2002. Microbiology (An Introduction), Brooks/Cole Thomson Learning, Canada.
3. Bauman, R. 2007. Microbiology (With diseases by Taxonomy), 2<sup>nd</sup> edition, Pearson Benjamin Cummings Publishers, San francisco.
4. Cappucino, J.G. and Sherman, N. 2005. Microbiology, A Laboratory Manual, 7<sup>th</sup> edition, Pearson Education INC. Delhi, India
5. Patnail, P. 1997. Hand Book of Environmental Analysis. CRC Press, Inc., USA.
6. Willey, J.M., Sherwood, L.M and Woolverton, C.J.2008. Prescott, Harley, and Klein's Microbiology, McGraw-Hill, New York.

**MB-2.7: (B) Agricultural Microbiology****32h****Unit I****16h**

Concepts and scope of agricultural microbiology, importance of microorganisms in agriculture, influence of microorganisms in plant growth, modern concept of microbial

inoculants in agriculture; biological nitrogen fixation-symbiotic and non-symbiotic nitrogen fixation, mechanism of nitrogen fixation and importance. Interaction of soil microorganisms with plants; Rhizosphere and phylloplane microorganisms. *Rhizobium* inoculants: Brief account of production and application of *Rhizobium* inoculant; physiology and genetics of nodulation and nitrogen fixation, strain selection and mass culturing.

## **Unit II**

**16h**

Brief account of production and utility of *Azotobacter*, *Azospirillum*, cyanobacteria, *Azolla*, *Frankia*. Phosphate-solubilizing, microorganisms-importance, application of these microorganisms in agriculture. Mycorrhizae, Types and applications of mycorrhizae. Methods of biofertilizer application-seed inoculation, soil amendment and nursery application.

### **References;**

1. Agrios, G. 2005. Plant Pathology, 5<sup>th</sup> edition, Reed Elsevier India Private Limited, New Delhi, India.
2. Carlile, M.G., Watkinson, S.C and Gooday, G.W. 1994. The Fungi, Academic Press, UK.
3. Gow, N.A.R and Gadd, G.M. 1996. The Growing Fungus, Chapman and Hall Publishers, London.
4. Mehrotra, R.S.1980. Plant Pathology, Tata McGraw-Hill publishing Company Limited, New Delhi.
5. Purohit, S.S. 2003. Agricultural Biotechnology, 2<sup>nd</sup> edition, Agrobios Publisher, Jodhpur, India.
6. Rangaswami, G and Bagyarai, D.J.2005. Agricultural Microbiology, 2<sup>nd</sup> edition, Prentice-Hall of India Private Limited, New Delhi.

## **MB-3.1: Agriculture Microbiology**

**64h**

### **Unit I**

**16h**

Concepts and scope of agricultural microbiology, importance of microorganisms in agriculture, influence of microorganisms in plant growth, modern concepts of microbial inoculants in agriculture. Interaction of soil microorganisms with plants: Rhizosphere and phylloplane microorganisms. Mass culturing and quality control of microbial inoculants-mother culture, shake culture and brief account of large scale production of biofertilizers, types of carrier materials, packing, storage, bench life and transportation of biofertilizers. ISI standards and quality testing at different levels. Methods of biofertilizer application- seed inoculation, soil amendment and nursery application.

### **Unit II.**

**10h**

Symbiotic and non-symbiotic nitrogen fixation, mechanisms of nitrogen fixation and importance. Brief account of production and application of *Rhizobium* inoculant; strain selection and mass culturing. Brief account of production and utility of *Azotobacter*, *Azospirillum*, cyanobacteria, *Azolla*, *Frankia*. Salient features and significance of strains and application of these organisms. Phosphate-solubilizing microorganisms-importance, culturing and applications of these microorganisms in agriculture. Mycorrhizae: types, Mass production and application of mycorrhizae.

### Unit III.

06h

**Phytopathology:** Introduction and historical milestones, significance of plant diseases, types of plant diseases, basic procedure of plant disease diagnosis, parasitism, pathogenicity and plant disease development, disease cycle, infection cycle and plant disease triangle **Levels of plant- pathogen interaction:** Prepenetration, host-recognition, role of host exudates, entry by plant pathogens through natural openings and wounds, direct penetration, process of pathogenesis, infection and establishment of pathogens in the host tissues.

### Unit IV

16h

Role of pathogen enzymes in pathogenesis- production of different enzymes and action of pathogen enzymes on host tissues and significance of these enzymes in disease development. Role of phytotoxins in plant pathogenesis-types of toxins produced by plant pathogens, effect of toxins on disease development. Role of plant growth regulators in plant pathogenesis. **Defense mechanisms in plants:** Structural and biochemical defense mechanisms role of elicitors, receptors and suppressors in disease development, molecular mechanisms in expression of plant disease resistance. **Epidemiology of plant diseases:** Effect of environmental factors on disease development; Dissemination of plant pathogens; Disease forecasting and its Significance, **Seed Pathology:** Importance of seed-borne diseases and seed health testing methods.

### Unit V

16h

**Plant Disease Management:** Cultural methods-exclusion, eradication, crop rotation and sanitation. Inspection and certification, quarantine regulations. Physical methods-soil solarization, hot water treatment, mulching and other methods. Chemical control of plant diseases-preparation and use of different chemicals, types of chemicals used in plant disease management; application of chemicals to soil, seeds, plant and store house problems and remedies for fungicidal resistance. Biological control of plant disease-selection, testing and use of antagonistic microorganisms and their metabolites, application methodology and significance. Breeding for disease resistance, systemic acquired resistance; protoplast, cell, tissue culture and somaclonal variation for disease resistance, biotechnological approaches in obtaining disease resistance plants, induced resistance, transgenic plants for plant disease management. Integrated disease management practices. Brief account of some important plant diseases (with one example for each group with description of pathogen, symptoms and management)- rots,

damping-offs, downy mildews, white rust, powdery mildews, smuts, rusts, wilts, leaf spots, anthracnose, galls, ergots, bacterial diseases, viral diseases, phytoplasmal diseases, nematode diseases, protozoal diseases, viroid diseases, non-parasitic diseases and post-harvest diseases.

### References;

1. Agrios, G. 2005. Plant Pathology, 5<sup>th</sup> edition, Reed Elsevier India Private Limited, New Delhi, India.
2. Ayres, P.G. 1992. Pests and Pathogens (Plant Responses to foliar Attack), Bioscientific Publishers.
3. Carlile, M.G., Watkinson, S.C and Gooday, G.W. 1994. The Fungi, Academic Press, UK.
4. Gow, N.A.R and Gadd, G.M. 1996. The growing fungus, Chapman and Hall Publishers, London.
5. Mehrotra, R.S.1980. Plant Pathology, Tata McGraw-Hill publishing Company Limited, New Delhi.
6. Purohit, S.S. 2003. Agricultural Biotechnology, 2<sup>nd</sup> edition, Agrobios Publisher, Jodhpur, India.
7. Rangaswami, G and Bagyarai, D.J.2005. Agricultural Microbiology, 2<sup>nd</sup> edition, Prentice-Hall of India Private Limited, New Delhi.
8. Agarwal, V.K and Sinclair, J.B. 1987. Principles of Seed Pathology, CBS Publishers, Delhi.
9. Srivastava, H.N. 2001. Plant Pathology, Pradeep Publications, Jalandhar.
10. Rao, N.S.S. 1993. Biofertilizers In Agriculture and Forestry, 3<sup>rd</sup> edition, Oxford & IBH Publishing Pvt. Ltd, New Delhi.
11. Dhingra, O.D and Sinclair, J.B. 1985. Basic Plant Pathology Methods, CBS Publishers, Delhi.
12. Nene, Y.L and Thapliyal, P.N. 1971. Fungicides In Plant Disease Control, 2<sup>nd</sup> edition, Oxford & IBH Publishing Co., New Delhi.
13. Nene, Y.L. 2001. Seed-borne Diseases Objectionable in Seed Production and their Management, Scientific Publishers, Jodhpur, India.

