


**University of Rajasthan  
Jaipur**

**SYLLABUS**

**M.Sc. Microbiology**

**(Semester Scheme)**

**I/II Semester Examination 2018-19**  
**III/IV Semester Examination 2019-20**

  
**Dy. Registrar**  
(Academic)  
University of Rajasthan  
JAIPUR

MAX MARKS -100

PASS MARKS- 36

THEORY PAPER DURATION: 3 HRS.

PRACTICAL: 6 HRS.

First Semester with laboratory work

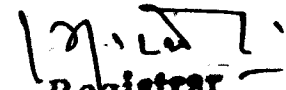
Session 2018-2019

S.No.	Subject code	Course title	Course category	Credit
1	MBC 701	General Microbiology	CCC	4
2	MBC 702	Techniques in Microbiology	CCC	4
3.	MBC 703	Microbial Biochemistry	CCC	4
4.	MBC 711	Lab.(Based on MBC 701, MBC 702 &MBC 703)		6
5.	MBE 701	Molecular Biology	ECC	4
6.	MBE 702	Biostatistics	ECC	4
7.	MBE 703	Bioinstrumentation	ECC	4
8	MBE 712	Lab. (Based on electives only)		6

Second Semester with laboratory work

Session 2018-2019

S.No.	Subject code	Course title	Course category	Credit
1	MBC 801	Bacteriology	CCC	4
2.	MBC 802	Microbial Metabolism &Physiology	CCC	4
3.	MBC 803	Medical Microbiology	CCC	4
4.	MBC 811	Lab.(Based on MBC 801,MBC 802 &MBC 803)		6
5.	MBE 801	Food Microbiology	ECC	4
6.	MBE 802	Environmental Microbiology	ECC	4
7.	MBE 803	Pharmaceutical Microbiology	ECC	4
8.	MBE 812	Lab.(based on Electives only)		6

  
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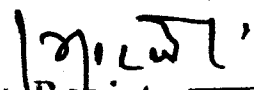
Third Semester with laboratory work

Session 2019-2020

S.No.	Subject code	Course title	Course category	Credit
1	MBC 901	Virology	CCC	4
2.	MBC 902	Microbial Genetics	CCC	4
3.	MBC 903	Dairy Microbiology	CCC	4
4.	MBC 911	Lab.(Based on MBC 901, MBC 902 & MBC 903)		6
5.	MBE 901	Phycology & Mycology	ECC	4
6.	MBE 902	Genetic Engineering	ECC	4
7.	MBE 903	Critical Reviews/ dissertation in Microbiology	ECC	4
8.	MBE 912	Lab.(based on Electives only)		6

Fourth semester with Laboratory work Session 2019-2020

S.No.	Subject code	Course title	Course category	Credit
1	MBC 1001	Immunology	CCC	4
2	MBC 1002	Microbial Ecology	CCC	4
3.	MBC 1003	Industrial Microbiology	CCC	4
4.	MBC 1011	Lab.(Based on MBC 1001, MBC 1002 & MBC 1003)		6
5.	MBE 1001	Genomics & Proteomics	ECC	4
6.	MBE 1002	Agriculture Microbiology	ECC	4
7.	MBE 1003	Clinical and Diagnostic Microbiology	ECC	4
8.	MBE 1012	Lab. (Based on electives only)		6

  
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## SCHEME OF EXAMINATION MICROBIOLOGY (2018-2019, 2019-2020)

- As per discussion of academic council, the student will require to earn 1 credits for PG course out of total 144 credits.
- In theory 15 hrs of teaching is equal to one credit.
- In practical 45 hrs of laboratory work is equal to 2 credits.
- Each Semester of PG course shall have 36 credits.
- Each Semester will have continuous assessment which will include internal assessment in theory and practical by internal examination /seminar/o examination- Viva voce etc. and the maximum marks will be 20.
- Each theory paper shall carry 100marks. It will be of 3 (three) hrs duration.
- Part A of question paper shall contain 10 (Ten) very short answer type question covering the entire syllabus. Each question will carry 2 (two) marks i.e. part A be of total 20 marks.
- In part B, there will be 4 questions, one per unit with internal choice. Each question will carry 20 marks i.e. total of 80 marks.
- Each practical examination will be of 6 hrs duration and will involve laboratory experiments / exercises and Viva -voce examination.

### SCHEME OF PRACTICAL EXAMINATION

For all Semesters the scheme of practical examination is as follows:

MM: 100	Duration 6 hrs
1. Major Exercise	16 Marks
2. Major Exercise	15 Marks
3. Major Exercise	15 Marks
4. Spotting	24 Marks
5. Seminar	10 Marks
6. Record	10 Marks
7. Viva-voce	10 Marks
Total	100 Marks

Syllabus M.Sc. Microbiology

Semester I

MBC 701: General Microbiology

Max. Marks

Unit I

Discovery of microbial world : History of Microbiology and contributions of Anton Leeuwenhoek, Joseph Lister, Paul Ehrlich, Edward Jenner, Louis Pasteur, Robert Koch, Martinus Beijerinck, Sergei Winogradsky, Alexander Fleming, Selman Waksman. Spontaneous generation controversy; Current thoughts on microbial evolution including origin of life; Scope and relevance of microbiology.

Unit -II

System of Classification- Binomial classification, Whittaker's five kingdom scheme, The domain system of classification and eight kingdom system of classification, Bergey's system of bacterial classification. Characteristics & Classification of Archaeobacteria & Cyanobacteria. Difference between prokaryotic and eukaryotic microorganisms.

Unit -III

General characteristics: Acellular microorganisms (Viruses, viroids & Prions), Nomenclature and classification of viruses.

Unit-IV

Cellular microorganisms with emphasis on distribution, occurrence, morphology, mode of reproduction and economic importance.

**Bacteria:** *Cyanobacteria, Spirochaetes, Rhizobium, Nitrosomonas, Clostridium, Lactobacillus, Streptococcus & Staphylococcus.*

**Fungi :** *Saccharomyces cerevisiae, Dictyostelium discoideum, Penicillium & Candida albicans*

**Algae :** *Diatoms & Dinoflagellates.*

**Protozoa:** *Entamoeba, Toxoplasma, Plasmodium, Trypanosoma & Giardia.*

Practicals:

1. Bacterial Smear preparation.
2. Identification of various bacteria: Simple staining.

3. Identification of various bacteria: Gram staining.
4. Identification of various algae.
5. Identification of various fungi: Lactophenol -cotton blue & Acid Fuschin.
6. Identification of various protozoans - Free living.
7. Identification of various protozoans: Parasitic.
8. Identification of Cyanobacteria.
9. Culture & Identification of yeast.
10. Anaerobic Cultivation

**Suggested Books:**

1. Aneja K.R., Jain P. and Aneja R., 2008, A text book of basic and applied microbiology. New Age Int. Publications. New Delhi.
2. Atlas R.M., 1995. Principles of Microbiology Mosby publishers. St. Louis.
3. Balows A., Truper. H. G., Dworkin M., Harder. W. and Schleifer. K. H., 1992. Prokaryotes. A handbook on the biology of bacteria: ecophysiology, isolation, identification, applications. Volumes I-IV, Springer-Verlag. New York.
4. Berg J.M., Tymoczko J.L. and Stryer L., 2007, Biochemistry Edition W.H. Freeman & Co. New York.
5. Holt J.G, and Krieg N.R., 1984-1989, Bergey's Manual of Systematic Bacteriology Edition (Volumes 1-4) Williams and Wilkins Co Baltimore, Springer.
6. Holt J.G., and Krieg N.R., Sneath P.H.A., Staley J.T. and Williams J.T., 1994, Bergey's Manual Determinative Bacteriology 9<sup>th</sup> Edition, Williams and Wilkins Co Baltimore, Springer.
7. Logan. A. and Logan N.A., 1994, Bacterial Systematics, Wiley-blackwell.
8. Nelson D. and Cox M.M., 2009, Principles of Biochemistry Edition W.H. Freeman & Co. New York.
9. Prescott L.M., Harley J.P. and Klein D.A., 2007. Microbiology 7<sup>th</sup> Edition, Mc Graw Hill Education.
10. Talaro K.P. and Talaro A., 2006, Foundations in Microbiology. Mc Graw Hill Education.
11. Tortora G.J., Funke B.R. and Benjamin C.L.C., 2008, Microbiology: An Introduction 10<sup>th</sup> Edition Cummings Publishing Company.
12. Wilson K. and Walker J., 2008, Principles and Technique of Biochemistry and Molecular Biology. 6<sup>th</sup> Edition Cambridge University Press.

