



**MAHATMA GANDHI UNIVERSITY  
KOTTAYAM,  
KERALA, INDIA**

**SCHEME AND SYLLABUS**  
**OF**  
**M.Sc. MICROBIOLOGY PROGRAMME (CSS)**  
**w.e.f. 2012 Admission**

# **SCHEME**

### **A. Scheme of Examination for First Semester M.Sc. Microbiology**

Course No.	Course Code	Subject	Credit	Marks		
				Internal	External	Total
Core 1	MB1PG01	Biochemistry	4	25	75	100
Core 2	MB1PG02	Biophysics, Bioinstrumentation & Bioinformatics	4	25	75	100
Core 3	MB1PG03	Cell Biology & Genetics	4	25	75	100
Core 4	MB1PG04	Physiology & Biostatistics	3	25	75	100
Practical 1	MB1PGP1	Laboratory Course I	4	25	75	100
<b>Total Credits - 19</b>						

### **B. Scheme of Examination for Second Semester M.Sc. Microbiology**

Course No.	Course Code	Subject	Credit	Marks		
				Internal	External	Total
Core 5	MB2PG05	General Microbiology	4	25	75	100
Core 6	MB2PG06	Immunology	4	25	75	100
Core 7	MB2PG07	Molecular Biology & Genetic Engineering	4	25	75	100
Core 8	MB2PG08	Metabolism & Enzymology	3	25	75	100
Practical 2	MB2PGP2	Laboratory Course II	4	25	75	100
<b>Total Credits - 19</b>						

### **C. Scheme of Examination for Third Semester M.Sc. Microbiology**

Course No.	Course Code	Subject	Credit	Marks		
				Internal	External	Total
Core 9	MB3PG09	Food & Industrial Microbiology	4	25	75	100
Core 10	MB3PG10	Agricultural & Environmental Microbiology	4	25	75	100
Elective 1*	As selected by the student		4	25	75	100
Elective 2*	As selected by the student		4	25	75	100
Practical 3	MB3PGP3	Laboratory Course III	4	25	75	100
<b>Total Credits - 20</b>						

#### **\*List of Courses for Electives 1 and 2**

- 1. MB3PGE1 Microbial Diversity & Extremophiles**
- 2. MB3PGE2 Marine Microbiology**
- 3. MB3PGE3 Environmental Science**
- 4. MB3PGE4 Molecular Microbiology**
- 5. MB3PGE5 Nanobiotechnology**
- 6. MB3PGE6 Microbial Quality Assurance, Biosafety and Intellectual Property Rights**

### **D. Scheme of Examination for Fourth Semester MSc. Microbiology**

Course No	Course Code	Subject	Credit	Marks		
				Internal	External	Total
Core 11	MB4PG11	Systematic Bacteriology	3	25	75	100
Core 12	MB4PG12	Virology, Mycology & Protozoology	4	25	75	100
Elective 3*	As selected by the student		4	25	75	100
Practical 4	MB4PGP4	Laboratory Course IV	4	25	75	100
Project	MB4PGD	Project	4		100	100
Viva Voce	MB4PGV	Viva Voce	3		100	100
<b>Total Credits - 22</b>						

#### **\*List of Courses for Elective 3**

- 1. MB4PGE7 Clinical Microbiology**
- 2. MB4PGE8 Microbial Genetics**
- 3. MB4PGE9 Biostatistics and Research Methodology**

# **SYLLABUS**

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## **First Semester M.Sc. Microbiology**

## MB1PG01 - BIOCHEMISTRY

Number of Hours / Week: 4

Credits: 4

### UNIT I

#### **Brief Review of Basic Biochemistry**

**Properties of water and aqueous solution:** Water as biological solvents; acid bases and buffers; physiological buffers; Henderson Hasselbach equations; fitness of aqueous environment for living organisms.

**Functional groups:** Structure and reactions; Review of organic reaction: classification; mechanisms **Stabilizing interactions:** Covalent bonds; Ionic bonds; Disulfide linkages; Non-covalent interactions: Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.

### UNIT II

**Biomolecules:** Composition; basic structure and function of biomolecules: carbohydrates, lipids, proteins, nucleic acids and vitamins.

**Hormones:** Classification; site of formation, target organs; mechanism of action of peptide and steroid hormones (with suitable examples).

### UNIT III

#### **Carbohydrates:**

Mono, di ,oligosaccharides, Glycosidic bonds; glycoproteins (O- linked and N- linked), glycolipids; **Polysaccharides:** Classification: Homopolysaccharides (Cellulose, Starch, Chitin, and Glycogen), Heteropolysaccharides, bacterial peptidoglycans, flagellin, lipopolysaccharides, chitin, glycosaminoglycans, hyaluronic acid, and heparin and their Structural characteristics and functions, bacterial polysaccharides Purification and Characterization of polysaccharides from biological systems.

### UNIT IV

#### **Complex Lipids:**

**Glycerophospholipids:** Structure and function of (Phosphatic acid, cardiolipin, Phosphatidyl serine, Phosphatidyl ethanolamine, Phosphatidyl glycerol, Phosphatidyl choline, Phosphatidyl inositol), CDP-diacylglycerol, Lung surfactants.

**Glycosphingolipids:** Structure and function of Sphingosine, ceramides & sphingomyelins, cerebroside, globosides, gangliosides, sulfatides .

**Eicosanoids:** Prostaglandins, Leukotrienes and Thromboxanes: Chemistry, formation and physiological function.

**Steroids:** Steroids in animal system: Glucocorticoids, mineralocorticoids and Sex hormones (Site of biosynthesis, functions and mechanism of action); Sterols in Plant system: Phytohormones: Brassinosteroids (functions); Sterols in microbial system: Microbial transformation of steroids .

### UNIT V

#### **Macromolecules: Structure and Function:**



**Protein structure and function:** Primary, Secondary, Tertiary and Quarternary structure of Proteins w.r.t: Globular protein (eg: Hemoglobin and Myoglobin), Fibrous protein: (Collagen), Membrane Protein (ATP synthetase), Protein sequencing, Evolutionary divergence of organisms and its relationship to protein structure and function.

**Nucleic acid structure and function:** Introduction, Phosphodiesterbonds, melting of the DNA molecule; Re association kinetics, structure of tRNA .

**References:**

1. Hiram. F. Gilbert (2002) *Biochemistry: A Students survival Guide* McGraw-Hill ISBN 0-07-135657-6
2. Pranab Kumar Banerjee (2008) *Introduction to Biophysics* S. Chand & Company ltd ISBN: 81-219-3016-2
3. David L. Nelson Michael M. Cox *Lehninger Principles of Biochemistry*, W. H. Freeman; Fourth Edition edition (April 23, 2004) ISBN-10: 0716743396 ISBN-13: 978-0716743392.
4. E.S. West, W.R. Todd, H.S. Mason and J.T. van Bruggen, *A Text Book of Biochemistry*, Oxford and IBH Publishing Co., New Delhi, 1974
5. Donald Voet, Judith G. Voet *Biochemistry* (2004) John Wiley & Sons Inc ISBN: 047119350X ISBN-13: 9780471193500, 978-0471193500
6. Geoffrey L Zubay, William W Parson, Dennis E Vance; *Principles Of Biochemistry* (1995) Mcgraw-hill Book Company – Koga ISBN:0697142752 ISBN-13: 9780697142757, 978-0697142757
7. Robert Horton H , Laurence A Moran, Gray Scrimgeour K *Principles Of Biochemistry*, (2006): Pearsarson 4/e ISBN: 0131977369, ISBN-13:9780131977365, 978-0131977365
8. Jeremy M.berg John L.tymoczko Lubert Stryer *Biochemistry* (2007) B.i.publications Pvt.Ltd 6th Edition ISBN:071676766X ISBN-13: 9780716767664, 978-716767664
9. Rastogi *Biochemistry* (2008) Mcgraw Hill ISBN:0070527954 ISBN-13: 9780070527959, 978-0070527959
10. J. L. Jain, Sunjay Jain and Nitin Jain (2008) *Fundamentals of Biochemistry* S. Chand & Co Ltd ISBN: 81-219-245

## **MB1PG02 - BIOPHYSICS, BIOINSTRUMENTATION AND BIOINFORMATICS**

**Number of Hours / Week: 4**

**Credits: 4**

### **UNIT I**

Laws of thermodynamics, the concept of enthalpy, entropy and free energy, thermodynamic equilibrium, redox potential, high energy molecules, examples of redox potential in biological system. DNA polymorphism, GC content and denaturation kinetics, Cot curve, DNA-Protein interaction-. Lambda repressor and cro binding to DNA. Interactions of transcription factors- HLH, bHLH, Leucine Zipper, Cys-His, Zinc fingers. Histone-DNA interaction, RNA protein interactions DNA-drug Interaction.

### **UNIT II**

Structural implication of peptide bond, Ramachandran plot, protein families, alpha domains, beta domains, alpha- beta domains, Protein-drug interaction peptide mass finger printing using MALDI-TOF, MASCOT database. Energy minimization in molecular docking

### **UNIT III**

Microscopy: Light, Scanning and Transmission electron, phase contrast, polarization, confocal and interference microscopy, CCD camera, Introduction to Atomic force microscopy. Spectroscopy: Beer-Lamberts law, Principle, Instrument Design, methods and Applications of UV-Visible spectra, IR spectra, Raman Spectra, Fluorescence spectra, NMR and ESR spectra

### **UNIT IV**

Principle, Instrument Design, methods and Applications of Chromatography, ion exchange, molecular sieve, affinity chromatography, TLC, GC, HPLC, Centrifugation and Ultra centrifugation, PAGE, SDS PAGE, Capillary Electrophoresis, isoelectric focusing, Potentiometry, pH meter, ion selective electrodes. Principle, Instrument Design, methods and Applications of Polarimetry, ORD, CD, Light scattering , Refractometry, Flow cytometry, Cytometry, X-ray diffraction by crystals, , Electron diffraction, Application in Biology, autoradiography, GM counter, Liquid scintillation counting, biosensor, dialysis, ultrafiltration

### **UNIT V**

Introduction to Bioinformatics, Internet, - data mining Online databases and search tools, data organization, Biological data bases, structural data bases, derived and specialized data bases , DNA and RNA sequence data bases, genomic sequences, protein sequence data bases, Distance matrix methods and parsimony. Multiple sequence alignments-tree alignments, star alignments, pattern in pair wise alignment, genetic algorithm. Sequence analysis softwares, SS search, BLAST, FASTA, CLUSTAL, Phylogenetic analysis, construction of phylogenetic tree, evolutionary changes in nucleotide and protein sequences, structure prediction, structural alignment tools, homology modeling, drug design. Applications of Bioinformatics: pharmaceutical industry, immunology, agriculture, forestry, basic research, cheminformatics in biology, geoinformatics, legal ethical and commercial considerations.