## MB 3.3: Immunology

64h

### Unit I

16h

**Overview of the immune system:** History, early theories of immunity, types of immunity - innate immunity and acquired immunity. **Organs and Cells of immune system:** Central lymphoid organs-bone marrow and thymus; peripheral lymphoid system-

spleen, lymphnodes, gut associated lymphoid tissues. **Lymphoid cells;** B cells, T cells, Natural killer cells, **Myeloid cells;** Neutrophils, Basophils and Eosinophils, Macrophages and Dendritic cells. Development of T and B-lymphocytes.

**Immunity:** Humoral Immunity, Cell mediated Immunity, Innate immunity, Acquired Immunity, active (natural and artificial) immunity, passive (natural and artificial) immunity. **Antigens;** Immunological properties of antigens, factors influencing immunogenicity, epitope, hapten, Agreptope, Adjuvants, Alum adjuvant, Freund's incomplete and complete Adjuvants, Effect of dose size of antigen on Immune response, Effect of rout of administration of antigen towards immune response, Contribution of Host towards immune response.

## Unit II

16h

**Antibodies/Immunoglobulins:** Immunoglobulin classes, basic structure and chemistry of IgG, IgM, IgA, IgE and IgD, Characteristic features of Primary response, Secondary response and Memory response; Antigenic determinants of immunoglobulins- isotypic, allotypic and idiotypic determinants; Generation of Antibody diversity and specificity. **Antigen-antibody reactions:** Immuno precipitation, Agglutination, Complement fixation, Immunofluorescence, ELISA, RIA, Western blotting. Production and applications of polyclonal and monoclonal antibodies. Different types of vaccines and their significance.

## Unit III

16h

**Complement System:** Major pathways of Complement system; Classical pathway, Lectin pathway and Alternative pathway, Generation of Membrane attack complex (MAC), Biological functions of complement components. **Major Histocompatibility Complex (MHC) and Antigen presentation:** Types, Structure and functions of MHC molecules, General organization and inheritance of the MHC, Role MHC and their expression pattern. **Presentation of Bacterial and Viral Antigens:** Phagocytosis, Processing and presentation of antigens by Class I and class II MHC molecules. **Transplantation Immunology:** Introduction, Types of Grafts, Immunologic basis of Graft rejection, clinical manifestations of Graft rejection, **HLA Typing:** Antibody dependant cell mediated cytotoxicity, Mixed Lymphocyte reactions. General and specific Immunosuppressive therapy. **Hyper Sensitive Reactions:** Introduction, Types of hypersensitive reactions; Type I, II, III and Delayed Type of Hypersensitivity (DTH). Autoimmune Diseases, Cytokines.

## Unit IV

16h

**Immune response to Infectious diseases: Viral Diseases;** Neutralization of Viruses, Cell mediated immunity to control Viral pathogens, Viruses can evade defense mechanisms. **Bacterial Diseases:** Immune response to extracellular and intracellular

bacteria, bacteria can evade defense mechanisms, Immune response to Bacterial pathogenesis. **Parasitic Diseases:** Immune response to Malaria, Trypanosoma, Leishmaniasis. **Fungal Diseases:** Innate and Acquired Immunity to control fungal infections. **Vaccines:** Introduction, active and passive immunization, designing vaccines for active immunization, Live attenuated vaccines, Inactivated or killed vaccines, Subunit vaccines (Toxoids, Bacterial polysaccharide capsules, Viral glycoproteins, Recombinant vaccines), Multivalent subunit vaccines, DNA vaccines.

### References;

1. Ananthanarayan, R and Paniker, C.K.J.2009.Text book of Microbiology, 8<sup>th</sup> edition, Universities press Private Limited, Hyderabad, India
2. Black, J.G. 1996. Microbiology Principles and Applications, 3<sup>rd</sup> edition, Prentice Hall Publications, USA.
3. Coiw, R and Sunshine, G. Immunology (A short course), 6<sup>th</sup> edition, Wiley Blackwell.
4. Forbes, B., Sahn, D.F and Weissfeld, A.S.1998. Diagnostic Microbiology, 11<sup>th</sup> edition, Mosby, Inc.Missouri.
5. Janeway, Travers, Walport and Shlomchik.2005. Immunobiology (The immune system in health and diseases), 6<sup>th</sup> editions, Garland Science Publishers, New York.
6. Kindt, T.J., Goldsby, R.A and Osborne, B.A.2007. Kuby Immunology, 6<sup>th</sup> edition, W.H. Freeman & Company, New York.
7. Male, D., Brostoff, J., Roth, D.B and Roitt, I.2006. Roitt Immunology, 7<sup>th</sup> edition, Mosby Elsevier Publishers.
8. Mims, C., Dockrell, H.M., Goering, R.V., Roitt, I., Wakelin, D. and Zucker, M. 2004. Medical Microbiology, 3<sup>rd</sup> edition, Elsevier Mosby, New York.

## MB-3.5 (A): Immunotechnology

64 h

### Unit I

16h

**Immune system:** Brief account of immune system, types of immunity, immune response, nature of immunogens, antigens and haptens. **The structure and types of antibodies:** Molecular structure of different types of antibodies and their biological functions. **Generation of Antibodies:** Production of polyclonal antibodies, production of monoclonal antibodies, Methodology for the production of hybridoma cells, screening, selection and cloning. **Purification of immunoglobulins:** Purification of immunoglobulins from serum samples– principles and procedures of salting-out (ammonium sulphate precipitation), ion-exchange, gel filtration and affinity chromatography, isoelectric focusing, electrophoresis, assessment of purity of immunoglobulins. **Methods to determine the affinity of Antigen-Antibody interactions:** Equilibrium dialysis, Surface plasmon resonance.