13. Woese C.R., 1981, Archeabacteria, Sci. Am. 244:98-122.
14. Woese C.R., Kandler O. and Wheelis M.L., 1990, Towards a Natural System of Organisms: Proposal for the Domains Archea, Bacteria and Eucarya. Proc. Natl. Acad. Sci., 87: 4576- 4570.
15. Woese C. R., 1987, Bacterial evolution, Microbiological Reviews. 51: 221-271.

### **MBC 702: Techniques in Microbiology**

Max. Mark

#### **Unit -I**

Basic principles and methods of sterilization & disinfection: Control of microorganisms: physical methods: heat, filtration and radiation; Chemical methods: Phenolics, alcohols, halogens, heavy metals, quaternary ammonium compounds, aldehydes and sterilizing gases; evaluation of antimicrobial agent effectiveness; Principle and function of Laminar air flow (LAF).

#### **Unit-II**

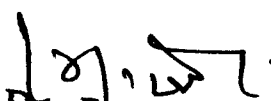
Basic principles for preparing microbes for light, dark field, phase contrast, confocal, fluorescent and electron (transmission and scanning) microscopy; Micrometry; Spore collection, preparation and basic principles of simple, Gram, negative, capsule, endospore, flagella, acid-fast and fluorescent staining.

#### **Unit-III**

Culture characteristics: Types of culture media, preparation of medium. Minimal requirements for growth; Nutritional types: Methods of isolation and maintenance of pure cultures (Pour plate method, streak plate method & spread plate method); Cultivation of bacteria: aerobic & anaerobic; Growth curve of bacteria; Cultivation and morphology of molds; Yeast morphology; Culture and isolation of viruses; Preservation of culture: Short term & long term; Disposal of culture.

#### **Unit-IV**

Principle and theory of biochemical activities of the microorganisms: Triple sugar -Iron test, ImVic test, Methyl red test, Citrate utilization test, Urease test, Catalase test, Oxidase test, Coagulase test, Sugar fermentation test, Hydrogen sulphide test and Nitrogen reductase test.

  
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### Practicals:

1. Laboratory rules and requirement, Bio safety equipments.
2. Microscopy (a) Dissecting & (b) Compound.
3. Microscopy: Phase contrast.
4. Media preparation: Liquid & solid and Sterilization.
5. Streak plate technique.
6. Pour plate technique.
7. Spread plate technique.
8. Use of selective and differential medium; Use of indicator media.
9. Cultivation of microorganisms- nutritional & physical requirements; Anaerobic cultivation.
10. Cultural characteristics of microorganisms.
11. Isolation and maintenance of pure cultures & Preservation of cultures.
12. Biochemical tests-Catalase test.

### Suggested Books:

1. Atlas R.M., 1997, Principles of Microbiology. 2<sup>nd</sup> Edition, Mc Graw Hill Publications
2. Balows A.A.G., Thuper M., Dworker W., Harder K. and Schleifer, 1991, The Prokaryote Springer.
3. Berg J.M., Tymoczko J.L. and Stryer L., 2007, Biochemistry Edition W.H. Freeman Company, New York.
4. Davis R.Y. Adeberg E.A. and Ingram J.L., 1991, General Microbiology.
5. Nelson D. and Cox M.M., 2009, Principles of Biochemistry Edition W.H. Freeman Company, New York.
6. Potter G.W.H and Potter G.W., 1995, Analysis of Biological Molecule: An Introduction Principles, Instrumentation and techniques, Kluwer Academic publishers.
7. Prescott, L.M., Harley J.P. and Klein D. A., 2007, Microbiology, 7<sup>th</sup> Edition, Mc Graw Hill.
8. Stainer, General Microbiology, 5<sup>th</sup> Edition, Printice Hall of India, Pvt. Ltd. New Delhi.
9. Talaro K.P. and Talaro A., 2006, Foundations in Microbiology, Mc Graw Hill Publications.
10. Verlog. Gunsales and Stainer, The Bacteria, Volumes I-V, Academic press.
11. Wilson K. & Walker J., 2008, Principles and Techniques of Biochemistry and Molecular Biology. 6<sup>th</sup> Edition, Cambridge University Press



### Unit-I

Chemical properties of water: ionization and acid base chemistry; Carbohydrates- classification configuration and conformation of monosaccharides, disaccharides polysaccharides.(structure cellulose,peptidoglycan,storage-glycogen)and glycoproteins; Lipids : General characters classification, biosynthesis of saturated and unsaturated fatty acids; Structure and functions triglycerides, phospholipids, glycolipids and steroids.

### Unit -II

Structure of amino acids: Classification of essential amino acids based on polarity: Protein structure -secondary tertiary, quaternary& protein folding and stability; Properties of protein acid - base & solubility, Ramchandran plot; Methods of purification: General approach; Protein solubility chromatography, electrophoresis & ultracentrifugation; Sequencing of protein Preliminary steps, polypeptide cleavage, Edman degradation & reconstruction of protein sequence.

### Unit -III

Laws of thermodynamics: First and second law, concept of free energy, oxidation reduct reactions; Enzymes: Classification and nomenclature, mechanism of enzyme action, enzyme inhibition, allostery, cofactors, coenzymes and prosthetic groups; Enzyme kinetics: Derivation Michaelis - Menton equation and its significance, Lineweaver-Burke plot & Haldane-Bri relationship.

### Unit-IV

Chemical analysis of microbial cells for- carbohydrates, amino acids, proteins, lipids and nucleic acids: Structure and classification of secondary metabolites: Antibiotics (penicillin, streptomycin etc), alkaloids (Ergot toxins), flavanoids, vitamins and bacterial toxins.

### Practicals:

1. Calibration of standard curve - Glycogen & Protein.
2. Quantitative estimation of total proteins (Lowry *et al.*, method).
3. Quantitative estimation of blood glucose & glycogen.
4. Quantitative estimation of lipids & total cholesterol.
5. Quantitative estimation of microbial DNA & RNA.

6. Quantitative estimation of any one microbial enzyme.
7. Quantitative estimation of polyphenol & carotenoids.
8. Quantitative estimation of secondary metabolites - flavanoids.

**Suggested Books:**

1. Alexander R.R. and Griffith J.M., 1993, Basic Biochemistry Methods, 2<sup>nd</sup> Edition, W
2. Atlas R.M., 1997, Principles of Microbiology, 11<sup>th</sup> Edition. McGraw Hills.
3. Berg J.M., Tymoczko J.L. and stryer L., 2007, Biochemistry, W.H. Freeman Company.
4. Cohen, 2011. Microbial Biochemistry, 2<sup>nd</sup> Edition, Springer.
5. Conn E.E. and Stumpf P.K., 2006, Outlines of Biochemistry, 5<sup>th</sup> Edition. John W Sons.
6. Moat A.G. and Foster J.W., 2002, Microbial Physiology, 3<sup>rd</sup> Edition. John Wiley and
7. Nelson D.L. and Cox M.M., 2009, Lehninger Principles of Biochemistry, 5<sup>th</sup> Edition Freeman and Company.
8. Plummer D., 1988, An Introduction to Practical Biochemistry, 3<sup>rd</sup> Edition, Tata M Hills.
9. Potter G.H.W. and Potter G.W., 1995, Analysis of Biochemical Molecules Introduction to Principles, Instrumentation and Techniques, Kluwer Academics Publ
10. Stryer, 2001. Biochemistry. Fifth Edition, WH Freeman.
11. Talaro K.P. and Talaro A., 2006, Foundation in Biochemistry, 6<sup>th</sup> Edition. Tata M Hills.
12. Voet D. and Voet J.G., 1995, Biochemistry, 4<sup>th</sup> Edition, John Willey and Sons Inc.
13. Willey J., Sherwood L. and Woolverton C., 2007, Prescott Harley/Klein's Microbi McGraw Hills.
14. Wilson E.K. and Walker J., Principles and techniques of practical biochemist Edition. Cambridge.
15. White D., 2000. The Physiology and Biochemistry of Prokaryotes, 2<sup>nd</sup> Edition, University Press.
16. Zubzy G.L., 2008, Biochemistry, 4<sup>th</sup> Edition, Addison-Welsey Educational Publisher

**Unit -I**

Nucleic acids: DNA structure; Chargaff's rule; Types of DNA; Reannealing and hybridization; DNA replication in prokaryotes and eukaryotes: Polymerases, replication origin, initiation, elongation and termination; Synthesis of telomeric DNA; topological properties: linking number, superhelicity, mechanism of topoisomerases; Drugs & inhibitors of DNA synthesis.