**Reference:**

1. *Introduction to Protein structure*: Branden and Tooze1.
2. *Biophysics*-Hoope W etal
3. *Molecular Biophysics*- Volkenstain M.V
4. *Introduction to Thermodynamics Of Irreversible Process*-Joh Wiley
5. *Statistical Methods In Biology*- Briley N.J.T
6. *Introduction to Biophysics*-Sokal R.R & Rohl F.J
7. *Bioinformatics: Sequence and Genome Analysis*- David Mount, Cold Spring Harbour Lab Press, New York.
8. *Bionformatics and Molecular Evolution*: Paul G Higgs, Teresa K Attwood.Blackwell pub.

## **MB1PG03- CELL BIOLOGY AND GENETICS**

**Number of Hours / Week: 4**

**Credits: 4**

### **UNIT I**

Membrane proteins, lipids. Fluid mosaic model, membrane fluidity, asymmetry, lipid raft, functions of membrane proteins & lipids. Functions of the memb: delineation and compartmentalization, localization & organization of function, regulation of transport: porins facilitated diffusion, porter molecules; Facilitated transport: symport, antiport, uniport, anion porter, glucose porter; Active transport: proton pumps; Na<sup>+</sup> K<sup>+</sup> pumps, Ca<sup>2+</sup> pumps; Ionic channels: general characteristics of ionic channels, types of ionic channels.

### **UNIT II**

ER: Rough and smooth ER, functions, Golgi complex: structure, types, modification of proteins, protein sorting and trafficking, secretory pathways, exo and endocytosis, coated pits and vesicles, Lysosomes and peroxisomes: enzymatic components and functions, Cytoskeleton: Microtubule, assembly and organization, microfilaments: actin structure and assembly, Intermediate filaments, types, filament based movement in muscle, sliding filament model. Mitochondrion: structural features and functions, Chloroplast structural features and functions, photosystems, LHC, RuBisco, Cell junctions- tight, gap junctions.

### **UNIT III**

Signal transduction: electrical impulses and their transmission: Structure and electrical properties of neurons, resting potential, action potential, propagation of action potential, voltage gated and ligand gated channels, synaptic transmission ,chemical signals and receptors, second messengers: cAMP, Ca ions, Ras pathway, glycogen breakdown by epinephrine.

Nucleus, structure of chromosomes, chromosome banding, mitosis and meiosis, chromosomal organization Cell cycle: G1, S,G2, M phases, model organisms, MPF, cyclins, checkpoints, Role of Rb & p53. Cell cycle inhibitors

Cellular differentiation: maternal, segmentation and homeotic genes,hox genes, gene interactions bicoid- nanos system. Differentiation in plants, floral development-apetalous, pistillate, agamous interactions. Cell death and cancer: Apoptosis and necrosis, apoptotic pathways , theories on apoptosis, types of tumor, induction of cancer, properties of cancer cells, oncogenes and c onco genes, tumor suppressors, Molecular pathways- PIP3 Akt, MAP kinase

### **UNIT IV**

Mono, di and trihybrid crosses, dominance, epistasis, pleiotropic interactions, multiple alleles- ABO blood groups, pseudoalleles, atavism, linkage, sex linkage, sex influenced genes, sex limited genes, linkage groups, two point and three point test crosses, determination of gene order, chromosome mapping, inherited disorders in metabolism-maple syrup urine disease,Lesch Nyhan syndrome, Cytoplasmic inheritance, cytoplasmic male sterility, Down's syndrome, polyploidy, aneuploidy , structural and functional genomics.

## UNIT V

Behavioral genetics, Hardy Weinberg principle, natural selection, genetic drift, Genetic variation, Allele frequencies and its changes, mutation , gene flow, random mating, inbreeding, outbreeding, assortive mating, hybrid vigour.

### Reference:

1. *Principles of Genetics*, Snustad, Simmons and Jenkins, John Wiley And Sons Inc
2. *Genetics*, Robert Weaver and Philip Hendricks, WH.C. Brown Publishers, Iowa  
*Fundamentals of Genetics*, B D Singh, Kalyani Publishers
3. *Introduction to Genetic Analysis*, Griffiths, Wessler, Lewontin, Gelbart, Suzuki and Miller, Freeman's and Co, New York
4. *Principles of Genetics: A.G.Gardner*, John Wiley and sons.
5. *Cell Biology*, Smith and Wood
6. *Cell and Molecular Biology* by Gerald Karp, Academic Press
7. *Cell and Molecular Biology* Cooper, Hausman, ASM Press.
8. *World of the Cell*, Becker, Reece, Poenie, The Benjamin/Cumming's Pub.
9. *Cell Biology*, Lodish et al, W H Freeman and Co., New York.
10. *Cell Biology* , Thomas D Pollard and W.C.Earnshaw, Saunder's Publishers

## **MB1PG04- PHYSIOLOGY AND BIOSTATISTICS**

**Number of Hours / Week: 4**

**Credits: 4**

### **UNIT- I**

#### **Plant Physiology 1:**

Autotrophy, heterotrophy, intake of water and nutrients, transpirations, photosynthesis, mineral nutrition, respiration, photorespiration, Growth and Reproduction; enzymes, Hormones and growth regulators- auxins, gibberlins, kinins, ethylene and other compounds - physiological function and mechanism of action

### **UNIT II**

#### **Plant Physiology 2:**

Mechanisms of action of phytochromes, cryptochromes & phototropins. Stress physiology, water stress and other stresses, Photoreceptors, Morphogenesis,, Totipotency - principles and differentiation, photomorphogenesis, phytochromes; physical and chemical properties, photoperiodism - general principles and response type.

### **UNIT-III**

#### **Human Physiology:**

**Blood and circulation:** Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, immunity, haemostasis. Elementary tissues- epithelial tissue, connective tissue, muscle tissue, nervous tissue, **Cardiovascular System:** cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of all above. **Respiratory system:** transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration.

### **UNIT IV**

**Nervous system:** brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture. **Excretory system:**, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance. **Thermoregulation:** Comfort zone, body temperature – physical, chemical, neural regulation, acclimatization. **Digestive system:** Digestion, absorption, energy balance, BMR.

### **UNIT V**

Scope of Biostatistics, probability and probability distribution analysis. Variables in biology- collection, classification and tabulation of data- graphical and diagrammatic representation- scatter diagrams, histograms- frequency polygon- frequency curve-logarithmic curves. Descriptive statistics- measures of central tendency, Arithmetic mean, median, mode, geometric mean, harmonic mean. Measures of dispersion, standard deviation, standard error, variance, coefficient of variation. Correlation and Regression. Test of significance. Basic idea of

significance test- hypothesis testing, levels of significance, Chi-square test and goodness of fit, comparison of means of two samples, three or more samples. Statistical packages.

**References:**

1. Lincoln Taiz, Eduardo Zeiger (2010) *Plant Physiology*, Palgrave, 5<sup>th</sup> ed.
2. Choudhuri, M A & Gupta, K K (2009) ***Practical Plant Physiology*** New Central Book Agency (P) Ltd
3. Lambers, Hans, Pons, Thijs L. Chapin, III, F. Stuart (2008) *Plant Physiological Ecology*, Springer 2nd ed
4. G. Rangaswami (2004). *Agricultural Microbiology*. Prentice-Hall of India Pvt.Ltd.
5. Widmaier, Raff, *Strang Vander's Human Physiology- The Mechanism of Body function*.
6. C. Guyton & John. E. Hall *Text book of Medical Physiology*.
7. John. B. West *Physiological basis of Medical Practice*.
8. William. F. Ganong *Review of Medical Physiology* (LANGE Basic Science).
9. K. Sembulingam & Prema Sembulingam *Essentials of Medical Physiology*.
10. Caldwell, D.R. (1995). *Microbial Physiology and Metabolism*, Wm. C. Brown Publishers, USA
11. Lansing M. Prescott, John P. Harley and Donald A. Klein. (2003). *Microbiology*. McGraw-Hill company, Newyork. 5th
12. Moat, A.G., Foster, J.W. and Spector, M. P (2002). *Microbial Physiology*, John Wiley & Sons, New York. 4<sup>th</sup> ed.
13. Pelczar Jr, M.J. Chan, E.C.S. and Kreig, N.R. (1993). *Microbiology*, Mc. Graw Hill. Inc, New York.
14. Salle, A.J. (1996). *Fundamental principles of Bacteriology* (7th edition). Tata McGraw-Hill publishing company limited, NewDelhi.
15. White, D. (1995). *The Physiology and Biochemistry of Prokaryotes*, Oxford University Press, Oxford, New York.
16. Rabert Poole, K. (2007) *Advances in Microbial Physiology*, Volume 53 Elsevier Science & Technology

## **MB3PGP1- LABORATORY COURSE I**

### **Credit 4**

#### **Biochemistry, Physiology & Cell Biology and Genetics:**

##### **Biochemistry:**

##### 1. Preparation of solutions:

- Percentage solutions,
- Molar solutions,
- Normal solutions
- Dilution of Stock solutions

##### 2. Preparation of buffers using the Henderson Hasselbach equation

##### 3. Spectrophotometric experiments:

- Verification of Beer Lambert's law
- Determination of UV-Visible spectrum of compounds
- Determination of Concentration of molecules from Molar Extinction Coefficient values

##### 4. Chromatographic techniques

- Separation of amino acids by Paper chromatography (Descending or Ascending)
- Separation of Plant pigments by Thin layer chromatography

##### 5. Extraction of Polysaccharides (Starch, Glycogen), Proteins, from appropriate source:

- Quantification of isolated polysaccharide (anthrone method), protein (Lowry's method) and lipids

##### 6. Estimations

- Quantitative estimation of reducing sugars by Dinitrosalicylic acid method
- Quantitative estimation of Methionine by Nitroprusside method
- Saponification value, iodine value, of fat sample
- Estimation of Cholesterol by Zak's method

##### 7. Qualitative analysis of Carbohydrate mixtures (a combination of polysaccharide, disaccharide and monosaccharide) following systematic scheme for analysis.