## Unit II

16h

**Immunological Techniques:** Immunoprecipitation in solution, Immunoprecipitation of soluble antigens in gel matrices, characterization of cell-bound molecules by immunoprecipitation. **Agglutination Reactions:** Hemagglutination reaction to detect antigen conjugated to the surface of red blood cells, Hemagglutination inhibition reactions to detect the presence of antiviral antibodies, Agglutination reaction to detect antibacterial antibodies. **Antibody assays based on Molecule binding to Solid phase supports:** **Radioimmuno assay** to measure the concentration of proteins and hormones in body fluids. **ELISA:** Indirect Elisa, Sandwich ELISA, Competitive ELISA, available enzyme systems for ELISA assays, Chromogenic, Fluorogenic or Chemiluminogenic Substrates, Modifications of ELISA using Biotin-Streptavidin Bonding interactions. ELISPOT assay to measure molecules secreted by individual cells. Western Blotting to detect specific protein in a complex protein mixture. **Microscopic Visualization of Cells and Subcellular Structures:** Immunocytochemistry and Immunohistochemistry, Immunoelectron Microscopy. **Immunofluorescence:** Fluorescence to visualize Cells and Molecules, Immunofluorescence Microscopy, Confocal fluorescence microscopy, Multiphoton fluorescence Microscopy, *In vivo* observation of Immune responses by Intravital Imaging.

## Unit III

16h

**Analysis of Cells:** Flow Cytometry, Magnetic activated cell sorting. **Analysis of Cell Cycle:** Assessment of cell division by Tritiated ( $^3\text{H}$ ) Thymidine uptake, Colorimetric assay for cell division, Use of antibodies to detect newly synthesized DNA, Analysis of cell cycle status of cell populations using propidium iodide, Follow of cell division by Carboxyfluorescein Ester. **Assays of cell death.**  $^{51}\text{Cr}$  release assay to measure cell death, Detection of Apoptotic cells by Fluorecently labeled Annexin V, TUNEL assay to measure Apoptotically generated DNA fragmentation, Caspase assay to measure the activity of enzymes involved in Apoptosis. **Biochemical approaches to elucidate signal transduction pathway:** Biochemical inhibitors to identify intermediates in signaling pathways. **Whole animal Experimental Systems:** Federal guidelines to protect Non-human research subjects, inbred strains to reduce Experimental variation, Congenic strains to study the effects of particular gene loci on immune response, *in vivo* examination of isolated cell populations, transgenic animals in Immunology, Knock-in and knockout animals.

## Unit IV

16h

**Vaccines:** Active or Passive immunization, passive immunization by preformed antibodies, active immunization to induce immunity and memory. **Different strategies to develop vaccines;** Live attenuated vaccines (BCG, Polio), Inactivated or killed vaccines, subunit vaccines, recombinant vector vaccines, DNA vaccines, multivalent vaccines, role of adjuvants to enhance the immune response to a vaccine.

**Immunotherapy:** Concept of immunotherapy, **Drugs in nonspecific immunotherapy;** Cyclophosphamide or Cytoxan, Purine antagonists (Azathioprine and 6-mercaptopurine), Folic acid analog (Methotrexate). **Corticosteroid therapy;** Concept, mechanism of steroid hormone action, General aspects of glucocorticoid therapy, Clinical uses of corticosteroids, side effects of steroids in treatment. **Specific Immunotherapy:** Antibody based therapy; Inhibitors of tumor necrosis factor (TNF), Antibodies against IL-2 receptors, Anti-IgE Immunotherapy for allergic diseases.

### **References;**

1. Coiw, R and Sunshine, G. Immunology (A short course), 6<sup>th</sup> edition, Wiley Blackwell.
2. Forbes, B., Sahm, D.F and Weissfeld, A.S.1998. Diagnostic Microbiology, 11<sup>th</sup> edition, Mosby, Inc.Missouri.
3. Janeway, Travers, Walport and Shlomchik.2005. Immunobiology (The immuno system in health and diseases), 6<sup>th</sup> editions, Garland Science Publishers, New York.
4. Kindt, T.J., Goldsby, R.A and Osborne, B.A.2007. Kuby Immunology, 6<sup>th</sup> edition, W.H. Freeman & Company, New York.
5. Male, D., Brostoff, J., Roth, D.B and Roitt, I.2006. Roitt Immunology, 7<sup>th</sup> edition, Mosby Elsevier Publishers.
6. Yadav, P.R. and Tyagi, R. 2005. Immuno-Biotechnology, Discovery Publishing House, New Delhi.

## **MB-3.5: (B) Fermentation Technology**

**64h**

### **Unit I**

**16h**

Basics of fermentation processes, definition, scope, history, chronological development of the fermentation industry. Component parts of fermentation process. Microbial growth kinetics, batch and continuous, direct, dual or multiple fermentations; scale-up of fermentation, comparison of batch and continuous culture as investigative tools, examples of the use of fed batch culture. Isolation, preservation and strain improvement of industrially important microorganism. Use of recombination system (Parasexual cycle, protoplast fusion techniques), application of recombinant strains, the development of new fermentation products.

### **Unit II**

**16h**

Screening (primary and secondary screening); detection and assay of fermentation products (Physico-chemical assay, biological assays). Inoculum development, criteria for transfer of inoculum, development of inoculum for yeast processes, bacterial fermentation and mycelial processes. Fermentation equipment and its use; (design of a fermentor, types of fermentor, agitation, aeration, antifoam, pH and temperature. Instrumentation and process variables control use of on-line, off line, on and off line

control. Media formulation – raw materials, fermentation media, solid state, surface and submerged fermentation.

### **Unit III**

**16h**

Fermentation type reactions (Alcoholic, bacterial, mixed acid, propionic acid, butanediol and acetone-butanol). Microbial production of enzymes (amylases, Proteases, cellulases, pectinases and lipases) primary screening for producers, large scale production. Immobilization methods. techniques of immobilization, effect of immobilization on enzyme activity, applications of immobilized enzymes, commercial production of enzymes-amylases, proteases, pectinases, cellulases and lipases, advantages and disadvantages of immobilization, Cell immobilization.

### **Unit IV**

**16h**

Fermentative production of industrial alcohol, production of beverages. Production of organic acids; citric acid, aminoacids; glutamic acid; production of vitamins. antibiotics; benzyl penicillin and tetracyclins, streptomycin production and applications, bacterial and fungal enzymes, (cellulases, amylases, xylanases, isomerases, proteases and lipases). Single cell protein, production of uses; single cell oil, production and uses.

### **References;**

1. Casida, L.E.2007. Industrial microbiology, New age international (P) Ltd., New Delhi.
2. Clark, D.P and Pazdernik, N.J.2009. Biotechnology applying the genetic revolution, Elsevier Academic Press, UK.
3. Glazer, A and Nikaido.1995. Microbial biotechnology fundamentals of applied microbiology, W.H.Freemn and company, USA.
4. Glick, B.R and Pasternak, J.J.2003. Molecular Biotechnology Principles and Applications of Recombinant DNA, 3<sup>rd</sup> edition, ASM Press, USA.
5. Harider, S.I. and Ashok, A. 2009. Biotechnology, A Comprehensive Training Guide for the Biotechnology Industry, CRC Press, New York.
6. Sridhar, S.2010. Industrial Microbiology, Dominant Publishers, New Delhi.
7. Tanuja.S and Purohit, S.S. 2008. Fermentation Technology, Agrobios Publication, Jodhpur, India.

## **MB-3.7: (A) Diagnostic Microbiology**

**32h**

### **Unit I**

**16h**

An overview of medical microbiology, significance of microbial diseases of humans. **Medical Specimens:** collection procedure and transport of body fluid specimens, gastrointestinal specimens, genital specimens, respiratory specimens, urine specimens

and wound specimens. **Specimens processing:** General methods, microscopy, culture methods and serology.