**Unit -II**

Transcription: Prokaryotes - polymerase, promoter, initiation, elongation and termination; Eukaryotes- promoters, initiation, elongation, termination and post translational modification of mRNA [capping & polyadenylation, Splicing: L & Y splicing (Group I and II introns) using spliceosome snurposome]; Ribozymes; Inhibitors of transcription.

**Unit -III**

Types of RNA: Structural features (mRNA, rRNA, tRNA); Genetic code: Degeneracy, start code, three rules governing the code; Protein synthesis in prokaryotes and eukaryotes: initiation, elongation and termination; Protein synthesis on membrane bound ribosomes: signal hypothesis; post translation modification in ER and Golgi complex; Drugs & inhibitors of protein synthesis.

**Unit -IV**

Regulation of gene expression: Operon concept, negative & positive regulation, inducible operons, corepressors and catabolite repression; Negative regulation-*Lac* operon; Positive regulation-*lac* operon; Regulation by attenuation -*trp* operon; Anti termination -N protein and *nut* site in  $\lambda$ .

**Practicals:**

1. Preparation of buffers and solutions (Normality & Molarity).
2. DNA isolation from different cell types: Microbes and eukaryotic cell.
3. Check for purity of isolated DNA sample: Microbes and eukaryotic cell.
4. Quantification of DNA (microbes & eukaryotic cell) using spectrophotometer.
5. DNA denaturation and determination of  $T_m$  and G+C content.
6. Agarose gel electrophoresis of bacterial DNA.
7. Total RNA isolation from bacterial cells.

### Suggested Books:

1. Bale J.W., 1994. Molecular Genetics of Bacteria, John Wiley & Sons.
2. Biology of the Gene, 6th Edition, CSHL Press.
3. Clarke D.P., 2005, Molecular Biology. 1<sup>st</sup> Edition, Elsevier Academic Press.
4. Friedberg C., Walker G.C. and Wolfman S., 1995, DNA repair and mutagenesis. A Publications.
5. Friefelder D., 1995. Molecular Biology. 2<sup>nd</sup> Edition. Narosa Publishing House
6. Gardner E.J., Simmons M.J. and Snustad D.P., 1991, Principles of Genetics. 8<sup>th</sup> Edition John Wiley & Sons Inc.
7. Larry S. and Wendy, 1997, Molecular Genetics of Bacteria. ASM Publications,
8. Lewin, 2000, Gene VII. Oxford University Press.
9. Maloy, 1994, Microbial Genetics. Jones & Bartlett Publishers
10. Pierce B.A., Genetics- A Conceptual Approach, 2<sup>nd</sup> Edition, W. H. Freeman & Co.
11. Sambrook J. and Russell D. 2001 Molecular Cloning: A laboratory manual. 3<sup>rd</sup> Edition CSHL press.
12. Streip and Yashbin, 1991, Modern Microbial Genetics. Niley Ltd.

### MBE 702: Biostatistics

Max. Marks

#### Unit-I

1. Introduction to Biostatistics
  - 1.1 Definitions of biostatistics
  - 1.2 Scope and applications of biostatistics
  - 1.3 Collection, organization and representation of data (graphical & diagrammatic)
2. Measures of Central tendency & Dispersion (Direct, Short cut and Step deviation methods where ever applicable)
  - 2.1 Mean, median & mode
  - 2.2 Mean deviation

- 2.3 Standard deviation & standard error
- 2.4 Variance & coefficient of variation
- 2.5 Confidence interval and level of confidence

## Unit II

- 3. Correlation and Regression
  - 3.1 Types of correlation
  - 3.2 Methods of studying correlation
  - 3.3 Regression analysis
- 4. Probability
  - 4.1 Basic concepts related to probability theory
  - 4.2 Classical, Posteriori, Personalitic & Axiomatic probability
  - 4.3 Theorems of probability & Probability distributions
  - 4.4 Properties of Binomial, Poisson, Normal and skewed distribution & their applicat  
in biology

## Unit III

- 5. Tests of Significance
  - 5.1 Hypothesis testing & level of significance
  - 5.2 Type I & II errors
  - 5.3 Significance of difference between means
  - 5.4 Z-test
  - 5.5 Students t-test (Unpaired & Paired)
  - 5.6 F-test (Variance ratio)
- 6. Analysis of Variance
  - 6.1 One way classification
  - 6.2 Two way classification

## Unit IV

- 7. Chi Square test
  - 7.1 Testing Goodness of fit
  - 7.2 Chi Square distribution and characteristics
  - 7.3 Applications of Chi-square test
  - 7.4 Yate's correction
- 8. Computational statistics using MS Excel.

### Practicals:

1. Preparation of frequency tables, Graphical representation of data: bar diagram, histogram, frequency polygon, frequency curve and ogives or cumulative frequency curve and diagram.
2. Measures of central tendency, Mean deviation, standard deviation and standard error (Individual, discrete and continuous series – Direct, short cut and step deviation).
3. Plotting of scatter diagram and regression lines. Calculation of correlation coefficient, regression equation and regression analysis.
4. Test of significance by student's t- test, F-test & chi-square test.
5. Statistical calculations using MS Excel.
6. Preparation of graphs using MS Excel.

### Suggested Books:

1. Bailey N.T.J., 2000, Statistical Methods in Biology, English Univ Press.
2. Bansi L., 1968, Mathematics of Probability of Statistics, S.Chand & Co., Delhi.
3. Baxevanis A.D. and Ouellette, 2005, Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd Edition, John Wiley and Son Inc.
4. Campbell R.C., 1974, Statistics for Biologist, Cambridge University Press.
5. Gralla P., 2000, How the Internet Work, Tech Media.
6. Kenny J.F. and Keeping E.S., 1964, Mathematics of Statistics Part I & II, Affiliated West Press Ltd, New Delhi.
7. Mount D.W., 2004, Bioinformatics Sequence and Genome Analysis, CSHL Press.
8. Shina P.K., 2002, Fundamentals of Computers, BPa Publications, New Delhi
9. Snedecor G.W. and Cochram W.G., 1968, Statistical Methods, Oxford & IBH, Delhi.
10. Tramontano A., 2007, Introduction to Bioinformatics, Chapman & Hall/CRC.
11. White R., 2000, How Computer Works, Tech Media.
12. Zvelebil M. and Baum. 2008, Understanding Bioinformatics, Chapman & Hall/CRC.

**Unit I**

Microscopy: Principles of microscopy, magnification power, resolution limit, resolving numerical aperture; Principles and application of light microscopy, properties of light, bright field, dark field, phase contrast and fluorescent microscopy; Principles and application of microscopy- transmission and scanning electron microscopy; Newer techniques in microscopy- confocal microscopy, scanning probe microscopy (scanning tunnelling microscope and atomic force microscope).

**Unit II**

pH meter. Centrifugation: Basic principles of analytical and preparative centrifuge, differential and density gradient, zonal and isopycnic centrifuge, High speed centrifuge and ultracentrifuge. Sedimentation coefficient, factors affecting sedimentation coefficient and application.

**Unit III**

Chromatography: Principles, types and applications of partition, adsorption, gel filtration, paper and thin layer chromatography; Affinity, ion exchange and gas chromatography; High performance liquid chromatography and Fast Performance Liquid Chromatography (FPLC)

Electrophoresis: Principle, types and applications, frontal and zonal electrophoresis, paper, starch gel, Polyacrylamide and agarose gel electrophoresis; Isoelectric focussing and Isotachopheresis; Two dimensional gel electrophoresis and pulse field gel electrophoresis. Immunological techniques: immunoelectrophoresis, immunodiffusion & immunofluorescence

**Unit IV**

Spectroscopy: Basic principles, principles and application of visible, ultraviolet, infrared and mass spectroscopy; Principles and application of NMR and ESR; Principles and application of colorimetry, fluorescence photometry, Atomic Absorption spectroscopy & Raman spectroscopy.

Radioisotopes -Types ;Radioactive units ; Radioactive Decay - Types and Measurement Principles and Applications of Geiger Muller counter , Liquid Scintillation counter, Proportional counter ,Gamma counter, Film badge, Pocket dosimeter, Thermoluminescent dosimeter ,Trefoil , Autoradiography, Radio immunoassay (RIA) & Radiation dosimetry.

### Practicals:

1. Studies on pH titration curves of amino acids / acetic acid.
2. Determination of pKa values and Henderson-Hasselbach equation ( at least two).
3. Preparation of samples using differential centrifuge.
4. Study of microbes –Fluorescent microscope.
5. Separation of bacterial lipids/amino acids/sugars/organic acids by TLC.
6. Separation of bacterial lipids/amino acids/sugars/organic acids by Paper chromatography.
7. Separation of biomolecules by Ion exchange / Gel permeation / Affinity chromatography.
8. Separation of bacterial DNA by gel electrophoresis.
9. Separation of mammalian serum protein by gel electrophoresis.
10. Study of UV absorption spectra of macromolecules (protein, nucleic acid & bacterial pigments).