(Starch, dextrin, glycogen, glucose, fructose, xylose, galactose, sucrose, maltose, lactose)



**Physiology:**

1. Determination of haemoglobin concentration
2. Determination of haematocrit
3. Enumeration of blood cells: a) erythrocytes by haemocytometry, b) total leukocyte by haemocytometry
4. Preparation of Blood smears for differential count and cell morphology
5. Determination of Erythrocyte sedimentation rate
6. Determination of bleeding time
7. Determination of blood clotting time

**Cell Biology and Genetics:**

1. Study of various stages of mitosis using cytological preparations of onion root tips.
2. Study of various stages of meiosis using cytological preparation of flower buds
3. Karyotype study using cytological preparation of dividing root tip cells of onion /photographs /permanent slides
4. Study in the ultra structure of cell organelles using electron microphotographs pics.
5. Solving genetic problems related to monohybrid, dihybrid ratio and interaction of genes

**References**

1. Introductory Practical biochemistry, S. K. Sawhney & Randhir Singh (eds) Narosa Publishing House, New Delhi, ISBN 81-7319-302-9, p 195 - 303
2. Standard Methods of Biochemical Analysis, S. K. Thimmaiah (ed), Kalyani Publishers, Ludhiana ISBN 81-7663-067-5, p 12 - 18
3. Hawk's Physiological Chemistry, Bernard L. Oser (ed) TATA McGRW Hill Publishing Company LTD, New Delhi, p 60 – 127, 1317- 1334
4. Experimental Biochemistry: A Student Companion, Beedu Sasidhar Rao & Vijay Deshpande (ed), I.K International Pvt. LTD, New Delhi ISBN 81-88237-41-8, p 13- 17, p 49 - 72
5. Practical Biochemistry, R.C. Gupta & S. Bhargava (eds) CBS Publishers and Distributors, New Delhi, ISBN 81-239-0124-0 p 9 – 27
6. Practical Clinical Chemistry, Harold Varley, CBS Publishers and Distributors, New Delhi,
7. Medical Laboratory Technology – A procedure manual for routine diagnostic tests Volume 1, K.L. Mukherjee, Tata McGraw-Hill Publishing company LTD, New Delhi

# **SYLLABUS**

## **Second Semester M.Sc. Microbiology**

## **MB2PG05- GENERAL MICROBIOLOGY**

**Number of Hours / Week: 4**

**Credits: 4**

### **UNIT I**

The historical foundations and development of microbiology. An overview of microbial world. Microbial diversity - Prokaryotic and eukaryotic microbial diversity .The bacteria and the archaea. Principles of bacterial taxonomy Molecular methods in taxonomy. Intraspecies classification of bacteria.

### **UNIT II**

Morphology and structure of bacteria. Surface structures and inclusions of bacteria. Viruses-unique properties, morphology and structure. Virion, Viroids and Prions. Viral replication. Viral diversity–bacterial, plant and animal viruses. Fungi –properties and classification. Identification of bacteria. Staining reactions. Cultural, physiological and biochemical properties. Molecular methods for identification.

### **UNIT III**

Factors influencing microbial growth. Environmental and nutritional factors. Nutritional types of bacteria. Autotrophs and Chemolithotrophs, Physiological groups of chemolithotrophs, Microbial locomotion – flagellar motility, gliding motility and amoeboid motion. Chemotaxis, Phototaxis and other taxes. Cultivation of bacteria- culture media and methods. Measurement of bacterial growth. Bacterial growth curve. Binary fission, Growth cycle, Microbial growth at different temperature, pH and oxygen level. Continuous cultures. Maintenance and transport of cultures.

### **UNIT IV**

Sterilization – Principles and methods, physical and chemical methods. Disinfectants – modes of action. Testing of disinfectants. Antibiotics – mechanism of action. Drug resistance in bacteria. Antibiotic sensitivity tests.

### **UNIT V**

Genetic materials in bacteria. Bacterial chromosome. Extrachromosomal genetic elements. Plasmid- copy number and incompatibility, Replication of plasmid. Episomes. Transposable element-IS element and transposon, Integrons and Antibiotic resistance cassettes, Multiple antibiotic resistant bacteria, Mu-virus.. Mutation, Site Directed Mutagenesis, DNA repair, Mutant selection. Mechanism of gene transfer – transformation, transduction and conjugation. Recombination- types, mechanism and enzyme involved. Gene mapping. Bacteriophage genetics-Plaques formation & phage mutants, genetic recombination in lytic cycle. Genetic system in Yeast & Neurospora.

## References

1. Russell AD, Hugo WB, & Ayliffe GAJ (1999) *Principles and practice of disinfection, preservation, and sterilisation* (Blackwell Science, Oxford) 3rd ed
2. Bryan LE (1984) *Antimicrobial Drug Resistance* (Academic Press, Orlando)
3. Topley WWC, Wilson GS, Parker T, & Collier LH (1990) *Topley and Wilson's Principles of Bacteriology, Virology and Immunology*. Edward Arnold, London. 8<sup>th</sup> ed.
4. Davis BD (1990) *Microbiology* (Lippincott, Philadelphia) 4th ed
5. Zinsser H & Joklik WK (1992) *Zinsser Microbiology* (Appleton & Lange, Norwalk, CT) 20th Ed
6. Gerhardt P (1994) *Methods for General and Molecular Bacteriology*. American Society for Microbiology, Washington, D.C.
7. Pelczar MJ, Chan ECS, & Krieg NR (1993) *Microbiology : concepts and applications* .McGraw-Hill.5<sup>th</sup> ed.
8. Prescott LM, Harley JP, & Klein DA (2005) *Microbiology* (McGraw-Hill, Boston ; London) 6th ed.

## **MBPG06 - IMMUNOLOGY**

**Number of Hours / Week: 4**

**Credits: 4**

### **UNIT I**

Infection, Source of infection, Methods of transmission. Immunity, Types of immunity. Mechanisms of innate immunity- barriers, inflammation, phagocytosis-mechanisms, Pattern recognition receptors - Scavenger receptors and the Toll-like receptors etc. Organs and cells with immune functions. Lymphocytes and lymphocyte maturation.

### **UNIT II**

Antigens, Antigenicity, Epitopes, Antibodies, Immunoglobulin – structure, classes and functions Fc receptors. Monoclonal antibodies – production and application, Antibody engineering. Antigenic determinants on Ig- Isotype, Allotype, Idiotype. Genetic basis of antibody diversity, Organization and Expression of Immunoglobulin Genes, V(D)J rearrangements; somatic hypermutation and affinity maturation, Class-switching, Antigen-antibody reactions, Agglutination, Precipitation, Complement fixation, Radioimmuno assay, Immunofluorescence, ELISA, Western blotting, Flow cytometry etc.

### **UNIT III**

Receptors on T and B cells for antigens, MHC, Antigen processing and presentation, Complement system, Complement activation, regulation, Biological effects of complements, B cell- generation, activation, differentiation, Humoral Immune response- Antibody formation, Primary and secondary immune response, Clonal selection theory. T-cell maturation, activation and differentiation, Cell mediated Immune response, Cytokines, Primary and secondary immune modulation

### **UNIT IV**

Immunology of organ and tissue transplantation- Allograft reaction and GVH reaction, Factors influencing allograft survival, Immunology of malignancy- Tumor antigens, Immune response in malignancy, Immunotherapy of cancer, Immunohematology- ABO and Rh blood group system, Immunology of blood transfusion, Hemolytic disease of new born.

### **UNIT V**

Immunological Tolerance, Autoimmunity- Mechanisms of autoimmunity, Autoimmune diseases. Inflammation, Hypersensitivity– immediate and delayed reactions, Clinical types of hypersensitivity, Immunodeficiency diseases, Immunoprophylaxis- Vaccines –types of vaccines, DNA vaccine and recent trends in vaccine development. Immunoregulation

### **References**

1. Roitt IM & Delves PJ (2001) *Roitt's essential Immunology*. Blackwell Science, Oxford. 10<sup>th</sup> ed.
2. Kindt TJ, Goldsby RA, Osborne BA, & Kuby J (2006) *Kuby Immunology*. W.H. Freeman, New York. 6<sup>th</sup> ed
3. Murphy K, Travers P, Walport M, & Janeway C (2008) *Janeway's Immunobiology*. Garland Science, New York. 7<sup>th</sup> ed
4. Chapel H (2006) *Essentials of clinical Immunology*. Blackwell, Malden, Mass. ; Oxford. 5<sup>th</sup> ed
5. Kimball JW (1986) *Introduction to Immunology*. Macmillan, London 2<sup>nd</sup> ed
6. Paniker CKJ (2006) *Ananthanarayan & Paniker's Textbook of microbiology*. Orient Longman. 7<sup>th</sup> ed.

## **MB2PG07 - MOLECULAR BIOLOGY & GENETIC ENGINEERING**

**Number of Hours / Week: 4**

**Credits: 4**

### **UNIT I**

**DNA Replication** – Process of DNA replication, semi-conservative, discontinuous uni and bidirectional, Okazaki fragments, DNA polymerases in eukaryotes and prokaryotes, Klenow fragment, modes of replication, theta, rolling circle, d-loop replication, Primosome, SSB, Helicase, Ligase, methylation and control, repetitive DNA sequences, minisatellite, microsatellite, DNA protein interaction DNA Linking number and topoisomerase, Inhibition of replication.

### **UNIT II**

**Transcription.** -Process of transcription, stages in transcription, RNA polymerases in prokaryotes and eukaryotes, sigma factor in prokaryotes, Rho dependant and Rho independent termination. Enhancers, Transcription factors in Eukaryotes, Differences in transcription between prokaryotes and Eukaryotes, post transcriptional modifications-Polyadenylation, capping, r-RNA processing, Splicing-Spliceosome, lariat structure, Group 1, II and III Introns Ribozyme, Importance of ribozyme, properties, application, RNase P, RNase III, RNase H. monocistronic and polycistronic m-RNA, Joint transcript of r-RNA and t-RNA in prokaryotes and their processing, Transplicing, alternate splicing, inhibitors of Transcription.

Molecular mechanism of gene regulation in prokaryotes-Transcriptional regulation in prokaryotes; Inducible & repressible system, positive and negative regulation; Operon concept, structure of operon, Lac, Trp, Ara operon, Catabolic repression, Attenuation. Role of Hormones in gene regulation.

**RNA World, RNA based technology-** Molecular mechanism of Ribozyme, Antisense RNA, SiRNA, MicroRNA, Riboswitches & their applications; Telomerase structure and function Nucleic acid as therapeutic agent

### **UNIT III**

#### **Translation**

Process of translation. Stages in translation, genetic code, properties, wobble hypothesis, eukaryotes and prokaryotes ribosomes, m-RNAs, t-RNAs, aminoacyl t-RNA synthetases, protein factors initiation complex, peptidyl transferase, releasing factors, differences between prokaryotic and eukaryotic systems, inhibition of translation. Post translation modification by cleavage, self assembly assisted self assembly chaperones, acylation, phosphorylation, acetylation and glycosylation, Histone acetylation and deacetylases, chromosome remodeling

complex. Intein splicing. Protein targeting, co-translational import, post translational import, SRP- structure and function, Blobel's concept, Lysosome targeting, M6P address Glycosylation core glycosylation terminal glycosylation, Dolichol phosphate.

#### **UNIT IV**

##### **Tools and techniques for Genetic Engineering- 1**

History of rDNA Technology, Cohen And Boyer Patents. Enzymes used in genetic engineering with special reference to restriction enzymes, ligases, and other DNA modifying enzymes. modification of restriction fragments, vaccinia topoisomerases, Cloning strategies - Use of linkers, adaptors, TA cloning, and homopolymer tails . Nucleic acid hybridization - Colony hybridization, plaque hybridization; Blotting techniques – Southern, Northern.

#### **UNIT V**

##### **Tools and techniques for Genetic Engineering- 2**

Vectors- Plasmid- pSC101, pBR322, pUC their development, features and selection procedures; Bacteriophages-  $\lambda$  and M13, Cosmids- features, advantages and cosmid cloning schemes; Phagemids- pEMBL, pBluescript, pGEM3Z , pSP64. Shuttle vectors- YAC. Ti-plasmids. Expression vectors. Construction of genomic libraries and cDNA libraries, procedures for recombinant selection and library screening, Chemical synthesis of DNA , DNA sequencing - plus and minus sequencing, Sanger's dideoxy sequencing, Maxim and Gilbert's method. Advanced sequencing procedures – pyrosequencing, Illumina, ABI / SOLiD and their applications. Principles, techniques and applications- PCR, RFLP, RAPD, AFLP, Foot and Finger printing etc.