## Unit II

16h

Laboratory diagnosis of important bacterial, viral, fungal and protozoal infections. (*Mycobacterium*, *Staphylococcus*, *Treponema*, *Salmonella*, HIV, Hepatitis, *Aspergillus*, *Candida*, *Plasmodium*). Antimicrobial drug testing procedures. Laboratory safety measures and sample disposal.

### References;

1. Coiw, R and Sunshine, G. Immunology (A short course), 6<sup>th</sup> edition, Wiley Blackwell.
2. Forbes, B., Sahn, D.F and Weissfeld, A.S.1998. Diagnostic Microbiology, 11<sup>th</sup> edition, Mosby, Inc.Missouri.
3. Janeway, Travers, Walport and Shlomchik.2005. Immunobiology (The immuno system in health and diseases), 6<sup>th</sup> editions, Garland Science Publishers, New York.
4. Kindt, T.J., Goldsby, R.A and Osborne, B.A.2007. Kuby Immunology, 6<sup>th</sup> edition, W.H. Freeman & Company, New York.
5. Male, D., Brostoff, J., Roth, D.B and Roitt, I.2006. Roitt Immunology, 7<sup>th</sup> edition, Mosby Elsevier Publishers.
6. Mims, C., Dockrell, H.M., Goering, R.V., Roitt, I., Wakelin, D. and Zucker, M. 2004. Medical Microbiology, 3<sup>rd</sup> edition, Elsevier Mosby, New York.

## MB-3.7 (B): Industrial Microbiology

32h

### Unit I

16h

Concepts and scope of Industrial microbiology, Screening and strain improvement in industrial microbiology. **Industrial fermentors:** Basic functions, design and components. **Different types of fermentors:** Chemostat and turbidostat, tower fermentors, membrane bioreactors, scale up of fermentation process. **Microbial growth kinetics:** Batch cultures, continuous cultures, fed-batch cultures, industrial production of biomass and metabolites.

### Unit II

16h

Fermentation media: desired qualities, sources of nutrition. Downstream processing: objectives and criteria. Industrial production of penicillin, alcohol, glutamic acid, vitamin A and alcoholic beverages. Industrial enzymes: Production and applications of amylases, proteases, pectinases, cellulases and lipases. Immobilization of enzymes or cells.

### References;

1. Casida, L.E.2007. Industrial microbiology, New age international (P) Ltd., New Delhi.
2. Casida, L.E.2007. Industrial microbiology, New age international (P) Ltd., New Delhi.
3. Clark, D.P and Pazdernik, N.J.2009. Biotechnology applying the genetic revolution, Elsevier Academic Press, UK.
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5. Glick, B.R and Pasternak, J.J.2003. Molecular Biotechnology Principles and Applications of Recombinant DNA, 3<sup>rd</sup> edition, ASM Press, USA
6. Harider, S.I. and Ashok, A. 2009. Biotechnology, A Comprehensive Training Guide for the Biotechnology Industry, CRC Press, New York.
7. Sridhar, S.2010. Industrial Microbiology, Dominant Publishers, New Delhi
8. Tanuja.S and Purohit, S.S. 2008. Fermentation Technology, Agrobios Publication, Jodhpur, India.
9. Patel, A.H. 1985. Industrial Microbiology, Macmillan India Ltd, New Delhi.

## **MB-4.1: Food and Industrial Microbiology**

**64h**

### **Unit I**

**16h**

**Food Microbiology:** Introduction, Food as a substrate for microorganism; factors influencing the growth of microorganisms (moisture, water activity, pH, nutrient content, inhibitory substances and biological structure. Source of food contamination-soil, water, air, sewage, plants and animals. Microbial examination of foods-microscopic techniques and culture techniques. Food spoilage-general means of food spoilage, microorganisms involved in food spoilage of cereals, vegetables, meat, fish, egg and canned foods. Chemical changes caused by microorganisms. Food preservation-general principles, removal of microorganisms, maintenance of anaerobic conditions; preservation using high temperatures; factors affecting heat resistance; determination of heat resistance; thermal death time, determination of thermal processes, heat treatments employed in food processing, growth of microorganisms at low temperatures, low temperatures storage, effect of freezing temperatures on microorganisms; preservation by drying; microbiology of dry foods; food preservatives and factors influencing their effectiveness; preservation methods using radiations. **Food-borne illnesses:** General account of food borne bacterial diseases-*Clostridium*, Gastroenteritis, *Vibrio*, enteropathogenic *Escherichia coli*, *Bacillus*; Food poisoning-mycotoxins (aflatoxins, ochratoxins, trichothecines, zearalenones, ergot alkaloids); food borne viruses, parasites; seafood toxicants.

### **Unit II**

**16h**

**Food fermentation**-bread, malt beverages, vinegar, fermented vegetable, general principles in the production of cultures for food fermentation. Microbial foods: single cell proteins (*Spirulina*, yeast, *Fusarium*), fats from microorganisms, single cell oil (PuFas from fungi); mushroom-value, cultivation and preservation methods. Food Control-Enforcement and control agencies, microbiological criteria for foods.

**Dairy Microbiology:** Nutritional level of milk, microbial flora of milk, sources of milk contamination. Bacteriology of milk: Incidence and characterization of pathogenic microorganisms in milk, bacteriological aspects of pasteurization, sterilization of milk; predominant types of microorganisms in chilled and refrigerated milk supplies and their importance; heat resistant types in milk and their role in milk spoilage; use of detergents and sanitizers in the cleaning and sanitation of dairy equipment's; principles of quality control tests for milk; bacteriological grading, market milk production and public health control.

**Microbiology of dairy products:** Microbiology of cream, butter, ice-cream and indigenous dairy products such as khoa, peda, yoghurt, acidophilus milk, dahi, kefir, koumiss, shrikhand, cultured butter milk, cheese and other fermented milk products; use of rennet and microbial rennet substitutes in cheese making.

**Microbiology of dairy starter cultures:** definition and properties of starter culture, criteria for starter selection, lactic and non-lactic starter cultures used in dairy industry; use of pure and mixed starter cultures in product manufacturing; production of flavour components by starter cultures; methods of starter maintenance, propagation and preservation; judging the quality of starter cultures; judging the quality of starter cultures. Defects associated with starter cultures – incidence, detection and control. Microbial utilization of whey; composition of different dairy effluents, methods for treatment and disposal of dairy effluents; their significance and applications. Current trends in microbiological quality control in dairy industry.

### Unit III

16h

**Industrial Microbiology;** Concepts and scope of Industrial microbiology. Screening and strain improvement in industrial microbiology: Industrial important species and strains, screening methods, strain development for improved yields, strain maintenance and preservation. Industrial fermentors: Basic functions, design and components-impellers, spargers, baffles, sterilization of fermentor, sterilization of air supply, inoculation methods, sampling methods, a brief account of monitoring and control devices. Different types of fermentors: Chemostat, turbidostat, gradostat, tabular fermentors, tower fermentors, membrane bioreactors, scale up of fermentation process-parameter and problems associated with scale up. Microbial growth kinetics: Batch cultures, continuous cultures, fed-batch (variable volume, fixed volume, cyclic), comparison of batch and continuous cultures in industrial production of biomass and metabolites. Fermentation media: desired qualities, sources of carbon, nitrogen, vitamins and minerals; role of buffers, precursors, inhibitors, inducers and antifoams.