### Suggested Books:

1. Freifelder D. Physical Biochemistry: Application to Biochemistry and Molecular Biology. Freeman Publications.
2. Walker J. & Wilson K., 2000. Principle & Technique – Practical Biochemistry 5th Ed. .
3. Wilson & Keith. Principles and Techniques of Practical Biochemistry. Cambridge Publications.
4. Rana SVS. Biotechniques . Rastogi Publications, Meerut.



**M.Sc. Microbiology**

**Semester II**

**MBC 801: Bacteriology**

**Max. Marks -100**

**Unit I**

Microbial evolution and diversity, Taxonomic ranks, Phenetic classification, Numerical taxonomy, 16s rRNA. Major characteristics used in taxonomy, Microbial phylogeny-Molecular characteristics. Phylogenetic trees, rRNA, DNA & proteins as indicators of phylogeny. Polyphasic taxonomy.

**Unit II**

Morphology and ultrastructure of bacteria: Size, shape and arrangement of bacteria, structure and chemical composition of cell wall of Gram positive and Gram negative bacteria and Archaea: Structure, composition and function of cell membrane, capsule, flagella, pili, gas vesicles, cytoplasmic matrix reserve food materials, nucleoid, plasmids.

**Unit III**

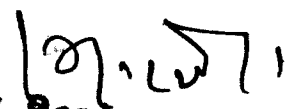
Bacterial life cycles, nutrition, respiration & reproduction; Economic importance of bacteria. Endospore: structure, formation and stages of sporulation; Chemoautotrophs, chemoheterotrophs. Nutritional categories among microorganisms, Nutritional requirements in bacteria and nutritional categories, the requirement of carbon, nitrogen and sulphur, growth factors, the role of oxygen, continuous culture, their applications, chemostats and turbidostats.

**Unit IV**

Antibacterial agents: General consideration and classification; Bacterial resistance to antibacterial agents-Acquisition of bacterial resistance, Mechanism of bacterial resistance. Bacterial resistance to drug classes & antibiotic susceptibility testing.

**Practicals:**

1. Quantitation of viable cells in bacterial culture.
2. Micrometry of bacterial cells.
3. Study of microorganism morphology: Hanging drop method and wet mount.
4. Preparation of bacterial smears and Negative staining.
5. Differential staining - Gram staining.
6. Differential Staining: Acid -Fast staining.

  
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7. Differential Staining: Spore staining.
8. Differential Staining: Capsule staining.
9. Differential Staining: Flagella staining.
10. Biochemical: Carbohydrate fermentation.

**Suggested Books:**

1. Morrey CB. The Fundamentals of Bacteriology.
2. Snyder L, Joseph E. Peters, Tina M. Henkin, Wendy Champness, 2007. Molecular Genetics of Bacteria. 4th edition. ASM Press.
3. Brown A., 1996, Benson's Microbiological Applications Complete Version. (Kindle edition).
4. Baron S. Medical Microbiology. 4<sup>th</sup> edition., Galveston (TX).
5. Lehmann KB. Atlas and Principles of Bacteriology and Text-Book of Special Bacteriologic Diagnosis. (Karl Bernhard) Andesite Press.

**MBC 802: Microbial Metabolism & Physiology**

**Max. Marks -100**

**Unit -I**

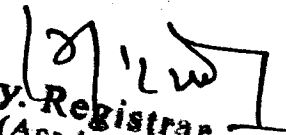
Microbial nutrition & growth: Nutritional categories of microorganisms; Nutritional requirements; Measurement of microbial growth, direct & indirect measurement of microbial growth; Influence of environmental factors on microbial growth.

**Unit-II**

Respiratory metabolism: Glycolytic pathway of carbohydrates breakdown, glycolysis, (Embden Meyerhoff pathway). Kreb's cycle and Entner - Duoderoff pathway, Phosphoketolase pathway, Pentose phosphate pathway, Oxidative and substrate level phosphorylation, Gluconeogenesis, Glycogen metabolism, glyoxylate cycle, fermentation of carbohydrates and homo- & hetero-lactic fermentation.

**Unit-III**

Bacterial photosynthesis: Classification of photosynthetic bacteria, (Anoxygenic, oxygenic); photoheterotrophs; Members of prochlorophyta; Unclassified bacteria; Photosynthetic pigments:

  
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Bioremediation: Metabolism in photosynthetic bacteria; photosynthetic electron transport system; mechanism of photosynthesis (cyclic & noncyclic); Calvin Benson cycle.

#### Unit-IV

Nitrogen fixation in symbiotic and free living system; oxygen and hydrogen regulation of nitrogen fixation, nitrification, denitrification and ammonifying bacteria; Pathway of nitrate assimilation in photosynthetic and non photosynthetic systems; transamination and deamination reaction; Synthesis of essential & non essential amino acids and Synthesis of peptidoglycans & polyamines.

#### Practicals:

1. Physiological differentiation of microorganisms of TSI differential media.
2. Study of nitrification.
3. Isolation and identification of symbiotic nitrogen fixer (*Rhizobium*) from root nodules.
4. Isolation and Identification of free living nitrogen fixer from soil.
5. Study of ammonification.
6. Fermentation of carbohydrates.
7. Study of chemolithotrophs.
8. Litmus milk-homo-fermentation/ hetero-fermentation.
9. Effect of temperature and pH on bacterial growth.
10. Determination of microbial growth.

#### Suggested Books:

1. Atlas R.M., 1997, Principles of Microbiology. 2<sup>nd</sup> Edition, Mc Graw Hill Publications.
2. Berg J.M., Tymoczko J.L. and Stryer L., 2007, Biochemistry. 6<sup>th</sup> Edition, W.H. Freeman and company, New York.
3. Nelson D. L. and Cox M. M., 2009, Lehninger's Principles of Biochemistry, W. H. Freeman.
4. Potter G.W.H and Potter G.W., 1995, Analysis of Biological Molecules: An introduction to principles, instrumentation and technique, Kluwer Academic Publications.
5. Prescott L.M., Harley J.P. and Klein D.A., 2007, Microbiology, 7<sup>th</sup> Edition, Mc Graw Hill.
6. Stryer, 2001, Biochemistry. 5<sup>th</sup> Edition, W.H. Freeman.
7. Talaro, K and Talaro A., 2006, Foundations in Microbiology, Mc Graw Hil. Publication

8. Willey J., Sherwood L. and Woolverton C., 2007, Prescott V Harley/Klein's Microbiology, The Graw Hill.

## MBC 803: Medical Microbiology

Max. Marks -100

### Unit I

Normal microbial flora in human ( skin, mouth, upper respiratory tract & eye) and its role, Normal human flora as pathogen, Anatomic position of normal flora; Pathogenic properties of bacteria – Colonization, invasion, production of toxins (exotoxins & endotoxins); Antimicrobial defences of host ; Cellular mechanisms of antimicrobial defences; Pathogenesis of viral infections.

### Unit II

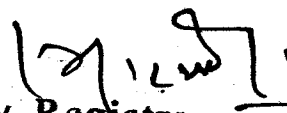
General characteristics, Morphology, Growth, Pathogenicity, Laboratory diagnosis and Therapy of pathogenic bacteria: *Pneumococci*, *Neisseriae*, *Enteric bacilli*, *Pseudomonas* and other non fermenting bacilli, *Haemophilus*, *Bordetella*, *Clostridia*, *Mycobacteria*, *Actinomycetes*, *Rickettsias*, *Mycoplasmas*, *Shigella*, *Vibrio* & *Yersinia*.

### Unit III

Structure, Reproduction, Pathogenicity, Diagnosis, Therapy and Epidemiology of disease caused by Fungus: *Cryptococcus neoformans*, *Blastomyces dermatitidis*, *Trichophyton*, *Histoplasma capsulatum*, *Coccidioides immitis*, *Candida albicans*, *Aspergillus fumigatus*, *Phacomycetes*, *Sporothrix schenckii*, *Eumycotic Mycetoma* & *Microsporium spp.*

### Unit IV

Properties, Pathogenesis, Laboratory diagnosis, Epidemiology, Control & Treatment of virus: Herpes virus (*H. simplex*, *H. zoster*, *Epstein-Barr viruses*), Pox viruses, Picornaviruses, Adenoviruses & Rubella virus.

  
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Multiplication. Pathogenesis and Oncogenic activity: (a) Oncogenic DNA viruses (Papovaviruses-Papilloma viruses, Hepatitis B virus, Oncogenic Herpes viruses); (b) Oncogenic RNA viruses (Lentivirus, HIV, Primate and Human type C Oncovirus).