#### **UNIT VI**

##### **Applications of Genetic Engineering**

DNA chips and microarray, gene screen technology; site directed mutagenesis, gene knockout techniques, Genetic markers, Gene transfer in plants and animals. Applications of transgenic technology. Animal cloning- stem cell technology, somatic cell nuclear transfer, Plant cell culture based techniques. Applications of Molecular Biology in forensic sciences, medical science etc.

#### **References**

1. M. Fogiel, J. A. Stone, Research and Education Association., (1995) *The genetics problem solver : a complete solution guide to any textbook*. REA's problem solvers (Research and Education Association, Piscataway, N.J.
2. Anthony. J. F. Griffiths (2002), *Modern genetic analysis*. 2<sup>nd</sup> ed. (W. H. Freeman ; Basingstoke : Palgrave, New York.



3. EJ Wood, Chris Smith (1996) *Cell biology*. 2<sup>nd</sup> ed. Chapman and Hall, London.
4. Gerald Karp.(2009) *Cell and Molecular Biology: Concepts and experiments*. 6<sup>th</sup> ed. John Wiley & Sons.
5. Geoffrey M Cooper, Robert E Hausman (2007) *The cell: a molecular approach*. 4<sup>th</sup> Ed. ASM Press.
6. EDP DeRobertis , EMF DeRobertis. (1995).*Cell and Molecular Biology*. 6<sup>th</sup> ed. B.I Waverly.
7. Bernard R Glick, Jack J Pasternak (2010) *Molecular Biotechnology. Principles and Applications of recombinant DNA*. 4<sup>th</sup> ed.
8. Sandy B Primrose , Richard Twyman (2009) *Principles of Gene Manipulation and Genomics*. 7<sup>th</sup> ed. John Wiley & Sons.
9. Terry A Brown. (2010) *Gene Cloning and DNA Analysis: An Introduction*. 6<sup>th</sup> ed. John Wiley & Sons.
10. Benjamin Lewin, Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick (2009) *Lewin's Genes X*. 10<sup>th</sup> ed. Jones and Bartlett Publishers International, London.
11. James D Watson. (2008) *Molecular biology of the Gene*. 6<sup>th</sup> ed. Pearson/ Benjamin Cummings.
12. Harvey F Lodish. (2004) *Molecular Cell Biology*. 5<sup>th</sup> ed. W.H Freeman.

## **MB2PG08 - METABOLISM AND ENZYMOLOGY**

**Number of Hours / Week: 3**

**Credits: 3**

### **UNIT 1**

**Metabolism of carbohydrates:** Glycolytic pathway, substrate level phosphorylation, significance of the mitochondrial respiratory chain and oxidative phosphorylation, Electron transport chain: structural components of the chain, complexes, free elements; Generation of the electrochemical proton gradient: Chemiosmosis ATP synthesis: structural and functional properties of ATP synthesis; Inhibitor agents and decoupling agents of the respiratory chain and ATP synthesis; Regulation of glycolytic pathway, Entner Doudoroff pathway, Gluconeogenesis and Glycogenesis. Synthesis of bacterial peptidoglycan, Bacterial photosynthesis- photosynthetic and accessory pigments

### **UNIT II**

**Metabolism of Proteins, lipids and nucleic acids:** Synthesis of amino acids, degradation, deamination, transamination, urea cycle  $\beta$  oxidation, synthesis of fatty acids, FAS, synthesis of cholesterol, degradation of cholesterol. Synthesis of bacterial LPS, Synthesis of purines and pyrimidines, salvage pathway, degradation regulation of pathways, Fermentation

### **UNIT III**

**Enzymes and Enzyme kinetics :** Holoenzyme, apoenzyme, and prosthetic group; Interaction between enzyme and substrate- Features of active site, activation energy, Rate Enhancement Through Transition State Stabilization, Enzyme specificity and types; Enzyme Commission system of classification and nomenclature of enzymes, Ribozymes, Abzymes. Coenzymes and their functions - NAD, NADP<sup>+</sup>, FAD, FMN, lipoic acid, TPP, pyridoxal phosphate, biotin and cyanocobalamin measurement and expression of enzyme activity, enzyme assays. Definition of IU, katal, enzyme turnover number and specific activity, Isolation of enzymes and the criteria of purity; Characterization of enzymes

Order of reaction, study of the factors affecting the velocity of enzyme catalyzed reaction- Derivation of Michaelis -Menten equation and Km value determination and its significance, Definition of V<sub>max</sub> value of enzyme and its significance, Lineweaver- Burk plot; Bi-substrate reactions: Classification, Reaction mechanisms; Using the King—Altman Method to Determine Velocity Equations; Allosteric enzymes: Examples, Effects of Co-operativity on Velocity Curves, Sigmoidal Kinetics for Nonallosteric Enzymes

### **UNIT IV**

**Enzyme inhibition and regulation:** Reversible and irreversible – examples. Reversible-competitive, noncompetitive and uncompetitive inhibition; Graphic Determination of Inhibitor Type; Dose—Response Curves of Enzyme Inhibition; Mutually Exclusive Binding of Two Inhibitors; Structure—Activity Relationships and Inhibitor Design; Tight Binding Inhibitors: Identifying Tight Binding Inhibition, examples; Time-Dependent Inhibition: examples; Distinguishing between modes of inhibitor interaction with enzyme  
Covalently modulated enzymes with examples of adenylation and phosphorylation; Zymogen form of enzyme and zymogen activation; Multienzyme complexes and their role in regulation of metabolic pathways; Allosteric regulation: example Aspartate transcarbamoylase, Isoenzymes-Lactate dehydrogenase and creatine phosphokinase

## UNIT V

**Application of enzymes:** Immobilisation of enzymes, Industrial uses of enzymes: production of glucose from starch, cellulose and dextrans, use of lactase in dairy industry, production of glucose fructose syrup from sucrose, use of proteases in food, leather and detergent industry. Diagnostic and therapeutic enzymes

## Reference

1. Fundamentals of Enzymology: The Cell and Molecular Biology of Catalytic Proteins by Nicholas C. Price, Lewis Stevens, and Lewis Stevens (2000) Publisher: Oxford University Press, USA ISBN: 019850229X ISBN-13: 9780198502296, 978-0198502296
2. Enzyme Kinetics: A Modern Approach Book: Enzyme Kinetics: A Modern Approach by Alejandro G. Marangoni (2003) Publisher: Wiley-Interscience ISBN: 0471159859 ISBN-13: 9780471159858, 978-0471159858
3. Enzyme Kinetics and Mechanisms by Taylor Publisher: Spring ISBN: 8184890478 ISBN-13: 9788184890471, 978-8184890471
4. Enzyme Mechanism by P.K. Shivraj Kumar (2007) Publisher: RBSA Publishers ISBN: 8176114235 ISBN-13: 9788176114233, 978-8176114233
5. Enzymes and Enzyme Technology by Kumar (2009) Anshan Pub ISBN: 1905740875, ISBN-13: 9781905740871, 978-1905740871
6. Enzymes in Industry: Production And Applications by Aehle W (2007) Publisher: John Wiley & Sons Inc ISBN: 3527316892 ISBN-13: 9783527316892, 978-3527316892
7. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry (second Edition) by Trevor Palmer, Philip Bonner (2007) Publisher: Horwood Publishing Limited ISBN: 1904275273 ISBN-13: 9781904275275, 978-1904275275
8. Lehninger Principles of Biochemistry, Fourth Edition by David L. Nelson Michael M. Cox Publisher: W. H. Freeman; Fourth Edition edition (April 23, 2004) ISBN-10: 0716743396 ISBN-13: 978-0716743392
19. E.S. West, W.R. Todd, H.S. Mason and J.T. van Bruggen, A Text Book of Biochemistry, Oxford and IBH Publishing Co., New Delhi, 1974

20. Biochemistry [with Cdrom] (2004) by Donald Voet, Judith G. Voet Publisher: John Wiley & Sons Inc ISBN: 047119350X ISBN-13: 9780471193500, 978-0471193500
21. Principles Of Biochemistry (1995) by Geoffrey L Zubay, William W Parson, Dennis E Vance Publisher: Mcgraw-hill Book Company – Koga ISBN:0697142752 ISBN-13: 9780697142757, 978-0697142757
22. Principles Of Biochemistry, 4/e (2006) by Robert Horton H , Laurence A Moran, Gray Scrimgeour K Publisher: Pearsarson ISBN: 0131977369, ISBN-13:9780131977365, 978-0131977365
23. Biochemistry 6th Edition (2007) by Jeremy M.berg John L.tymoczko Lubert Stryer Publisher: B.i.publicationsPvt.Ltd ISBN:071676766X ISBN-13: 9780716767664, 978-716767664
24. Biochemistry (2008) by Rastogi Publisher: Mcgraw Hill ISBN:0070527954 ISBN-13: 9780070527959, 978-0070527959

## **MB2PGP2 - LABORATORY COURSE-II**

**Credits: 4**

**(Microbiology, Immunology, Molecular Biology and Genetic Engineering)**

### **MICROBIOLOGY AND IMMUNOLOGY**

- Microscopic examination of bacteria in living conditions
- Testing of motility
- Staining procedures- Gram's, Volutin, Spore, Capsule, Negative, Acid Fast, Fungal staining etc.
- Cultivation of bacteria and fungi
- Sterilization methods
- Study of cultural characteristics and biochemical reaction of bacteria
- Testing of disinfectants
- Bacterial growth curve
- Antibiotic sensitivity tests- disc diffusion, MIC
- Sterility testing of solution, vaccines, drugs and surgical methods
- Raising of immune sera
- Serological tests for the diagnosis of microbial infections
- Agglutination and precipitation tests
- Immunodiffusion in gel
- ELISA

### **MOLECULAR BIOLOGY AND GENETIC ENGINEERING**

- PAGE- Protein separation
- DNA and RNA isolation from different sources
- Agarose gel electrophoresis of nucleic acids
- Estimation of DNA and RNA
- Polymerase Chain Reaction

- Restriction enzyme digestion
- Ligation, Bacterial transformation and blue white screening
- Expression and purification of recombinant proteins
- Comparison of microbial genome size
- Online sequence analysis, BLAST
- Phylogenetic analysis

## References

1. Cheesbrough M (2006) *District Laboratory Practice in Tropical Countries. Vol.2* Cambridge University Press. 2<sup>nd</sup> ed.
2. Collee JG & Mackie TJ (1996) *Mackie and McCartney Practical Medical Microbiology* .Churchill Livingstone, Edinburgh. 14<sup>th</sup> ed
3. Gradwohl RBH, Sonnenwirth AC, & Jarett L (1980) *Gradwohl's Clinical Laboratory Methods and Diagnosis* .Mosby, St Louis, Mo. ; London. 8<sup>th</sup> ed
4. Dubey RC & Maheshwari DK (2002) *Practical Microbiology* (S. Chand & Company Limited
5. Aneja KR (2003) *Experiments In Microbiology, Plant Pathology And Biotechnology*. New Age International.
6. Sambrook J. and Russell D. 2001. *Molecular Cloning: A Laboratory Manual*, 3rd edition. Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.
7. Sambrook J., Fritsch E.F., and Maniatis T. 1989. *Molecular Cloning: A Laboratory Manual*, 2nd edition. Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.