## Unit IV

16h

**Downstream processing:** objectives and criteria, foam separation, precipitation methods, filtration devices, filter aids, industrial scale centrifugation and cell disruption methods, liquid-liquid extraction, solvent recovery, chromatography, microfiltration, ultrafiltration, drying devices, crystallization and whole broth processing. Industrial fermentation of penicillin, lactic acid, glutamic acid, vitamin A and alcoholic beverages-wine, beer and whisky. **Industrial enzymes:** production and applications of amylases, proteases, pectinases, cellulases and lipases. Immobilization of enzymes or cells: methods, substrates, advantages and applications. Modern approaches to industrial waste treatments.

### References;

1. Downes, F.P and Ito, K.2001. Compendium methods for the Microbiological Examination of Foods, 4<sup>th</sup> edition, APHA, Washington, DC
2. Doyle, M.P., Beuchat, L.R. and Montville, T.J. 2001. Food Microbiology, Fundamentals and Frontiers, 2<sup>nd</sup> edition ASM Press Washington DC.
3. Frazier, W.C and Westhoff, D.C.1988. Food Microbiology, 4<sup>th</sup> edition, Tata McGraw-Hill Publishing Company, New Delhi
4. Marth, E.H and Steele, J.L.2001. Applied Dairy Microbiology, r, Marcel Dekker AG Publishers, Switzerland.
5. Parihar, P and Parihar, L.2006. Dairy Microbiology, 2<sup>nd</sup> edition, Agrobios Publishers, Jodhpur, India
6. Casida, L.E.2007. Industrial microbiology, New age international (P) Ltd., New Delhi.
7. Clark, D.P and Pazdernik, N.J.2009. Biotechnology applying the genetic revolution, Elsevier Academic Press, UK.
8. Sridhar, S.2010. Industrial Microbiology, Dominant Publishers, New Delhi
9. Stanbury, P.E, Whitaker, A. and Hall, S.J. Principles of fermentation technology.

## MB-4.2: Microbial Biotechnology

64h

### Unit I

16h

**Microbial Biotechnology:** Introduction, Definition, Concepts, Microorganisms as tools, use of microorganisms and their products in biotechnology. **Microorganisms for the production of macromolecules:** Production of chymosin in *E. coli*. Production of Hepatitis B surface antigen proteins in yeast cells; expression of foreign gene products in a secreted form (Prochymosin in yeast). **Microbial insecticides:** *Bacillus thuringiensis*, Baculoviruses, entomopathogenic fungi- *Beauveria*. Bacterial production of polysaccharides, xanthan gum, microbial production of polyester- polyhydroxy alkanooates. **Fungal biotechnology:** fungal production of alkaloids, antibiotics, enzymes, organic acids.

### Unit II

16h

**Microbial production of useful products:** Production and applications of insulin, human interferon, human growth hormone. **Agricultural biotechnology:** Development of insect-resistant, herbicide-resistant plants; use of plants as bioreactors for the production of immunoglobulins. Terminator seed technology. **Animal biotechnology:** General principles and applications for the production of transgenic mice, cattle, pigs. **Gene therapy:** General principles of gene therapy, brief account of genetic diseases and techniques involved in gene therapy. **Environmental Biotechnology:** Principles of degradative capabilities of microorganisms, genetic engineering for the control of pollutants. Microorganisms in mineral recovery and removal of heavy metals from aqueous effluents.

### Unit III

16h

**Biotransformations;** Introduction, biocatalytic selection, biocatalytic immobilization and performance, Immobilized enzyme reactors. **Recombinant proteins of high value;** Applications of high value proteins, analytical enzymes, therapeutic proteins, regulatory aspects of therapeutic proteins. **Regulations and patenting in Biotechnology:** Regulating the use of biotechnology, deliberate release of genetically engineered organisms, regulation policies of human gene therapy. Patenting of biotechnological inventions, organisms and protocols. Social and ethical aspects of biotechnology.

### Unit IV

16h

**Nanotechnology: Microorganisms for synthesis of nanomaterials;** Natural and artificial synthesis of nanoparticles in microorganisms; Use of microorganisms for nanostructure formation, testing of antimicrobial effect of nanoparticles using microorganisms. **Biological Methods of Synthesis:** Use of bacteria, fungi, Actinomycetes for nanoparticle synthesis, Magnetotactic bacteria for natural synthesis of magnetic nanoparticles; Mechanism of formation; Role of plants in nanoparticle synthesis.

### References;

1. Casida, L.E.2007. Industrial microbiology, New age international (P) Ltd., New Delhi.
2. Clark, D.P and Pazdernik, N.J.2009. Biotechnology applying the genetic revolution, Elsevier Academic Press, UK.
3. Glazer, A and Nikaido.1995. Microbial biotechnology fundamentals of applied microbiology, W.H. Freeman and company, USA.
4. Glick, B.R and Pasternak, J.J.2003. Molecular Biotechnology Principles and Applications of Recombinant DNA, 3<sup>rd</sup> edition, ASM Press, USA
1. Harider, S.I. and Ashok, A. 2009. Biotechnology, A Comprehensive Training Guide for the Biotechnology Industry, CRC Press, New York.
2. Sridhar, S.2010. Industrial Microbiology, Dominant Publishers, New Delhi.
3. Ratledge, C and Kristiansen, B. 2001. Basic Biotechnology, 2<sup>nd</sup> edition, Cambridge University Press, USA.



4. Ratner, M and Ratner, D. 2003. Nanotechnology, Pearson education, New Delhi, India.
5. Rao, M.B. and Reddy.K.K. 2007. Introduction to Nanotechnology, Campus books international, New Delhi.
6. Lindsay, S.M. 2010. Introduction to Nanaoscience, Oxford university press. New York.

## **MB-4.3: Environmental Microbiology**

**64h**

### **Unit I.**

**16h**

**Environment and Ecosystem:** Physical, chemical and biological aspects of environment, natural habitats of microorganisms, microorganisms in ecosystem as producers and decomposers. Biogeochemical cycles-role of microorganisms in transformation and maintenance of carbon, nitrogen, phosphorus and sulphur in nature.

**Soil Microbiology** Historical development of soil microbiology. Physical characteristics and nutrient status of soil. Distribution of microorganisms in soil, their importance in maintaining soil fertility, organic matter and composting. Influence of environmental factors on soil microorganisms. Role of microorganisms in formation of different soils. Enumeration and isolation of soil microorganisms. Brief account of interactions among soil microorganisms-mutualism, commensalism, antagonism, competition, synergism, parasitism and predation. Bioremediation of pollutants in soil, biodegradation of pesticides in soil.