**Practicals:**

1. Laboratory rules and regulation in Pathological laboratory.
2. Collection of specimen –Basic concepts, Transport containers for anaerobic specimens & collection.
3. Techniques for transfer of clinical specimens & selection of primary culture media, Interpretation of culture.
4. Identification based on metabolic characteristics.
5. Antibiotic susceptibility testing.
6. New Technologies in the laboratory diagnosis of infectious diseases.

**Suggested Books :**

1. Baron S., 1996. Medical Microbiology, 4th ed. Galveston (TX) .
2. Geo. F. Brooks & Stephen A. Morse. Jawetz, Melnick, & Adelberg's Medical Microbiology. 26<sup>th</sup> edition. McGraw-Hill.
3. Kenneth J. Ryan. C. George Ray. Sherris Medical Microbiology, Sediton
4. Kenneth J. Ryan, MD; Sean Elliott, MD; Lynn Joens, PhD; Chuck Sterling, BS, PhD (Tucson, AZ) .Paul Pottinger, MD (Seattle, WA)., 2014, Sherris Medical Microbiology, 6<sup>th</sup> ed. McGraw-Hill Education ,
5. Murray PR, Rosenthal KS , Kobayashi GS & Pfaller MA., 2015, Medical Microbiology 8<sup>th</sup> ed. MosbyInc. St Louis, Missouri.

**Unit:1**

Important microbes involved in spoilage of food: Meat, poultry, vegetables & dairy products: Microbial deterioration of cereals, pulses, fish & sea foods during storage; Feed for cattle: Use of microbes and microbial enzymes in the improvement of nutritive quality of feed.

**Unit: II**

Toxins: Bacterial and mycotoxins, important microbes secreting toxins, chemical nature of important toxins, their role in food poisoning; Physiology and mechanism of action, modification and detoxification, prevention and control of toxin contamination. Starter cultures- their biochemical activities. Production and preservation of fermented foods- Soya sauce, sauerkraut, meat – sausages & baker's yeast.

**Unit III**

Microbial biomass and single cell proteins; Uses of microbes in meats and poultry products vegetables etc.; Low calorie sweeteners, flavour modifiers & food additives; Food quality monitoring Indian fermented food.

**Unit IV**

Microbial enzymes in food industry, Tea and coffee fermentations, Vinegar, Wine & Beer production: Food preservation methods, Use of low & high temperature, radiations – UV, Gamma and Microwave, chemicals and naturally occurring anti microbials.

**Practicals:**

1. Statutory tests for microbiological analysis of canned foods.
2. Single cell Protein (SCP) cultivation.
3. Preparation of fermented food & beverages: Sauer Kraut, Koji & Soya sauce.
4. Sampling & analysis of microbial load on food contact surfaces.
5. Isolation and identification of common microorganisms spoiling food: Bacteria & fungi.
6. Aflatoxin production from fungi.

**Suggested Books:**

1. Banwart GJ. Basic Food Microbiology. CBS Publishers & Distributors
2. Frazier WC and Westhoff D C, Food Microbiology. Tata McGraw-Hill Publishing Company Limited. New Delhi.
3. Adams MR and Moss MO. Food Microbiology. New Age International Ltd.

### Unit-I

Microbes in extreme environments: Environment induced genetic and physiological adaptation in microbes; Disinfection of potable water supplies and hospital wastes; Bacterial indicators of water safety : Microbial assessment of water quality; Standard for tolerable levels of fecal contamination.

### Unit-II

Biodegradation and Bioremediation: Microbial degradation of lingo-cellulosic substances, keratin and chitin; Bioremediation: Microbial degradation of herbicides, pesticides, hydrocarbons including polycyclic (petroleum, gas production, fossil fuel & polychlorinated biphenyls etc.), oil spills, heavy metals, chlorinated and polychlorinated compounds; Biological treatment of effluents of sugar, pulp and paper industry.

Biodeterioration: Biodeterioration of buildings and monuments of cultural heritage, microbial deterioration of paper, textile, leather, rubber, glass, paints and metals; Principal methods for their protection.

### Unit -III

Aerobic treatment of waste water (Trickling filters, Rotating biological contractors, Fluidized bed reactors, Activated sludge, Oxidation ponds), anaerobic treatment of waste water (Anaerobic contact digesters, Packed bed reactors, Up-flow anaerobic sludge blanket reactors) Advanced waste water treatment for removal of suspended solids, nutrients (N&P), Oil and grease, Toxic compounds and dissolved inorganic substances, Solid waste disposal (sanitary landfills and composting).

### Unit -IV

Microbial diversity; Microbiology of air, soil & water; Techniques in environmental microbiology : Methods for determination of numbers, biomass and activities of microbes in soil, water, plant surfaces and dead organic materials; Bioremediation techniques: *in situ* (Bioventing, air sparging, liquid delivery system, aerobic bioremediation & phytoremediation) and *ex situ* (land farming, composting, biopiling & slurry -phase).

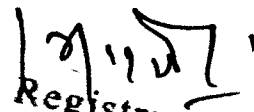
### Practicals:

1. Enumeration of micro-organisms from air.

1. Enumeration of micro-organisms from soil.
2. Micro-organisms degrading oil/textile dyes/petrol.
3. Biodeterioration of paper/textile.
4. Bacteriological examination of water (Potable /hospital wastes):
  - a. Presumptive test
  - b. Confirmed test
  - c. Completed test
5. Identification of pathogenic microbes in water samples.
6. Chemical Oxygen Demand (COD)
7. Biological Oxygen Demand (BOD).
8. Total dissolved solids (TDS).
9. Total hardness.
10. Fluoride and Nitrate content.

**Suggested Books:**

1. Atlas R.M. and Bartha R., 1993, *Microbial Ecology*, Benjamin Cummings Publishing Co. Redwood City, CA.
2. Baker K.H. and Herson D.S., 1994, *Bioremediation*, McGraw Hills Inc., NY.
3. Christon J.H., 2001, *A Manual of Environmental Microbiology*, ASM Publications.
4. Colwd D., 1999, *Microbial Diversity*, Academic Press.
5. Forster C.F. and John D.A., 2000, *Environmental Microbiology*, Ellis Horwood Ltd. Publications.
6. Grant W.D. and Long P.E., 1981, *Environmental Microbiology*, Kluwer Academic Publishers.
7. Hurst C.J., Crawford R.L., Garland J.L., Lipson D.A. and Mills A.L., 2007, *Manual of Environmental Microbiology*, ASM Press.
8. Jjemba P.K., 2004, *Environmental Microbiology: Principles and Applications*, Science Publishing Inc.
9. Johri B.N., 2000, *Extremophiles*, Springer Verlag, NY.
10. Maier R., Pepper I., and Gerba C., 2008, *Environmental Microbiology*, Academic Press.
11. Mitchel R., 2009, *Environmental Microbiology*, 2nd Edition, Wiley-Blackwell.
12. Pepper I., Gerba C.P. and Brusseau M.L., 2006, *Environmental and Pollution Science*, Academic Press, USA.
13. Ralph M.A., 1997, *Environmental Microbiology*, John Wiley and Sons Inc.

  
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14. Singh A., Kuhad R.C. and Ward O.P., 2009, Advances in Applied Bioremediation, Springer.
15. Varman A.H. and Evans M.G., 2000, Environmental Microbiology, Manson Publishing Ltd.

### MBE 803: Pharmaceutical Microbiology

Max.Marks : 100

#### Unit – I

Antibiotics and synthetic antimicrobial agents (Aminoglycosides,  $\beta$  lactams, tetracyclines, ansamycins, macrolid antibiotics); Antifungal antibiotics; Antitumor substances; Peptide antibiotics; Chloramphenicol, Sulphonamides and Quinolone antimicrobial agents; Chemical disinfectants, antiseptics and preservatives.

#### Unit – II


Mechanism of action of antibiotics (inhibitors of cell wall synthesis, nucleic acid and protein synthesis); Molecular principles of drug targeting; Drug delivery system in gene therapy bacterial resistance to antibiotics; Mode of action of bacterial killing by quinolinones; Bacterial resistance to quionolinones; Mode of action of non – antibiotic antimicrobial agents; Penetrating defenses – How the antimicrobial agents reach the targets (cellular permeability barrier, cellular transport system and drug diffusion).

#### Unit – III

Microbial production and Spoilage of Pharmaceutical Products; Microbial contamination & spoilage of pharmaceutical products (sterile injectibles, non injectibles, ophthalmic preparations and implants) and their sterilization; Manufacturing procedures and in process control of pharmaceuticals; Other pharmaceuticals produced by microbial fermentations (streptokinase, streptodornase); New vaccine technology, DNA vaccines, synthetic peptide vaccines, multivalent subunit vaccines and Vaccine clinical trials.