# **SYLLABUS**

## **Third Semester M.Sc. Microbiology**

## **MB3PG09 - FOOD AND INDUSTRIAL MICROBIOLOGY**

**Number of Hours / Week: 4**

**Credits: 4**

### **UNIT I**

Incidence and type of microorganisms in food and milk. Contamination and Spoilage of food and milk, Principles of food preservations. Analysis of microbial quality of food and milk. Preservation and preparation of milk products. Fermented food products and beverages.

### **UNIT II**

LAB-- homo and heterolactic fermentations. Single cell protein, Production of edible mushroom, Enzymes in food industry, Nutraceuticals and its applications. Quality assurance: Microbiological quality standards of food. HACCP, ISI. Food poisoning – Food borne diseases, Newer pathogens and emerging foodborne diseases. GMOs, IPR.

### **UNIT III**

Introduction to microbes in industrial processes. Isolation and screening of industrially useful microorganisms, Primary and secondary screening, Strain improvement in industrial microbiology; improvement of characters other than product yield.

### **UNIT IV**

Design of a fermentor, instrumentation and process control; Types of fermentors. Types of fermentations: aerobic and anaerobic; Submerged and Solid State; Importance of media in fermentation, media formulation and modification. Kinetics of growth in batch, continuous, fed-batch fermentation, Fermentation process: Inoculum development- scaling up of process form shake flask to industrial fermentation etc. Storage of cultures for repeated fermentations, Screening, detection and assay of fermentation products (physical, chemical and biological assay). Downstream processing.

### **UNIT V**

Microbes in the production (microbial strains, substrate, flow diagrams, product optimization, and applications) of the following: Industrial alcohol; organic acids, amino acids, alkaloids, enzymes and immobilized enzymes; Vitamins; antibiotics, recombinant products. Microbial transformations of steroids and steriols, nonsteriod compound; Recombinant DNA products- insulin, somatostatin, interferon. Immobilisation of microbial cells

### **References**

1. Casida LE (1968) *Industrial microbiology* (Wiley, New York ; London).
2. Doyle MP, Beuchat LR, & Montville TJ (2001) *Food microbiology : fundamentals and frontiers* (ASM Press, Washington, D.C.) 2<sup>nd</sup> ed.



3. Frazier WC & Westhoff DC (2004) *Food Microbiology* (Tata McGraw Hills Publishing Company Limited)
4. Rose AH (1983) *Food microbiology* (Academic Press, London)
5. Garbutt JH (1997) *Essentials of food microbiology* (Arnold, London)
6. Wood BJB (1998) *Microbiology of fermented foods* (Blackie Academic & Professional, London) 2<sup>nd</sup> ed.
7. Ayres JC, Mundt JO, & Sandine WE (1980) *Microbiology of foods* (Freeman, San Francisco)
8. Robinson RK (1990) *Dairy microbiology* (Elsevier Science Pub. Co., London ; New York) 2<sup>nd</sup> Ed
9. Casida LE (1964) *Industrial Microbiology* (Wiley, New York)
10. Prescott SC, Dunn CG, & Reed G (1982) *Prescott & Dunn's industrial microbiology* (AVI Pub. Co., Westport, Conn.) 4<sup>th</sup> Ed
11. Waites MJ (2001) *Industrial microbiology* (Blackwell Science, Oxford)
12. McNeil BE & Harvey LME (1990) *Fermentation : a practical approach* (IRL Press at Oxford University Press)
13. Enfors SO, Häggström L, & Technology RIo (2000) *Bioprocess Technology: Fundamentals and Applications* (Royal Institute of Technology)
14. Atkinson B (1974) *Biochemical reactors* (Pion, London)
15. Chand S, Jain SC, Association AIB, & Biotechnology IDo (1999) *Fermentation Biotechnology - Industrial Perspectives: Proceedings of the Symposium on Biotech Industry - a Challenge for 2005 A.D. : with Special Reference to Fermentations [New Delhi]* (All India Biotech Association & Dept. of Biotechnology)
16. Biotechnology. (1983) Volume 3. Edited by H. J. Rehm and G. Reed. Verlag Chemie.
17. Crueger W, Crueger A, & Brock TD (1990) *Biotechnology: a textbook of industrial microbiology* (Sinauer Associates)
18. Demain AL & Davies J (1999) *Manual of industrial microbiology and biotechnology*. editors in chief, Arnold L. Demain, Julian E. Davies / editors, Ronald M. Atlas (ASM Press, Washington, D.C.) 2<sup>nd</sup> ed.

## **MB3PG10 - ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY**

**Number of Hours / Week: 4**

**Credits: 4**

### **UNIT I**

Aerobiology- -Microbial contamination of air – Sources of contamination- Microbial indicators of air pollution. Enumeration of bacteria in air, Air sampling devices. Air sanitation.Effect of Air Pollution on plants and Human.

### **UNIT II**

Aquatic microbiology: Microbiology of water – Water pollution and water borne pathogens – Bacteriological examination of water – Indicator organisms. Purification and disinfection of water Microbiology of sewage – Waste water treatment – BOD, COD. Role of microbes in marine fouling

### **UNIT III**

Microbial flora of soil and factors affecting them, Bio geochemical cycling – Nitrogen, Carbon, Phosphorus, Sulphur cycles and its importance.

### **UNIT IV**

Microbial interaction – Plant-microbe, microbe-microbe interactions. Mycorrhizae, Biological Nitrogen fixers-Symbiotic and free living nitrogen fixers- physiology and genetics of nitrogen fixers, Phosphate solubilizers, Phytopathogens – Bacterial , fungal, Viral diseases. (Wilt, Blight, Canker, Mosaic etc.) – Control measures. Biofertilizers, Microbial control of pests and diseases. Integrated pest management. GM crops and its importance.

### **UNIT V**

Recycling of liquid and solid wastes – Composting – Biogas – Biodegradation. Bioremediation, Bioleaching, Xenobiotic degradation. Microbial corrosion- Biofilms degradation of petroleum products. Microbes in mineral leaching and metal concentration, Microbial enhanced oil recovery

### **References:**

1. Mitchell R (1974) *Introduction to environmental microbiology* (Prentice-Hall, Englewood Cliffs, N.J.,)
2. Atlas RM & Bartha R (1998) *Microbial ecology : fundamentals and applications* (Benjamin/Cummings, Menlo Park, Calif. ; Harlow) 4<sup>th</sup> ed.
3. Campbell RE (1983) *Microbial ecology* (Blackwell Scientific Publications, Oxford ; Boston) 2<sup>nd</sup> ed
4. Rheinheimer G (1991) *Aquatic microbiology* (John Wiley and Sons) 4<sup>th</sup> ed

5. Dart RK (1980) *Microbiological aspects of pollution control* (Elsevier Scientific, Amsterdam) 2<sup>nd</sup> ed.
6. Alexander M (1977) *Introduction to soil microbiology* (Wiley, New York ; London) 2<sup>nd</sup> ed.
7. Rao NSS (1995) *Soil microorganisms and plant growth* (Science Publishers, Inc.; New Hampshire, U.S.A) 3<sup>rd</sup> ed.

## **MBPGE1 - MICROBIAL DIVERSITY AND EXTREMOPHILES**

**Number of Hours / Week: 4**

**Credits: 4**

### **UNIT I**

**Biodiversity:** Introduction to Microbial biodiversity – distribution, abundance, ecological niche. Types- Bacterial, Archaeal and Eucaryal. Molecular techniques for studying microbial biodiversity- use of DNA probes, markers, Expressed sequence tagging (EST), Denatured Gradient Gel electrophoresis, RFLP, RAPD, MALDI-TOFF, Fluorescent in situ hybridization (FISH) Conservation of marine Bio resources, Metagenomics etc.

### **UNIT II**

**Characteristics and classification of Archaeobacteria:** Psychrophiles; Thermophiles: Classification, habitats and ecological aspects. Extremely Thermophilic Archaeobacteria, Applications of thermozymes and psychrophilic archaeal extremozymes; Methanogens: Classification, Habitats and applications.

### **UNIT III**

**Alkalophiles and Acidophiles:** Classification , alkaline environment , soda lakes and deserts , calcium alkalophily Applications .Acidophiles: Classification, life at low pH, acidotolerance, applications.

### **UNIT IV**

**Halophiles and Barophiles:** Classification, Dead Sea, discovery basin, cell walls and membranes – Purple membrane, compatible solutes. Osmoadaptation / halotolerance. Applications of halophiles and their extremozymes. Barophiles: Classification, high-pressure habitats, life under pressure, barophily, death under pressure.

### **UNIT V**

**Space Microbiology:** Aims and objectives of Space research. Life detection methods a] Evidence of metabolism (Gulliver) b] Evidence of photosynthesis (autotrophic and heterotrophic) c] ATP production d] Phosphate uptake e] Sulphur uptake . Monitoring of astronauts microbial flora:

### **Reference**

1. *Extremophiles* by Johri B.N. 2000. Springer Verlag. , New York
2. *Microbial Diversity* by Colwell, D. 1999, Academic Press.

3. *Microbial Life in Extreme Environments*. Edited by D. J. Kushner. Academic Press.
4. *Microbiology of Extreme Environments*. Edited by Clive Edward. Open University Press. Milton Keynes.
5. *Microbiology of Extreme Environments and its potential for Biotechnology*. Edited by M.S. Da Costa, J.C. Duarate, R.A. D. Williams. Elsevier Applied Science, London.
6. *Extreme Environment. Mechanism of Microbial Adaptation*. Edited by Milton R. Heinrich. Academic Press.
7. *Thermophiles. General, Molecular and Applied Microbiology*. Edited by Thomas D. Brock. Wiley Interscience Publication.
8. *Microbiology: Dynamics and Diversity* by Perry.
9. *Microbial Ecology. Fundamentals and Applications* by. Ronald M. Atlas and Richard Bartha. 2nd and 4th Edition. The Benjamin Cummins Publication Co. Inc.
10. *Microbial Ecology*. 2nd Edition. by R. Campbell. Blackwell Scientific Publication.
11. *Brocks Biology of Microorganisms*. 8th Edition. (International Edition - 1997) by Michael T. Madigan, John M. Martinko. Jack Parker. Prentice Hall International Inc.
12. *Advances in Applied Microbiology*. Vol. 10. Edited by Wayne W. Umbreit and D. Pearlman. Academic Press.