### **Unit II**

**16h**

**Aquatic microbiology:** Aquatic environment: Temperature, hydrostatic pressure, light, salinity, turbidity, pH, nutrients. Distribution of microorganisms in the aquatic environment. Methods in the study of fresh and marine water microorganisms. Role of aquatic microorganisms in food chain of aquatic environment. Eutrophication-role of nitrogen and phosphorus in eutrophication, process and control of eutrophication. Microorganisms and water Pollution-Microflora of natural and polluted water, sources and characteristics of water pollutants; health hazards due to water pollution; microorganisms as indicators of water pollution; water quality criteria and assessment; bacteriological examination of water for potability. The role of microorganisms in the purification of waste water: waste water treatment process, aerobic-anaerobic-design and functioning of treatment plant; microbial ecology and application of trickling filters; activated sludge process, microbial treatment of sludges. Water-borne diseases and their prevention.

### **Unit III**

**16h**

**Microbiology of the atmosphere:** Microorganisms in air, sources of air-borne microorganisms. Intramural and Extramural aeromicrobiology. Techniques for

microbiological sampling of air, impactors and impingers-Gravity slide, Plate exposure, vertical cylinder, Anderson's sampler, Hirst's trap, Burkard's 7-day volumetric sampler, rotarod sampler. Brief account of air-borne diseases of humans and plants. Brief account of air-borne allergens and their significance. **Microorganisms in extreme environments:** Extreme environments of temperature, salinity, pressure, pH. Extreme thermophiles, psychrophiles, extreme halophiles, barophiles and other microorganisms in extreme environments. Radio sensitivity of microorganisms, effect of radiation on microorganisms, mechanisms of radio-tolerance in microorganisms.

#### Unit IV

16h

**Biodeterioration and Bioremediation:** Microorganisms as biodeteriogens and their role in cycling of matter. Microbial degradation of cellulose, lignin, pectin, chitin, synthetic polymers, xenobiotic compounds, petroleum and other hydrocarbons. Solid wastes, chemical wastes, utilization of microorganisms in industrial effluent treatment technologies. Bioremediation of xenobiotic pollutants. Factors influencing bioremediation. Metal toxicity to microorganisms, importance of microorganisms in ore-leaching, use of microorganisms in metal extraction.

#### References;

1. Atlas, R and Bartha, R.2005. Microbial Ecology Fundamental and Applications, 4<sup>th</sup> edition, Pearson Education (P) Ltd. Delhi, India
2. Bhatia, S.C. 2008. Hand Book of Environmental Microbiology, Atlantic Publishers Pvt. Ltd. New Delhi.
3. Gilman, J. 2001. A Manual of Soil Fungi, Biotech Books, Delhi.
4. Maier, R., Pepper, I and Gerba, C.P.2006. Environmental Microbiology, Reed Elsevier India Private Limited, New Delhi, India
5. Patnail, P. 1997. Hand Book of Environmental Analysis. CRC Press, Inc., USA.
6. Subba Rao, N.S.1999. Soil Microbiology, Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi, India
7. Thakur, I.S. 2006. Environmental Biotechnology, I.K. International Pvt. Ltd. New Delhi.

### M.Sc., in Microbiology (CBCS)

#### I Semester

#### Hard core: Practical MB-1.4: Fundamentals of Microbiology

1.	Safety measures in Microbiology laboratory
2.	Preparation of Glass Ware
3.	Study of Microscopes
4.	Sterilization methods and sterilization indicators
5.	Preparation of culture media
6.	Isolation of microorganisms from natural soil

7.	Pure culture techniques and aspartic transfer
8.	Culturing of microorganisms from solid and liquid media
9.	Study of cultural characteristic of bacteria
10.	Bacterial motility-Hanging drop technique
11.	Preparation of stains and indicators
12.	Simple staining
13.	Negative staining
14.	Gram's staining
15.	Acid fast staining
16.	Endo spore staining
17.	Measurement of microbial cell`number / Spore number using hemocytometer
18.	Measurement of microorganisms by micrometry
19.	Slide culture for fungi
20.	Study of microbial culture preservation methods
21.	Microbial growth assessment-viable count and turbidity
22.	Evaluation of disinfectant: the use – dilution method
23.	Evaluation of antiseptic: the filter paper disc method
24.	Study of Algae
25.	Study of Fungi
26.	Study of Protozoa

## **M.Sc., in Microbiology (CBCS)**

### **I Semester**

#### **Hard core: Practical MB-1.5: Biochemistry and Biostatistics**

1.	Preparation of molar and normal solutions
2.	Determination of the concentration of HCl by volumetric analysis
3.	Determination of the concentration of NaOH by volumetric analysis
4.	Ionization of water and concept of pH and pOH
5.	Titration curve of strong acid and strong base
6.	Titration curve of weak acid and strong base
7.	Buffers
8.	Qualitative analysis of carbohydrate
9.	Qualitative estimation of proteins
10.	Quantitative estimation of total carbohydrate by Anthrone method
11.	Quantitative estimation of protein by Biuret method
12.	Estimation of free fatty acids
13.	i ) Circular paper chromatogram
14.	ii) Thin layer chromatography
15.	Component and uses of Colorimeter / Spectrophotometer
16.	Component and uses of pH meter
17.	Mean, mode, median
18.	Standard deviation

19.	Chisquare test
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**M.Sc., in Microbiology (CBCS)**

**I Semester**

**Hard core: Practical MB-1.6: Microbial Physiology and Bioinformatics**

1.	Starch Hydrolysis test
2.	Gelatin hydrolysis test
3.	Casein hydrolysis test
4.	Citrate utilization test
5.	Urease test
6.	Methyl red test
7.	Voges Praskour test
8.	Indole production test
9.	Melonate utilization test
10.	Phenlyalanine test
11.	Fermentation ability of the microorganisms
12.	Triple sugar iron agar test
13.	H <sub>2</sub> S production test
14.	Lecithinase test
15.	Lipase test
16.	B-Galactosidase test
17.	Catalase test
18.	Oxidase test
19.	KOH Solubility test
20.	Identification of unknown bacteria using different physiological tests
21.	Prediction of nucleotide sequence
22.	Prediction of amino acid sequence

**M.Sc., in Microbiology (CBCS)**

**I Semester**

**Soft core: Practical MB-1.8 (A): Mycology**

1.	Preparation and use of mycological media
2.	Isolation of fungi from soil, air, water and other sources
3.	Isolation of yeast from different sources
4.	Single spore isolation and establishment of pure culture
5.	Culture preservation of fungi
6.	Population count of fungi in soil by serial dilution method
7.	Mounting media and stains for fungi

8.	Techniques for microscopic preparation of fungi
9.	Fungal growth assessment by colony diameter measurement
10.	Spore germination assay
11.	Effect of different sugars on spore germination
12.	Types of spores in fungi
13.	Extraction and estimation of intracellular and extra cellular proteins of fungi
14.	Determination of fungal enzyme activity
15.	Extraction and estimation of fungal lipids
16.	Detection of aflatoxin by thin layer chromatography
17.	Detached leaf biomass for phytotoxins of fungal origin
18.	Detection of antibiotic activity of fungal culture broth
19.	Biodegradation of agricultural wastes by fungi
20.	Microbial interaction; Fungi and fungi, Fungi and bacteria
21.	Types studs of the following genera <i>Aspergillus, Penicillium, Neurospora, Saccharomyces, Erysiphae, Xylaria, Polyporus, Peziza, Lycoperdon, Agaricus, Puccinia, Ustilogo, Alternaria, Drechslera, Sclerotium, Saprolegnia, Rhizopus, Trichoderma, Candiada</i>