#### Unit – IV

Regulatory practices and applications in Pharmaceuticals; Elementary idea of IP, BP and USP; Government regulatory practices and policies and FDA perspective; Rational drug design; Immobilization procedures for pharmaceutical applications (liposomes); Macromolecular,

  
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cellular and synthetic drug carriers: Biosensors in pharmaceuticals: Application of microbial enzymes in pharmaceuticals: Regulatory aspects of quality control: Quality assurance and quality management in pharmaceuticals ISO, WHO and US certification; Sterilization control and sterility testing (heat sterilization, D value, z value, survival curve, Radiation, gaseous and filter sterilization) and Chemical & biological indicators.

#### Practicals:

1. Spectrophotometric / Microbiological methods for the determination of Griesofulvin.
2. Bioassay of chlormphenicol by plate assay method or turbidimetric assay method.
3. Treatment of bacterial cells with cetrimide, phenol and detection of Leaky substances such as potassium ions, amino acids, purines, pyrimidines and pentoses due to cytoplasmic membrane damage.
4. To determine MIC, LD<sub>50</sub> of Beta-lactum /amino-glycoside/ tetracycline/ansamycins.
5. Sterility testing by *Bacillus stearothermophilus*.
6. Sampling of pharmaceuticals for microbial contamination and load (syrups, suspensions, creams and ointments, ophthalmic preparations).
7. Determination of D value, Z value for heat sterilization in pharmaceuticals.
8. Determination of antimicrobial activity of chemical compounds (Phenol, resorcinol, thymol, formaldehyde) under standardized experimental conditions.

#### Suggested Books:

1. Cooper M. S., 1973, Quality control in the Pharmaceutical Industry. Vol.2. Academic Press New York.
2. Gregoriadis G., 1979, Drug Carriers in biology & Medicine . Academic Press New York.
3. Hooper D. C and Wolfson J. S., 1989, Quinolone antimicrobial agents. ASM Washington, DC.
4. Denyer S. P., Hodges N. A., Gorman S. P., 2007, Hugo and Russell's : Pharmaceutical Microbiology. 7<sup>th</sup> edition. Wiley
5. Hugo W.B and Russell A.D., 1998, Pharmaceutical Microbiology . 6<sup>th</sup> edition. Blackwell Scientific Publications.
6. Kavanagh F., 1972, Analytical Microbiology –Volume II. Academic Press New York.
7. Hewitt W., 2003, Theory and application of Microbiological Assay. Elsevier
8. Rehm H.J and Reed G. in cooperation with Puhler A. and Stadler P., 1986, Biotechnology. Vol 4. Wiley VCH Publications, Federal Republic of Germany.
9. Webber P., Advances in Applied Biotechnology Series Vol 10, Biopharmaceuticals in transition. Industrial Biotechnology Association. Gulf Publishing Company Houston.

Willig S. H., Tuckerman M. M. and Hitchings W.S., IV Good Manufacturing Practices for Pharmaceuticals. 2<sup>nd</sup> edition.. Merceel Dekker, NC New York.

## Syllabus M.Sc Microbiology

### Semester III

### MBC 901: Virology

**Max.Marks: 100**

#### Unit -I

General virology: Brief outline on discovery of viruses, nomenclature & classification of viruses; Distinctive properties of viruses, morphology & ultra structure; Capsids & their arrangements; Type of envelopes and their composition; Viral genomes: their types and structures, replication of viruses; Viron, viroids & prions.

#### Unit-II

Bacteriophages: Classification; morphological groups; virulent dsDNA phages (T-4 phage), one step growth curve, ssDNA phage ( $\Phi$ X174); bacteriophage typing; Lytic cycle, Lysogenic cycle; Cyanophages: Morphology and growth cycle; Mycophages : types; Taxonomic affinity.

#### Unit-III

General characters of major plant viruses: Tobacomosaic virus group (TMV); Tymovirus group (circular mosaic virus); Tomato spotted wilt virus; Cauliflower mosaic virus; Effects of these viruses on plants; General characters of major human and animal viruses: Adenovirus, Poxvirus, Picornavirus, Retrovirus & Reoviruses.

#### Unit-IV

Cultivation of viruses: Growth of viruses in embryonated egg, experimental animals and cell cultures, primary and secondary cell lines, suspension cell cultures and monolayer cell cultures; Assay of viruses: Physical and chemicals methods of assay (protein, nucleic acid, radioactivity tracers, electron microscopy etc); Infectivity assay of plant viruses & animal viruses, plaque method, pock counting and end point method.

#### Practicals:

1. Virus plaques assay:

2. Study of plant virus-TMV.
3. Study of plant virus-CaMV.
4. Study of animal viruses.
5. Study of retroviruses.
6. Growth of viruses in embryonated eggs.
7. One step growth curve of (ΦX174) virus.
8. Use of suspension /monolayer cell cultures for viral cultivation.

### Suggested Books

1. Cann A.J., 1997, Principles of Molecular Virology. 2<sup>nd</sup> edition, Academic Press, California.
2. Cann A.J., 2001. Principles of Molecular Virology. 3<sup>rd</sup> edition, Elsevier Academic Press.
3. Carter J. and Saunders V., 2007, Virology; Principles and Applications, 1<sup>st</sup> edition, John Wiley & Sons.
4. Conrat H.F., Kimball P.C. and Levy J.A., 1988, Virology. 2<sup>nd</sup> edition, Prentice Hall, Englewood Cliff, New Jersey.
5. Dimmock N., Easuton A. and Leppard K., 2005, Introduction to Modern Virology. 5<sup>th</sup> edition, Blackwell Publishing.
6. Dimmock N.J. and Primrose S. B., 1994, Introduction to Modern Virology. 4<sup>th</sup> edition, Blackwell Scientific Publications, Oxford.
7. Flint S.J., Enquist L.W., Krung R. Racaniello V.R. and Skalka A.M., 2004, Principles of Virology. ASM Press.
8. Granoff A. and Webster R.G., 1999, Encyclopaedia of Virology. Volume I, II and III, San Diego Academic Press.
9. Hull R., 2002, Plant Virology. 4<sup>th</sup> Edition, Academic Press.
10. Knipe D.M. and Howley P.M., 2006, Fields Virology. Lippincott-Raven, Philadelphia, USA.
11. Luria S.E., 1978, General Virology. 3<sup>rd</sup> edition, Jhon Wiley and Sns. New York.
12. Parker T., Lerline M., Collier H., 1990, Principles of Bacteriology, Virology and Immunity. 7<sup>th</sup> Edition.
13. Ram Reddy S. and Reddy S. M., 2007, Essentials of Virology Scientific Publishers (India) Jodhpur.

14. Straus J.H. and Straus E.S., 1998. Evolution of RNA Viruses. Am. Rev, Microbiology, 42; 27-83.
15. Wanger E.K., Hewlett M., Bloom D. and Camerini D., 2007, Basic Virology. 3<sup>rd</sup> edition, Blackwell Publishing.

### **MBC 902: Microbial Genetics**

**Max. Marks: 100**

#### **Unit-I**

Gene: Seymour Benzer experiment, complementation test, cistron, recon & muton; Mutation mapping at molecular level; Mutation: Spontaneous mutation, induced mutation and mutagens, molecular mechanism of mutagens, suppressor, intragenic & intergenic mutation, Isolation and detection of bacterial mutants; DNA repair: direct repair, excision repair (base and nucleotide), mismatch repair, SOS repair and translesion DNA synthesis.

#### **Unit -II**


Homologous recombination: Holliday junction (single strand & ds break); homologous recombination protein: Rec A, Ruv AB complex & Ruv C, Rec BCD pathway and Rec F pathway, FLP/FRT and Cre / Lox system; Transposable elements: Classes and genetic organisation of transposable elements, insertion sequences (IS elements), composite and complex transposons & mechanism of transposition, CRISPER CAS

#### **Unit-III**

Gene transfer mechanisms: Bacterial transformation (mechanism of transformation, transfection & competence); Transduction: Generalized transduction, specialized transduction & abortive transduction; Conjugation: effective contact & pili in conjugation, the "F" factor, conjugal transfer process, high frequency recombination (Hfr) strains, the order of chromosome transfer, formation of F'(F prime), mapping by using transformation, transduction and conjugation, Horizontal gene transfer.