## MBPGE2-MARINE MICROBIOLOGY

Number of Hours / Week: 4

Credits: 4

### UNIT I

**Marine Microbial flora:** Marine environment – sea-benthic & littoral zone, salt pan, mangroves and estuarine microbes, microbial loop – marine microbial community – planktons, bacteria, fungi, protozoa Methods of collection and estimation of marine microbes. Influence of physical, chemical and biological factors on marine microbes.

### UNIT II

**Marine Adaptability:** Survival at extreme environments – starvation – adaptive mechanisms in thermophilic, alkalophilic, osmophilic and barophilic, psychrophilic microorganisms – hyperthermophiles and halophiles

### UNIT III

**Marine Microbial Disease:** Marine food borne pathogens & Water borne pathogens – *Aeromonas, Vibrio, Salmonella, Pseudomonas, etc.*

### UNIT IV

**Marine Pollution:** Microbial indicators of marine pollution and control-, biofouling, biocorrosion, biofilms and bioremediation

### UNIT V

**Marine Microbial Biotechnology:** Marine natural products, valuable chemicals, bioactive compounds from marine microorganisms, marine bio-sensor and transgenic marine organisms. Biosurfactants, biopolymers and novel enzymes from marine organisms.

### References:

1. Prescott LM, Harley JP, & Klein DA (2005) *Microbiology* (McGraw-Hill, Boston ; London) 6<sup>th</sup> ed
2. Maier RM, Pepper IL, & Gerba CP (2009) *Environmental Microbiology* (Elsevier Academic Press)
3. Nybakken JW & Bertness MD (2005) *Marine biology: an ecological approach* (Pearson/Benjamin Cummings)
4. Belkin S & Colwell RR (2006) *Oceans And Health: Pathogens In The Marine Environment* (Springer Science+Business Media)
5. Gal YL, Ulber R, & Antranikian G (2005) *Advances in Biochemical Engineering/Biotechnology Advances in Biochemical Engineering / Biotechnology Series Vol 96. Marine Biotechnology Vol 1* Series Editor: Scheper, T
6. Bhakuni DS & Rawat DS (2005) *Bioactive Marine Natural Products* (Springer)

## **MBPGE3 - ENVIRONMENTAL SCIENCE**

**Number of Hours / Week: 4**

**Credits: 4**

### **UNIT I**

Definition, principles and scope of environmental science. Earth, Man and environment, ecosystem, pathways in ecosystem . Physico-Chemical and Biological factors in the environment. Geographical classification and Zones. Structure and functions of ecosystem- Abiotic and biotic components, Energy flows, Food chains, Food web, Ecological pyramids: types and diversity. Terrestrial (Forest, grass land) and Aquatic (Fresh water, marine, eustarine) ecosystems. Mineral cycling. Habitat and niche. Major terrestrial biomes. Impact of microorganisms on global ecology, Microorganisms in extreme environment.

### **UNIT II**

Definition , Principles and scope of ecology. Human ecology and Human settlement. Evolution, origin of life and speciation. Population ecology: characteristics and regulation. Community ecology: structure and attributes. Levels of species diversity and its management, Edges and Ecotones. Ecological succession. Common flora and fauna in India. Endangered and Threatened Species.

### **UNIT III**

Biodiversity status: monitoring and documentation. Biodiversity management approaches. Conservation of biological diversity, methods and strategies for conservation. Natural resources, conservation and sustainable development. Hotspots of biodiversity, National parks and Sanctuaries.

### **UNIT IV**

Environmental pollution- Air: Natural and anthropogenic source of pollution, Primary and Secondary pollutants , Methods of monitoring and control of air pollution, Effects of pollutants on human beings, plants, animals, material and on climate, Acid rain, Air Quality standards. Water: Types, Sources and consequences of water pollution, Physio-chemical and Bacteriological sampling and analysis of water quality, Soil: Physio-chemical and Bacteriological sampling as analysis of soil quality, Soil pollution- Control, Industrial waste effluents, and heavy metals. Their interaction with soil components, Noise: Sources of noise pollution, Noise control and battement measures. Impact of noise on human health. Radioactive and thermal Pollution. Bioremediation- Strategies for bioremediation, Biosensors, biological indicators of pollution and monitoring, Detoxification of hazardous chemicals, mycotoxins. Biological weapons.

## UNIT V

Introduction to environmental impact analysis, Impact Assessment Methodologies, Generalized approach to impact analysis ,Guidelines for Environmental Audit, Introduction to environmental Planning, Environmental priorities in India and Sustainable development, Environment protection- issues and problems, International and national efforts for environment protection. Global environmental problems- Ozone depletion, global warming, climatic change, desertification, green movement, ecofeminism. Current environmental issues in India

### References:

1. Chapman JL & Reiss MJ (1999) *Ecology : principles and applications* (Cambridge University Press, Cambridge) 2<sup>nd</sup> ed.
2. Jones A (1997) *Environmental biology* (Routledge, London)
3. Odum EP & Barrett GW (2005) *Fundamentals of ecology* (Thomson Brooks/Cole, Belmont, CA) 5<sup>th</sup> Ed
4. Odum EP (1983) *Basic ecology* (Saunders College, Philadelphia, [Pa.] ; London
5. Kumar A (2004) *A Textbook of Environmental Science* (APH Publishing Corporation)
6. Allaby M (2000) *Basics of Environmental Science* (Routledge)
7. Cunningham WP, Cunningham MA, & Saigo BW (2003) *Environmental science : a global concern* (McGraw-Hill, Boston ; London) 7<sup>th</sup> ed
8. Pickering KT & Owen LA (1997) *An introduction to global environmental issues* (Routledge, London) 2<sup>nd</sup> ed.



## **MBPGE4- MOLECULAR MICROBIOLOGY**

**Number of Hours / Week: 4**

**Credits: 4**

### **UNIT 1**

Phylogenetic overview of bacteria and archaea, Molecular biology of microbial evolution, rRNA sequence and cellular evolution, Signature sequences and phylogenetic probe. Identification and characterization of microorganisms. Molecular typing methods: Bacterial strain typing, Pulsed Field Gel Electrophoresis, PCR-based microbial typing, Genotyping by Variable Number Tandem Repeats, Multilocus Sequence Typing, Automated Ribotyping, Molecular subtyping for epidemiology.

### **UNIT II**

Genome wide approach to study prokaryotic biology, Microbial genome – comparison of genome size, Insight from genome of *E.coli*, *Streptomyces coelicolor* and *Neurospora crassa*. Unculturable bacteria and Metagenomics. Bacterial differentiation and molecular basis of endospore formation, Microbial stress response, Microbes in special habitat: Bacterial biofilm, molecular basis of biofilm development, biofilm dispersal strategies, biofilm in infection, quorum sensing. Extremophiles, molecular adaptation to extreme environment. Endophytes – metabolite diversity.

### **UNIT III**

Molecular basis of microbial virulence. Bacterial adherence: basic principles, effects of adhesion on bacteria and host cells. Bacterial invasion of host cells; mechanism. Bacterial toxins: classification based on molecular features, Identification of novel toxins by genome mining, Application of bacterial toxin in cell biology and pharmacology. Microbial induction of apoptosis. Molecular and visual clinical diagnosis methods. Molecular detection and characterization of bacterial pathogens, detection of bioterrorism. Laboratory controls and standards in molecular diagnostics.

### **UNIT IV**

Microbial production of recombinant proteins : expression, purification and applications, Microbes in plant transformation, *Agrobacterium tumefaciens* T-DNA transfer process, Manipulation of *Agrobacterium* for genetic engineering, vectors for *Agrobacterium* mediated transformation, Microbial production of plant metabolites; engineering *E.coli* for the production

of curcumin. Combinatorial and engineered biosynthesis, Microbial polketides and their applications.

**References:**

1. Persing DH (2011) *Molecular microbiology : diagnostic principles and practice* (ASM Press, Washington, DC) 2<sup>nd</sup> ed
2. Madigan MT, Martinko JM (2006) *Brock biology of microorganisms* (Pearson Prentice Hall, Upper Saddle River, NJ ; London) 11<sup>th</sup> ed.
3. Moat AG, Foster JW, & Spector MP (2002) *Microbial physiology* (Wiley-Liss, New York ; [Chichester]) 4<sup>th</sup> ed

## **MBPGE5 - NANOBIO TECHNOLOGY**

**Number of Hours / Week: 4**

**Credits: 4**

### **UNIT I**

History – bionanotechnology – concept and future prospects – application in Life Sciences. Terminologies – nanotechnology, bionanotechnology, biogenic nanoparticles, nanomedicine, nanowires, quantum Dots, nanocomposite, nanoparticles.

### **UNIT II**

Molecular nanotechnology – nanomachines – collagen. Uses of nanoparticles – cancer therapy – manipulation of cell and biomolecules. Cytoskeleton and cell organelles. Types of nanoparticles production – physical, chemical and biological. Biosynthesis of nanoparticles by various groups of microorganisms, Microorganisms synthesizing silver nanoparticles, Mechanism involved in silver nanoparticles biosynthesis, Process design for industrial scale synthesis of nanoparticles,

### **UNIT III**

Nanoparticles – types, functions – Silver, Gold and Titanium. Physical and chemical properties of nanoparticles. Interaction of nanoparticles with biomolecules, Characterization of nanoparticles – UV-Vis spectroscopy, Electron Microscopy – HRTEM, SEM, AFM, EDS, XRD, F-IR and DLS.

### **UNIT IV**

Uses of nanoparticles in biology : Drug delivery – protein mediated and nanoparticle mediated. Uses of nanoparticles in MRI, DNA and Protein Microarrays. Nanotechnology and nanoparticles in health sectors. Toxicology in nanoparticles – Dosimetry.

### **UNIT V**

Advantages of nanoparticles – drug targeting, protein detection, MRI, development of green chemistry – commercial viability of nanoparticles. Disadvantages – health risk associated with nanoparticles, inadequate knowledge on nanoparticles research.

### **References:**

1. Parthasarathy, B.K. (2007). *Introduction to Nanotechnology*, Isha Books.
2. Elisabeth Papazoglou and Aravind Parthasarathy (2007). *Bionanotechnology. Volume 7 of Synthesis Lectures on Biomedical Engineering*. Morgan & Claypool Publishers.
3. Bernd Rehm (Ed) (2006). *Microbial Bionanotechnology: Biological Self-assembly Systems and Biopolymer-based Nanostructures*. Horizon Bioscience.
4. David E. Reisner, Joseph D. Bronzino (2009). *Bionanotechnology: Global prospects*. CRC Press.

5. Ehud Gazit (2007). *Plenty of Room for Biology at the Bottom: An Introduction to Bionanotechnology*. Imperial College Press, London

## **MBPGE6 - MICROBIAL QUALITY ASSURANCE, BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS**

**Number of Hours / Week: 4**

**Credits: 4**

### **UNIT I**

**Bioethics:** Principles of Bioethics; Belmont Report on protection of human beings on biomedical and behavioral research: respect for persons, beneficence, justice, etc.; Bioethic committees; professional ethics- medical, euthanasia; Public perception of process of biotechnology involved in generation new forms of life; example: ethical issues related to creations of Dolly and on reproductive cloning- Human Fertilization and Embryology Act & Cloning Prohibition Bill 1997; ethical concerns of biotechnological research and innovations.