## M.Sc., in Microbiology (CBCS)

### I Semester

#### Soft core: Practical MB-1.8 (B): Principles of Genetics

1.	Mitosis in plants
2.	Meiosis in plants/animals
3.	Study of polytene chromosomes in salivary glands of <i>Drosophila</i>
4.	Study of human karyotype
5.	Genomic DNA extraction: a) Bacteria b) Plant c) Fungi
6.	Study of <i>Drosophila</i> a) Morphology b) Culturing c) Mutants d) X- linked inheritance
7.	Agarose gel electrophoresis for DNA separation
8.	Quantification of DNA by U.V spectrophotometer
9.	Determination of T <sub>m</sub> of DNA from different sources by spectrophotometer method
10.	Photographs of genetic disorders
11.	Karyotyping of different syndromes
12.	Study of human karyotyping
13.	Genetic problems

	a) Restriction mapping b) Linkage mapping c) DNA sequencing d) Study of different types of vectors
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## M.Sc., in Microbiology (CBCS)

### II Semester

#### Hard core: Practical MB-2.3: Microbial Genetics and Molecular Biology

1.	Isolation of bacteria/fungal DNA
2.	Quantitative estimation of DNA by Diphenyl amine method
3.	Quantitative estimation of RNA by Orcinol method
4.	Estimation of protein by Bardford's method
5.	Isolation of Coliphages from sewage
6.	Bacterial survival against UV-radiation
7.	Isolation of antibiotic resistant mutant by gradient plate method
8.	Isolation and characterization of petite mutant in yeast
9.	Induction of mutation in yeast and bacteria by chemicals / radiation
10.	Replica plating technique
11.	Bacterial plasmid isolation
12.	Restriction digestion of DNA
13.	Ligation
14.	Bacterial transformation
15.	Bacterial conjugation
16.	Genetic problems
17.	Prediction of nucleotide sequence
18.	Prediction of protein sequence

## M.Sc., in Microbiology (CBCS)

### II Semester

#### Hard core: Practical MB-2.4: Medical Microbiology

1.	Isolation of normal micro flora of human
2.	Isolation and identification of <i>Staphylococci</i>
3.	Isolation and identification of <i>Streptococci</i>
4.	Isolation and identification of <i>Escherichia</i> , <i>Pseudomonas</i> , <i>Salmonella</i> ,
5.	Isolation of Gram-negative intestinal pathogen
6.	Detection of Urinary tract pathogens
7.	Examination of bacteria by using urine dip slide technique
8.	Detection of <i>Mycobacterium tuberculosis</i> in sputum by AFB staining
9.	Determination of dental caries susceptibility by Snyder Agar test
10.	Detection of Malarial parasite in blood smear

11.	Stool examination for parasites
12.	Determination of antibiotic sensitivity of bacteria: Kirby-Bauer method
13.	Determination of Phenol-coefficient of antimicrobial compounds
14.	Estimation of Hemoglobin content in blood
15.	Total RBC count
16.	Total WBC count
17.	Differential WBC count
18.	Determination of Erythrocyte sedimentation rate (ESR)
19.	Syphilis detection by VDRL Test
20.	Detection of <i>Salmonella</i> by WIDAL test
21.	Observation of diseased specimens/slides of organisms

### M.Sc., in Microbiology (CBCS)

#### II Semester Practical

#### Soft core: Practical MB-2.6 (A): Plant -Microbe Interactions

1.	Isolation of plant saprophytes-bacteria and fungi
2.	Isolation of plant pathogens-bacteria and fungi
3.	Isolation of plant pathogens form seeds by standard blotter method and seed wash method
4.	Effect of plant saprophytic bacteria on seed germination and seedling vigour
5.	Effect of plant saprophytic fungi on seed germination on seedling vigour
6.	Effect of plant pathogenic bacteria on seed germination on seedling vigour
7.	Effect of plant pathogenic fungi on seed germination on seedling vigour
8.	Selective isolation of plant growth promoting rhizobacteria <i>Rhizobium/Pseudomonas</i>
9.	Effect of extra cellular bacterial/fungal enzymes on plants
10.	Effect of extra cellular bacterial/fungal phytotoxins on plants
11.	Biological seed treatment for prevention of seed / seedling infections
12.	Histopathological preparations for necrotroph induced reactions in plants
13.	Histopathological preparations for biotroph induced reactions in plants
14.	Effect of plant root exudates on fungal spore germination
15.	Analysis of plant root exudates for amino acids / sugars
16.	Effect of plant extracts on fungal growth

### M.Sc., in Microbiology (CBCS)

#### II Semester

#### Soft core: Practical MB-2.6 (B): Microbial Enzymology

1.	Preparation of solutions
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2.	Preparation of buffers
3.	Ionization of water and concept of pH and pOH
4.	Principle and use of pH meter
5.	Screening of microorganism for invertases
6.	Screening of microorganism for amylase
7.	Screening of microorganism for proteases
8.	Screening of microorganism for lipases
9..	Principle and use of colorimeter
10.	Quantitative estimation of total carbohydrate by DNS method
11.	Quantitative estimation of protein by Lowry's method
12.	Construction of glucose-calibration curve
13.	Determination of activity of microbial invertase
14.	Determination of activity of microbial amylase
15.	Determination of specific activity of microbial amylase
16.	Determination of optimum pH for microbial amylase activity
17.	Determination of optimum temperature for microbial amylase activity
18.	Effect of inhibitor on microbial amylase activity
19.	Determination of Km and Vmax of microbial amylase

## M.Sc., in Microbiology (CBCS)

### III Semester

#### Hard core: Practical MB-3.3: Agricultural Microbiology

1	Comparison of rhizosphere microorganisms from different crop plants
2.	Isolation of <i>Rhizobium</i>
3.	Isolation of <i>Azospirillum</i>
4.	Isolation of <i>Azotobacter</i>
5.	Isolation of phosphate solubilising microorganisms
6.	Isolation and identification of cyanobacteria
7.	Estimation of phosphate by Fiskay-subbarao method
8.	Estimation of phosphate by Koenig and Johnson's method
9.	Detection and quantification of mycorrhizae by root clearing technique
10.	Seed health testing by dry seed examination
11.	Seed health testing by seed wash method
12.	Detection of seed-borne fungi by blotter method
13.	Detection of seed-borne fungi by agar plate method
14.	Detection of seed-borne fungi by deep freeze method
15.	Study of plant diseases caused by fungi, bacteria and viruses
16.	Histopathological preparations of diseased specimens
17.	Effect of seed-borne pathogens on seed germination and seedling vigour