#### **Unit IV**

Genome organisation: Prokaryotic genome- nucleoid; Eukaryotic genome: Structure of chromatin, nucleosome. organisation & remodelling and high order organization of

  
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chromosomes, centromere & telomere; DNA methylation and gene imprinting; C value paradox and Cot curves; repetitive and non repetitive DNA sequences; Cot ½ and Rot ½ values; Pseudogenes, gene families & gene cluster super families.

**Practicals:**

1. Study of conjugation in *E. coli*.
2. Effect of UV radiations and repair mechanisms in bacteria.
3. Isolation of antibiotic resistant mutants by disc methods.
4. Isolation of antibiotic resistant mutants by gradient plate method.
5. Isolation of mutants by replica plate method.
6. Ames test.
7. Preparation of competent cells.
8. Transformation.
9. Transduction.
10. Isolation of plasmid DNA.

**Suggested Books:**

1. Brown T.A., 2006, *Gene Cloning and DNA Analysis*. 5<sup>th</sup> edition, Blackwell Scientific Publishing, Oxford.
2. Glick B.R. and Pasternak J.J., 2003, *Molecular Biotechnology*. ASM Press Washington D.C.
3. Lewin B., 2007. *Gene IX*. Jones and Bartlett Publishers, Sudbury, Massachusetts.
4. Maloy S.R., Cronan J.R. and Freifelder D., 2009, *Microbial Genetics*. 2<sup>nd</sup> edition, Narosa Publishing House, New Delhi.
5. MHRB, ASM publications.
6. Snyder L. and Champness W., 2007, *Molecular Genetics of Bacteria*. 3<sup>rd</sup> edition, ASM Press.
7. Streips U.N. and Yasbin R.E., 2002, *Modern Microbial Genetics*. 2<sup>nd</sup> edition, Wiley Publishers.
8. Trun N. and Trempy J., 2004, *Fundamental Bacterial Genetics*. 1<sup>st</sup> edition, Blackwell Science Publishers.

**Unit I**

Milk – Contents & their % ; Microbiology of milk and milk processing; Microbiology of raw milk. Processed milk, Cream & butter, concentrated milk, flavoured milk & dried milk; Microbiology of ice cream & related products.

**Unit II**

Starter cultures-Fermented milk, Therapeutic milk, Butter , Yoghurt, Soft cheese & hard cheese; Introduction to probiotics, prebiotics & synbiotics; Quality control in dairy industry; Hazard Analysis Critical Control Point (HACCP).

**Unit III**

Role of microbes in milk and dairy products; Microbiological examination of raw / pasteurized milk. standard plate count, direct microscopic count and reductase test, composition of milk, sources of contamination of milk, ability of milk to cause diseases.

**Unit IV**

Pathogens: *Arthrobacter* spp., *Bacillus cereus*, *Campylobacter* spp., *Clostridium botulinum*, *Clostridium perfringens*, *Cronobacter (Enterobacter) sakazakii* , *Escherichia coli*, *Listeria monocytogenes*, *Mycobacterium*., *Micrococcus*., *Salmonella* spp , *Staphylococcus aureus* & *Yersinia enterocolitica*, *Aspergillus* spp., *Fusarium* spp., *Mucor*, *Penicillin*, *Geotrichum*, *Cladosporium* , *Yeast*., *Phoma* spp., *Cluvaromyces*, *Beberomyces*, *Alternaria*, *Eurotium*.

Cleaning and sanitizing in milk production & processing; Control of microorganism in dairy processing; Regulatory control of milk & dairy products; Treatment of dairy wastes.

**Practicals:**

1. Microorganisms in cheese spoilage.
2. Detection of fungal spoilage of dairy products.
3. Bacterial contamination in milk.
4. Determination of bacteria number: Standard plate count.
5. Determination of bacteria number: Direct microscopic count.
6. Methylene Blue Reduction Test (MBRT).
7. Turbidity testing for milk.
8. Presumptive test for coliforms in milk & butter.
9. Fermented milk.

10. Identification of microbes in curd / chach using differential staining.

**Suggested Books:**

1. Britz T. and Robinson R. K., 2008, *Advanced Dairy Science and Technology*. Wiley Blackwell.
2. Elmer H. M and James S., 2001, *Applied Dairy Microbiology*. 2nd edition. CRC Press.
3. Robinson R. K., 2002 *Dairy Microbiology Handbook: The Microbiology of Milk and Milk Products*. 3<sup>rd</sup> edition. Wiley.
4. Yousef A E. and Carlstrom C., 2003, *Food Microbiology: A Laboratory Manual*. Wiley.

**MBE 901: Phycology and Mycology**

**Max.Marks : 100**

**Unit-I**

General characters and classification of algae; Important features, asexual and sexual reproduction in representative genera of Chlorophyceae (*Chlamydomonas*, *Spirogyra* & *Dianoflagellates*) Pheophyceae (*Ectocarpus* & *Sargassum*), Bacillariophyceae (Diatoms) and Rhodophyceae (*Polysiphonia*) and Cyanophyceae (*Spirulina*, *Anabaena*).

**Unit-II**

General characters & classification of fungi; Mastigomycotina (*Albugo*, *Phytothora*), Zygomycotina (*Rhizopus*), Ascomycotina (*Sacchromyces* & *Neurospora*), Basidiomycotina (*Puccinia* & *Agaricus*) and Deuteromycotina (*Cercospora* & *Colletorichum*); Unique characteristics of filamentous fungi that are advantageous for genetic analysis (Parasexual analysis, gene silencing): Ascomycetes yeast (*S.crevisae*), Ascomycetes filamentous fungi (*Neurospora crassa* and *Aspergillus nidulans*) & Basidiomycetes filamentous fungi (*Coprinus cinereus*).



### Unit-III

Economic importance of algae: Algae as pollution indicator, eutrophication agent and its role in bioremediation; algae in global warming and environmental sustainability; cyanobacteria and selected microalgae in agriculture-biofertilizer and algalization.

### Unit-IV

Lichens: Structure, relationships, reproduction, ascolichens, basidiolichens, deuterolichens, Mycorrhiza: ecto-, endo-, ectendo- VAM; Fungi as insect symbionts & biocontrol agent, fungi attack on other microorganisms; Economic importance of fungi.

Mycoses infections: Structure, Genome, dimorphism, pathogenesis & treatment

- (a) Superficial mycoses ( *Microsporum*, *Trichophyton*, *Epidermophyton*, *Pityrosporon orbiculare*, *Candida albicans*, *Piedraia* )
- (b) Cutaneous mycoses ( *Sporothrix schenckii*, *Epidermophyton*, *Lophophyton*, *Microsporum*, *Nannizzia*, *Trichophyton*, *Candida albicans* and related species, *Neoscytalidium dimidiatum*, *Scopulariopsis brevicaulis*).

### Practicals:

1. Fungi cultivation methods.
2. Study of mycorrhizae.
3. Study of lichens.
4. Study of representative algae listed in syllabus.
5. Cultivation and morphology of molds.
6. Identification of fungi and molds from food samples.
7. Study of representative fungi listed in syllabus.
8. Spore print of mushrooms.
9. Use of algae for biofuel production.
10. Slides as per syllabus.

### Suggested Books:

1. Atlas R.M., 1997, Principles of Microbiology. 2<sup>nd</sup> edition, MC Graw Hill.
2. Barsanti L. and Gualtieri P., 2006, Algae: Anatomy, Biochemistry and Biotechnology. Taylor and Francis Group, LLC.
3. Chatterjee K.O., 1999, Parasitology. Calcutta Publication.
4. Lee R.E., 1999, Phycology. 3<sup>rd</sup> edition, Cambridge University Press, Cambridge.

5. Nester E.W., Anderson O.G. and Nester M.T., 2006, Microbiology: A Human Perspective. Mc Graw Hill.
6. Prescott L.M., Harley J.P. and Klein D.A., 2007 Microbiology. 7<sup>th</sup> edition, Mc Graw Hill.
7. Talaro K.P. and Talaro A., 2006, Foundations in Microbiology. Mc Graw Hill.
8. Wilfey J., Sherwood, L. and Woolverton C., 2007, Prescott Harley/ Klein's Microbiology. McGraw Hill.

### **MBE 902: Genetic Engineering**

**Max. Marks -100**

#### **Unit I**

Basics of recombinant DNA technology: Enzymes used in recombinant DNA technology: Nuclease, DNA ligase, polymerase, reverse transcriptase, terminal deoxy-nucleotidyl transferase, alkaline phosphatase; Modification of restriction fragment ends: Sticky and blunt end ligation with linkers & adapters and homo-polymer tailing.

#### **Unit-II**

Cloning vectors: Properties of plasmids, yeast plasmid (YAC), shuttle vectors, bacteriophages, cosmids, bacterial artificial chromosomes, Ti based vectors, retroviruses; Isolation and purification of genomic and plasmid DNA; Gene libraries: Genomic library, screening of libraries (shot gun approach) & cDNA library.