### **UNIT II**

**Biosafety and Genetically Modified Organisms:** Guidelines on biosafety in conducting research in biology / biotechnology; ethics in use of animals for scientific research; ethical clearance norms for conducting studies on human subjects; Biosafety regulatory framework for GMOs at international level: Cartagena protocol on Biosafety; Advanced Information Agreement (AIA) procedure - procedures for GMOs intended for direct use, risk assessment, handling, transport, packaging and identification of GMOs; Different levels of regulatory framework in India governing research in GMOs; National Environment Policy. Biosafety guidelines, Requirements and procedures for recombinant DNA: Registration, review and approval of rDNA research. IBSC, RCGM and GEAC for GMO applications in food and agriculture

### **UNIT III**

**Food safety and Quality assurance:** Food safety- issues and factors affecting. Shelf life of Food Products- factors affecting shelf life and methods to check the shelf life. Food laws and regulations- National food legislation/ authorities and their role, product certifications (ISI mark of BIS), international organization and agreements-food and agricultural organization (FAO), world health organization(WHO), codex alimentarius, codex India, world international organization for standardization(ISO) Food safety and quality management systems: general principle of food safety, risk management, hazard analysis critical control point system (HACCP), quality management system, Food Packaging: Need, material used and labeling.

### **UNIT IV**

**IPR:** Types of IP: Patents, Trademarks, Copyright & Related Rights GATT and IPR, IPR in India, WTO Act, Convention on Biodiversity (CBD), patent Co-operation Treaty (PCT), Procedure for filing a PCT application, forms of patents and patentability, The patentability of microorganisms, process of patenting, process and product patenting, Indian and international agencies involved in IPR & patenting, Global scenario of patents and India's position, patenting

of biological material, GLP, GMP. Patent databases, Patent infringement. Patent law for Protection of traditional knowledge; Geographical Indicators

### References:

1. Frederic H. Erbisch, Karim M. Maredia (2004). *Intellectual Property Rights in Agricultural Biotechnology*, CABI Publisher.
2. Mittal D.P. (1999). *Indian Patents Law*. Taxmann Allied Services (p) Ltd.
3. Christian Lenk, Nils Hoppe, Roberto Andorno (2007). *Ethics and Law of Intellectual Property: Current Problems in Politics, Science and Technology*, Ashgate Publisher (p) Ltd.
4. Felix Thiele, Richard E. Ashcroft (2005). *Bioethics in a Small World*. Springer.
5. John Bryant (2002) *Bioethics for Scientists*. John Wiley and Sons Publisher
6. World Health Organization, Geneva (2004) *Laboratory Biosafety Manual*, 3<sup>rd</sup> Edition (Revised)
7. Diane O. Fleming. (2006); *Biological safety: Principles and Practices*, 4<sup>th</sup> edition. ASM Press
8. Beier, F.K., Crespi, R.S. and Straus, T. (1985) *Biotechnology And Patent Protection-An International Review*. Oxford and IBH Publishing Co. New Delhi
9. Sasson A. (1988) *Biotechnologies and Development*, UNESCO Publications
10. Singh K (1993) *Intellectual Property rights on Biotechnology- A status report*. BCIL, New Delhi
11. *Regulatory Framework for GMOs in India* (2006) Ministry of Environment and Forest, Government of India, New Delhi
12. *Cartagena Protocol on Biosafety* (2006) Ministry of Environment and Forest, Government of India, New Delhi
13. Birch, G. and Campbell-Platt, G. (Eds.). (1993) *Food Safety - the Challenge Ahead*. Intercept Ltd., Andover, England
14. Finley, J., Robinson, S. and Armstrong, D. (Eds.). 1992. *Food Safety Assessment*. Vol. 484 of ACS symposium series. American Chemical Society, Washington D.C
15. Jones, J. (1992). *Food Safety*. 2<sup>nd</sup> ed. Eagen Press, St. Paul Minnesota
16. Sohrab.(2001) *A Practical Guide For Implementation Of Integrated ISO 9001 HACCP System For Food Processing Industries*. Allied Publishers.
17. Bhatnagar, D. and Cleveland, T. (Eds.). (1992). *Molecular Approaches to Improving Food Quality and Safety*. Van Nostrand Reinhold, New York
18. Hubbert. W and Hagstad, H. (1996). *Food Safety & Quality Assurance*. 2<sup>nd</sup> ed. Iowa State University Press, Ames, Iowa
19. Roberts, H. (Ed.). (1981). *Food Safety*. John Wiley & Sons, New York
20. Krammer, A. and Twigg, B.A. (1970). *Quality control for the food industry*. 3<sup>rd</sup> Ed., Avi Pub Co., Westport.

## **MB3PGP3 - LABORATORY COURSE III**

### **Credit 4**

**(Agricultural, Food, Industrial and Environmental Microbiology)**

#### **Agricultural and Environmental Microbiology**

- Isolation and Study of common soil bacteria, fungi and actinomycetes
- Enumeration of soil microbes by plate culture methods
- Study of antagonistic activities among soil microbes
- Estimation of rhizosphere microbial population and calculation of R:S ratio
- Isolation of non-symbiotic nitrogen fixing bacteria
- Isolation of *Rhizobium* from nodules of leguminous plants
- Study of common plant pathogens
- Isolation of phosphate solubilizing microorganisms
- Isolation of mycorrhizal spores and its identification
- Azolla cultivation
- Bacteriological examination of air
- Bacteriological examination of water- SPC, Presumptive, Confirmed and Complete test etc.
- Determination of BOD, DO & COD

#### **Food and Industrial Microbiology**

- Bacteriological examination of food- vegetables, meat products, traditional foods etc
- Bacteriological analysis of milk, standard plate count, presumptive test for coliforms, methylene blue reduction test and phosphatase test.
- Cultivation of edible mushrooms.
- Crowded plate technique for screening of industrially important microorganisms- microbes producing enzymes, antibiotics etc.
- Production of ethyl alcohol, Alcoholimetry
- Production of wine
- Production of citric acid
- Solid state and submerged fermentation

References

1. Practical Microbiology (2002) Dubey R.C.and Mahaswari D.K. S.Chand & Company Ltd. New Delhi.
2. Experiments in Microbiology, Plant pathology and Biotechnology. (1996) K.R.Aneja, New Age International (P) Limited, New Delhi. 2<sup>nd</sup> ed.

# **SYLLABUS**

## **Fourth Semester M.Sc. Microbiology**

## **MB4PG11- SYSTEMATIC BACTERIOLOGY**

**Number of Hours / Week: 3**

**Credits: 3**

### **UNIT I**

Molecular taxonomy – G +C content, DNA – DNA hybridization, Plasmid profiles etc. DNA finger printing methods RFLP, RAPD, STRR & LTRR, REP, ERIC –PCR, rRNA. Types of rRNA - 23s rRNA, 16S rRNA & 5S rRNA. Importance of 16SrRNA in microbial identification and taxonomy. Introduction to Molecular phylogeny – tree terminology, software programs for making phylogenetic trees – MEGA, Phylip, RAPDistance. Introduction to Metagenomics

### **UNIT II**

Study of identifying characters- morphological and cultural; pathogenicity; epidemiology and laboratory identification of -Aerobic cocci such as Staphylococci, Streptococci and Neisseriae Anaerobic cocci, Gram positive bacilli. Corynebacterium, Bacillus, Anaerobic rods- Clostridia, Bacteroidaceae etc.

### **UNIT III**

Gram negative bacilli. Enterobacteriaceae- *E.coli*, Proteus, Klebsiella, Shigella Salmonella etc. Pseudomonas. Haemophilus. Pasteurella, Yersinia, Francisella, Bordetella. Brucella. Vibrios.

### **UNIT IV**

Spirochetes. Mycoplasma. Rickettsiae. Chlamydiae. Acid fast bacilli- Mycobacteria- *M.tuberculosis*, *M.leprae*, Non tuberculous mycobacteria. Actinomycetes- Nocardia, Actinomyces, Miscellaneous Bacteria- Listeria, Campylobacter, Helicobacter, Legionella, Acinetobactor etc.

### **References**

1. J.G.Holt, (Ed) Bergey's Manual of Systematic Bacteriology, Vol.1-4 ( 1984-1989) Williams and Wilkins, Baltimore.
2. Greenwood, D., Slack, R.C.B., Peutherer, J.F., and Barer, M.R. (2007). Medical Microbiology : A Guide to Microbial Infections: Pathogenesis, Immunity, Laboratory Diagnosis and Control. Elsevier Health Sciences UK. 17<sup>th</sup> ed
3. Topley, W.W.C., Wilson, G.S., Parker, T., and Collier, L.H. (1990). Topley and Wilson's Principles of Bacteriology, Virology and Immunology (Edward Arnold)
4. Zinsser, H., and Joklik, W.K. (1992). Zinsser microbiology (Lange) 20th ed.



5. Ananthanarayan, R., and Paniker, C.K.J. (2006). Textbook of microbiology(Orient Blackswan) 7<sup>th</sup> ed
6. Mackie, T.J., McCartney, J.E., and Collee, J.G. (1989). Mackie & McCartney practical medical microbiology. Churchill Livingstone, 13<sup>th</sup> ed
7. Jawetz, E., Melnick, J.L., and Adelberg, E.A. (1987). Review of medical microbiology (Appleton & Lange)
8. Talaro, K.P., Cowan, M.K., and Chess, B. (2009). Foundations in Microbiology (McGraw-Hill Higher Education)
9. Page, R.D.M., and Holmes, E.C. (1998). Molecular Evolution: A Phylogenetic Approach (Blackwell Science)
10. Primrose, S.B. (1998). Principles of genome analysis: a guide to mapping and sequencing DNA from different organisms (Blackwell Science) 2<sup>nd</sup> ed.
11. Adolph, K.W. (1996). Microbial Genome Methods (CRC Press)
12. Dunham, I. (2003). Genome Mapping And Sequencing (Horizon Scientific)
13. Brendan Wren (Ed), Nick Dorrell (2002) Functional Microbial Genomics. Volume 33, Methods in Microbiology, Academic Press, UK.
14. Primrose, S.B., and Twyman, R. (2009). Principles of Genome Analysis and Genomics (John Wiley & Sons) 3<sup>rd</sup> ed.

## **MB4PG12- VIROLOGY, MYCOLOGY AND PROTOZOOLOGY**

**Number of Hours / Week: 4**

**Credits: 4**

### **UNIT I**

General properties of viruses. Morphology and structure of viruses, Bacteriophages, viroids, prions . Genetic modification of viruses. Virus multiplication. Cultivation of viruses.

### **UNIT II**

Virus infections. A systematic study of medically important viruses such as Pox, Herpes, Adeno, Entero, Myxo, Arbo, Rhabdo, Hepatitis, Oncogenic and HIV. Miscellaneous viruses. General methods for the laboratory diagnosis of viral diseases. Prophylaxis of virus diseases .Antiviral agents.

### **UNIT III**

General characters of fungi. Classification of fungi, Reproduction in fungi. Methods for the study of fungi. Cultivation of fungi.