18.	Fungicide evaluation by spore germination inhibition assay
19.	Fungicide evaluation by agar diffusion method
20.	Effect of fungicidal seed treatment on seed-borne fungi
21.	Testing of antagonism by dual culture plate technique
22.	Testing of antimicrobial property of antagonists culture filtrate
23.	Biological seed treatment with <i>Trichoderma</i> for the prevention of seed borne pathogens
24.	Mass culturing of beneficial microorganisms using agricultural waste <i>Trichoderma</i>
25.	Isolation of fluorescent Pseudomonads
26.	Post harvest diseased samples
27.	Observation of diseased specimens, sections and slides

**M.Sc., in Microbiology (CBCS)**  
**III Semester**  
**Hard core: Practical MB-3.4: Immunology**

1.	Study of organs of immune system
2.	Study of cells of immune system
3.	Total WBC count
4.	Differential WBC count
5.	Types of antigens and adjuvants
6.	Production of polyclonal antiserum
7.	Methods of bleeding
8.	Separation of plasma from blood
9.	Separation of serum from blood
10.	Determination of antibody titer of the serum
11.	Purification of IgG from serum
12.	Agglutination tests: Haemeagglutination
13.	Immunoprecipitation Radial/ double diffusion
14.	ELISA

**M.Sc., in Microbiology (CBCS)**  
**III Semester**  
**Soft core: Practical MB-3.6 (A): Immunotechnology**

1.	Study of organs of immune system
2.	Study of cells of immune system
3.	Total WBC count

4.	Differential WBC count
5.	Types of antigens and adjuvants
6.	Preparation of antigens a. Whole cell antigens b. Purified proteins
7.	Preparation of antigen-adjuvant mixtures
8.	Methods of antigen administration to animals a. Intramuscular b. Intraveinal c. Intraperitoneal d. Intradermal
9.	Production of polyclonal antiserum
10.	Methods of bleeding
11.	Separation of plasma from blood
12.	Separation of serum from blood
13.	Determination of antibody titer of the serum
14.	Purification of IgG from serum
15.	Agglutination tests: Haemeagglutination
16.	Immunoprecipitation Radial/ double diffusion
17.	ELISA

## M.Sc., in Microbiology (CBCS)

### III Semester

#### Soft core: Practical MB-3.6 (B): Fermentation technology

1.	Isolation of <i>Actinomyces</i> and their screening for antibiotic production
2.	Isolation of fungi from different sources (soil, mud, water) and mutagenic studies using UV radiation
3.	Assessment of secondary metabolite substances from culture filtrate
4.	Biochemical test for vinegar during fermentation
5.	Demonstration of fermentation by using yeast
6.	Submerged fermentation for production of citric acid
7.	Submerged fermentation for production of protease
8.	Submerged fermentation for production of lipase
9.	SSF for production of proteases
10.	SSF for production of lipases
11.	Precipitation of protein from a crude extract by Ammonium sulphate precipitation method
12.	SDS gel electrophoresis of protein/enzymes
13.	Colorimetric estimation of amino acids by ninhydrin method
14.	Colorimetric estimation of sugars from raw materials
15.	Colorimetric estimation of vitamins by DNPH method

16.	Colorimetric estimation of protein by Lowry's method
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**M.Sc., in Microbiology (CBCS)  
IV Semester**

**Hard core: Practical MB-4.4: Food and Industrial Microbiology**

1.	Microbiological examination of food utensils
2.	Microbiological examination of vegetables
3.	Microbiological examination of spices
4.	Microbiological examination of meat
5.	Microbiological examination of fruits
6.	Microbiological examination of cereals
7.	Microbiological examination of fish and fish products
8.	Detection of faecal pollution in drinking water
9.	Bacteriological examination of soft drinks
10.	Bacteriological examination of bottled mineral water
11.	Bacteriological examination of drinking water
12.	Microbiological analysis of ice-cream
13.	Microbiological examination of canned foods
14.	Microbiological examination of spoiled foods
15.	Detection of aflatoxin in food and feed by thin layer chromatography
16.	Post harvest spoilage of fruits and vegetables
17.	Determination of TDP
18.	Determination of TDT
19.	Food preservation methods-chemical and physical
20.	Hydrolytic rancidity
21.	Estimation of lactic acid in milk
22.	Estimation of lactose in milk
23.	Extraction of casein from milk
24.	pH determination test of milk
25.	Rapid platform tests for milk quality assessment -Organoleptic test -Clot on boiling test -Alcohol test -Turbidity test
26.	Dye reduction test a) Methylene blue reduction test b) Resazurin dye reduction test
27.	Microbial reaction in litmus milk
28.	Bacteriological examination of milk i) Presumptive test ii) Confirmed test iii) Completed test
29.	Direct microscopic count of bacteria in milk: breed count

30.	Standard plate count of milk
31.	Different dairy products

### **M.Sc., in Microbiology (CBCS)**

#### **IV Semester**

#### **Hard core: Practical MB-4.5: Microbial Biotechnology**

1.	Screening and isolation of amylase producing fungi from different sources
2.	Determination of microbial amylase activity
3.	Determination of specific activity of amylase
4.	Determination of effect of substrate concentration on amylase activity
5.	Production of amylase by submerged fermentation
6.	Production of amylase by solid state fermentation
7.	Raw materials used in industrial Microbiology
8.	Study of fermentation using yeast
9.	Estimation of alcohol by colorimetric method
10.	Estimation of alcohol by specific gravity method
11.	Estimation of citric acid by AOAC method
12.	Estimation of citric acid by submerged fermentation
13.	Estimation of citric acid by solid state fermentation
14.	Determination of activity and specific activity of invertase in yeast
15.	Study of carbohydrate utilizing capacity of bacteria
16.	Estimation of free fatty acids
17.	Estimation of Ascorbic acid in the microbial sample
18.	Wine production
19.	Yeast/bacterial cell immobilization
20.	Synthesis of nanoparticles by bacteria
21.	Synthesis of nanoparticles by fungi
22.	Synthesis of nanoparticles by plants

### **M.Sc., in Microbiology (CBCS)**

#### **IV Semester**

#### **Hard core: Practical MB-4.6: Environmental Microbiology**

1.	Soil moisture content determination
2.	Estimation of total alkalinity of soil
3.	Ammonification in soil
4.	Isolation of soil microorganisms by direct plate method
5.	Enumeration of microbial population in soil by serial dilution method
6.	Baiting technique for isolation of soil microorganisms
7.	Estimation of dissolved oxygen of water
8.	Estimation of free carbon-dioxide
9.	Estimation of total solid content of water

10.	Estimation of total acidity of water
11.	Estimation of total alkalinity of water
12.	Estimation of catalase activity in water
13.	Estimation of BOD of sewage water
14.	Determination of chemical oxygen demand of water
15.	Estimation of chloride in water sample
16.	Estimation of oxidizable organic matter of water
17.	Bacteriological examination of water-MPN test
18.	Study of aquatic microflora-algae
19.	Study of aquatic microflora-fungi
20.	Enumeration of air borne microorganisms by gravity slide method
21.	Enumeration of air borne microorganisms by gravity plate method
22.	Enumeration of air borne microorganisms by vertical cylinder trap
23.	Pictures of different air samplers
24.	Effect of pH on bacterial / fungal growth
25.	Effect of temperature on bacterial / fungal growth
26.	Effect of osmotic pressure on bacterial / fungal growth
27.	Radio sensitivity in bacteria