### **UNIT IV**

Fungal infections in man. Superficial and deep mycoses. Opportunistic fungal infections & Mycotic poisoning. Common laboratory contaminants. Molds and their association with other organisms.

### **UNIT V**

Protozoa- General features and classification. Medically important protozoans.*Entamoeba histolytica*, *Giardia lamblia*, *Trichomonas*, Trypanosomes, Leishmania, Plasmodium, Toxoplasma and Pneumocystis.

### **References**

1. Molyneux, D.H., and Ashford, R.W. (1983). The biology of Trypanosoma and Leishmania, parasites of man and domestic animals (New York, International Publications Service)
2. Garraway, M.O., and Evans, R.C. (1991). Fungal nutrition and physiology (Malabar, FL, Krieger Pub. Co.).
3. Fields, B.N., Knipe, D.M., and Howley, P.M. (2007). Fields virology, 5th edn (Philadelphia, Wolters Kluwer Health/Lippincott Williams & Wilkins)

4. Fraenkel-Conrat, H., and Wagner, R.R. (1974). Comprehensive virology (New York, Plenum Press).
5. Topley, W.W.C., Wilson, G.S., Parker, T., and Collier, L.H. (1990). Topley and Wilson's Principles of Bacteriology, Virology and Immunology (Edward Arnold)
6. Medical Mycology a practical approach by Evans and Richardson (Ed). IRL Press at Oxford University Press, Oxford.
7. Emmons, C.W. (1977). Medical mycology (Philadelphia, Lea & Febiger) , 3rd ed
8. Rippon, J.W. (1988). Medical mycology : the pathogenic fungi and the pathogenic actinomycetes, (Saunders ,Philadelphia) 3rd ed
9. Chatterjee, K.D. (2009). Parasitology (CBS Publishers & Distributors) 13<sup>th</sup> ed
10. Kucera, L.S., and Myrvik, Q.N. (1985). Fundamentals of medical virology (Lea & Febiger, Philadelphia)2nd ed
11. Beaver, P.C., Jung, R.C., Cupp, E.W., and Craig, C.F. (1984). Clinical parasitology (Lea & Febiger, Philadelphia) 9th ed
12. Desselberger, U. (1995). Medical virology: a practical approach (IRL Press)
13. Ananthanarayan, R., and Paniker, C.K.J. (2006). Textbook of microbiology(Orient Blackswan) 7<sup>th</sup> ed.

## **MBPGE7- CLINICAL MICROBIOLOGY**

**Number of Hours / Week: 4**

**Credits: 4**

### **UNIT I**

Microbiology laboratory safety - Biological Safety Cabinets; Biocontainment, Biosafety Levels; Biosafety guidelines,- biosafety concerns at the level of individuals, institutions; Laboratory and associated infections. Good microbiological practices. Classification of biological agents based on hazards. Mailing of biohazardous materials.

### **UNIT II**

Diagnostic cycle; General concepts for specimen collection, transport and processing. Infection control, Emerging infections; Quality assurance & quality control in microbiology, Accreditation of laboratories; Normal microbial flora of the human body.

### **UNIT III**

Etiology, pathogenesis and laboratory diagnosis of- Blood Stream infections, Respiratory Tract infections, Central Nervous System infections, Gastrointestinal Tract infections, Urinary Tract infections, Genital Tract infections. Sexually transmitted diseases. Nosocomial infections.

### **UNIT IV**

Skin, soft tissue and wound infections. Burn infections. Infections of sinuses, bone and bone marrow. Infections of eye and ear. Pyogenic infections. Infections in immunocompromised and immunodeficient patients. Infections in foetus and neonates.

### **UNIT V**

Serodiagnosis of infectious diseases; Molecular techniques in diagnostic microbiology. Automation in Microbiology; Laboratory control of antimicrobial therapy; Immunoprophylaxis, Immunity in infections.

### **References**

1. Blair, J.E.e., Lennette, E.H.e., and Truant, J.P.e. (1970). Manual of clinical microbiology. American Society for Microbiology, Bethesda, Md.
2. Gradwohl, R.B.H., Sonnenwirth, A.C., and Jarett, L. (1980). Gradwohl's clinical laboratory methods and diagnosis. Mosby, London.8<sup>th</sup> ed

3. Lennette, E.H., Balows, A., Hausler, W.J., and Shadomy, H.J. (1985). Manual of clinical microbiology. American Society for Microbiology, Washington, D.C. 4<sup>th</sup> ed.
4. Topley, W.W.C., Wilson, G.S.S., Parker, T., and Collier, L.H. (1990b). Topley and Wilson's principles of bacteriology, virology and immunology. Edward Arnold, 8<sup>th</sup> ed
5. Mukherjee, K.L. (2010) Medical Laboratory Technology .Tata McGraw-Hill Education. 2<sup>nd</sup> ed.
6. Sood, R. 1999. Medical Laboratory Technology- Methods and Interpretations. Jaypee Brothers Medical Publishers(P) Ltd. New Delhi. 5<sup>th</sup> ed.
7. Cheesbrough, M. (2006). District Laboratory Practice in Tropical Countries. Cambridge University Press. 2<sup>nd</sup> ed.
8. Mackie, T.J., McCartney, J.E., and Collee, J.G. (1989). Mackie & McCartney practical medical microbiology. Churchill Livingstone, 13<sup>th</sup> ed
9. Black, J.G. (1999). Microbiology : principles and explorations. Prentice Hall International ,London. 4<sup>th</sup> ed.
10. Kindt, T.J., Goldsby, R.A., Osborne, B.A., and Kuby, J. (2006). Kuby immunology. W.H. Freeman, New York. 6<sup>th</sup> ed.
11. Forbes, B.A., Sahm, D.F., Weissfeld, A.S., and Bailey, W.R.D.m. (2007). Bailey & Scott's diagnostic microbiology. Elsevier, Mosby, London. 12<sup>th</sup> ed

## **MBPGE8- MICROBIAL GENETICS**

**Number of Hours / Week: 4**

**Credits: 4**

### **UNIT 1**

Introduction to microbial genetics, early concepts of bacterial variations, adaptations, mutation and genetic components of bacteria and fungi and segregation of genetic characters

### **UNIT II**

DNA as genetic material, Structure of Nucleic acid, DNA replication, DNA damage, repair and genetic code. Mutation types and induction by various agents. Genetics of bacteriophage, phage induced mutation.

### **UNIT III**

Gene expression and regulation, Transcription, Post transcriptional modifications, translation, post translational modification, Reverse transcription, Regulation of mRNA synthesis-operon concept, Attenuation, Catabolic repression and autoregulation

### **UNIT IV**

Introduction to DNA technology, Conjugation, Transduction, and Transformation, Cloning vectors, Restriction enzymes, Plasmid, Transposon, and Insertion sequences

### **UNIT V**

Techniques used in molecular biology, Restriction Fragment Length Polymorphism, Randomly Amplified Polymorphic DNA, PCR, DNA finger printing, DNA sequencing and Gene therapy

### **References**

1. Snustad, D.P. (2010). *Principles of Genetics*, 5th ed., International student edn (Hoboken, N.J., Wiley)
2. Prescott, L.M., Harley, J.P., and Klein, D.A. (2005). *Microbiology*, 6th ed. edn (Boston ; London, McGraw-Hill)

3. Madigan, M.T., Martinko, J.M., Stahl, D.A., and Clark, D.P. (2011). *Brock Biology of Microorganisms* (Pearson Education) 13<sup>th</sup> ed.

## **MBPGE9 - BIOSTATISTICS AND RESEARCH METHODOLOGY**

**Number of Hours / Week: 4**

**Credits: 4**

### **UNIT I**

Definition– Scope of Biostatistics, Probability analysis, Variables in Biology- Collection, Classification and Tabulation of data. Frequency distribution. Diagrammatical and graphical representations– Bar diagram, Histogram, Pie diagram

### **UNIT II**

Measures of Central tendency- Arithmetic Mean, Median, Mode. Calculation of Mean, Median, Mode in series of discrete and continuous observations. Open end classification. Measures of dispersion- standard deviation, standard error etc. ANOVA- one way and two way classification.

### **UNIT III**

Correlation and regression- Karl Pearson's coefficient of correlation, Positive and Negative Correlation. Regression- linear and non-linear, regression coefficient

### **UNIT IV**

Basic ideas of significant tests- Testing of hypothesis, Level of significance, tests based on - z-test, Student's t-test, Chi square test. Testing of goodness of fit.

### **UNIT V**

Problem, selection and project designing. Review of literature, Collection, processing and presentation of data. Interpretation of results. Editing the final draft. Presentation of research project.

### **References:**

1. Gupta SP (2010) *Statistical Methods*. Sultan Chand & Sons. 28<sup>th</sup> ed.
2. Palanisamy .S and Manoharan M.(1994). **Statistical methods for Biologists**. Palani paramount

3. Khan I.A, Khanum.A, (2008) Fundamentals of Biostatistics. Ukaas Publications, Hyderabad. 3<sup>rd</sup> ed.
4. George W. Snedecor, William G. (1989) Cochran *Statistical Methods*. Iowa State University Press. 8<sup>th</sup> ed.
5. Kothari CR (2008) *Research Methodology: Methods and Techniques*.New Age International Limited. 2<sup>nd</sup> ed.

### **MB4PGP4 -LABORATORY COURSE IV**

**Number of Hours / Week: 4**

**Credits: 4**

- Study of the morphology, staining characters, cultural characters and identification of medically important bacteria *Staphylococci, Streptococci, Neisseria, Pneumococcus, E.coli, Klebsiella, Salmonella, Shigella, Proteus, Pseudomonas, Vibrio, Bacillus and Mycobacterium sp.*
- Isolation and identification of bacteria from mixed culture.
- Study of common laboratory contaminants.
- Culture methods for isolation and identification of fungi- KOH mount preparation, Lactophenol cotton blue staining, Slide culture technique etc.
- Gram staining and Germ tube test of *Candida albicans*
- Cultivation of viruses in embryonated eggs different routes – harvesting
- Examination of peripheral blood for haemoflagellates and malarial parasites
- Study of normal microbial flora of human beings
- Techniques for collection of clinical specimens for microbiological analysis- Macroscopic, microscopic examination of clinical samples. Culture methods- identification and antibiotic sensitivity test of isolates

#### **References**

12. Cheesbrough, M. (2006). District Laboratory Practice in Tropical Countries. Cambridge University Press. 2<sup>nd</sup> ed.
13. Mackie, T.J., McCartney, J.E., and Collee, J.G. (1989). Mackie & McCartney practical medical microbiology. Churchill Livingstone, 13<sup>th</sup> ed



14. Gradwohl, R.B.H., Sonnenwirth, A.C., and Jarett, L. (1980). Gradwohl's clinical laboratory methods and diagnosis. Mosby, London. 8<sup>th</sup> ed
15. Cappuccino, J.G., and Sherman, N. (2008). Microbiology: A Laboratory Manual (Pearson/Benjamin Cummings. 9<sup>th</sup> ed