#### **Unit -III**

Introduction of recombinant vectors into bacterial and non bacterial cells; Selection of recombinant clones; Colony hybridization, Plaque hybridization, immunochemical methods; Application of genetic engineering: Scientific, medical, industrial, agricultural and environmental applications; Human genome project.

#### **Unit-IV**

Polymerase chain reaction (PCR): Basic principle, components of PCR, PCR techniques: Standard PCR, Inverse PCR, reverse transcriptase mediated PCR, Anchored PCR, Asymmetric

PCR & Real time PCR; DNA sequencing: dideoxy method (Sanger sequencing). Chemical degradation (Maxam-Gilbert method); Strategies for sequencing large DNA fragments; Automated sequencing and pyro sequencing; Brief description of Probes: Types; RFLP, AFLP and RAPD: Southern, Western and Northern blotting.

**Practicals:**

1. Isolation of bacterial genomic DNA.
2. Visualization and documentation of bacterial genomic DNA using gel doc system.
3. Restriction digestion and ligation of bacterial genomic DNA.
4. Recovery of genomic DNA embedded in Agarose gels (freeze squeeze, column).
5. SDS PAGE- Bacterial proteins.
6. Demonstration of Southern hybridization technique.
7. PCR techniques.

**Suggested Books:**

1. Adams M.R and Moss M.O., 1995, Food Microbiology, Royal Society of Chemistry Publications, Cambridge.
2. Alberts B., Johnson A., Lewis J., Raff M., Roberts K. and Walter P., 2007, Molecular Biology of the Cell, 5<sup>th</sup> Edition, Garland Science, New York and London.
3. Banwart G.J., 1993, Basic Food Microbiology, CBS Publishers and Distributors, Delhi.
4. Berg J.M., Tymoczko J.L. and Stryer L., 2008, Biochemistry, 5<sup>th</sup> Edition, Freeman W.H. and Company New York, USA.
5. Cruegar W. and Cruegar A., 1990, Biotechnology: A textbook of industrial microbiology, 2<sup>nd</sup> Edition, Sinauer Associates .Inc.
6. Frazier W.C. and Westhoff D.C., 1998, Food Microbiology, Tata Mc Graw Hill Publishing Company Ltd, New Delhi.
7. Hobbs B.C and Roberts D., 1993, Food poisoning and Food Hygiene, 6<sup>th</sup> Edition Edward Arnold (A division of Hodder and Stoughton, London).
8. Jay J.M., 1992, Modern Food Microbiology, 4<sup>th</sup> Edition, Van Nostraand Reinhold Co., New York.
9. Lewin B., 2007, Gene IX, Jones and Bartlett Publishers, Sudbury, Massachusetts.
10. Robinson R.K., 1990, Dairy Microbiology, Elsevier Applied Sciences, London.
11. Stanburg P.E., Whittaker A. and Hall S.J., 1995, Principles of fermentation technology, 2<sup>nd</sup> Edition, Pergamon Press.

12. Watson J.D., Baker T.A., Bell S.P., Gann A., Levin M. and Losick R., 2007, Molecular Biology of the Gene, 6<sup>th</sup> Edition, Benjamin Cummings, San Francisco, USA.
13. Weaver R.F., 2007, Molecular Biology, 4<sup>th</sup> Edition, McGraw Hill, New York, USA.

**MBE 903: Critical Reviews in Microbiology / Dissertation**

**Max.Marks: 100**

**The dissertation work would involve practical work on a selected problem. It should include:**

1. Introduction
2. Review of Literature
3. Materials & Methods
4. Results (Statistically analyzed if required)
5. Discussion
6. Conclusion
7. References

- **For evaluation the dissertation / critical reviews will be sent to External examiner/s.**
- **Presentation and Viva- Voce of this paper would be a part of the elective practical MBE 912.**

# Syllabus Microbiology

## Semester IV

### MBC 1001; Immunology

Max.Marks : 100

#### Unit I

1. Historical background; Innate immunity, Adaptive immunity (cell mediated and humoral), Natural and artificial immunity; Active and Passive immunity, Barriers to infection; Phases of Immune responses; Clonal selection hypothesis.
2. Hematopoiesis; Cells of immune system; Lymphoid organs-Primary and Secondary.
3. Immunoglobulin-General structure, Ig isotypes, structure and function.

#### Unit II

4. Antigens-Properties, Types (Isotypes, Allotypes, Idiotypes), Antigen specificity, superantigen, Determinants-linear, conformational and neo-antigenic, Haptens, Adjuvants
5. Characteristics of primary antigen- antibody interactions; antigen-antibody interactions (Precipitations, Agglutinations, RIA, ELISA, Immunoelectrophoresis, Crossed antigen-antibody electrophoresis, Western blotting etc).
6. Complement pathways (Classical, alternative and lectin), Biological significance and deficiencies.
7. Hybridoma technology-monoclonal antibodies and its applications; Production of polyclonal antibody and its application.

#### Unit III

8. Mechanism of cell mediated and humoral immunity.
9. MHC types and structure, Exogenous and endogenous antigen capture and presentation to the lymphocytes, Cross presentation of exogenous antigens.
10. Vaccine-Route of immunization, Natural immunization schedule, Types: attenuated and inactivated vaccine, synthetic peptide, DNA vaccine, Recombinant vaccine, subunit vaccine, idiotype based vaccine, glycoconjugate vaccine, ISCOM's and plantibodies , vaccine delivery system.
11. Immunity to microbes: Bacteria, Fungi, Virus and Helminthes, Pathogen recognition receptor (PRR) and Pathogen Associated Molecular Pattern (PAMP).

## Unit IV

12. Cytokine (Properties, receptors, cytokine related disease and cytokine -based therapy). Hypersensitivity (Classification, types and disease).
13. Autoimmune diseases- Addison's disease, Graves' disease, Hashimoto's thyroiditis, autoimmune haemolytic anemia; rheumatoid arthritis, Goodpasture's syndrome, Sjögren's syndrome.
14. Immune deficiencies-B cell deficiencies (X-linked agammaglobulinemia, X-linked hyper-IgM syndrome); T cell deficiencies (22q11 deletion syndrome, CD8 deficiency); B and T cell deficiencies (Common  $\gamma$  chain deficiency, ADA deficiency).

### Practicals:

1. Dissect, localize and study the structure of lymphoid organs (Demonstration and detailed study).
2. Preparation of antigen and route of immunization.
3. Generation of antibody in mice/rat/rabbit/guinea pig and sample collection (retro-orbital and heart).
4. Agglutination: Widal test.
5. Precipitation.
6. Ouchterlony's double diffusion.
7. Radial Immunodiffusion.
8. Immunoelectrophoresis: RIE.
9. ELISA.
10. Viability and cell counting of peritoneal macrophages using trypan blue.
11. Slides: Spleen, thymus, lymph node, ileum- Peyer's patch. Blood cell types identification; slides from experiments.
12. Differential Blood Counts

### Suggested Books:

1. Abbas A.K., Lichtman A.H., Pillai, S. and Saunders, 2007, Cellular and Molecular Immunology. Elsevier.
2. Benjamin, 2004, Immunology- A short course.
3. Claus C., 1996, Immunology- Understanding of Immune System. Wiley, New York.
4. Delves P.J., Martin S.J., Burton D.R. and Roitt I.M., 2006, Roitt's Essential Immunology. 11<sup>th</sup> edition. Blackwell Publishing/Oxford University Press.
5. Kindt T.J., Goldsby R.A., Osborne B.A. and Kuby J., 2006, Kuby Immunology. 6<sup>th</sup> Edition. WH Freeman, New York.

6. Levinson W. and Jawetz E.. 2001, **Medical Microbiology and Immunology**. Lange Publications.
7. Paul W.E., 2000. **Fundamental Immunology**. 4<sup>th</sup> edition, New York. Raven Press.

## **MBC 1002: Microbial Ecology**

**Max.Marks : 100**

### **Unit I**

Biotic and abiotic environment, Composition and structure of environment. Concept of biosphere, communities and ecosystems. Ecosystem characteristics, structure and function. Liebig's law of minimum, Shelford's law of Tolerance, Food chains, food webs and trophic structures. Ecological pyramids.

### **Unit II**

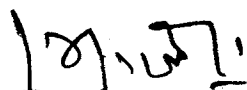
Inter species interactions in microbes: Antagonism, competition, commensalisms, synergism, parasitism and predation. Gansse's and Hardin's principles of competition. Beneficial interactions of microbes with animals: Rumen microbiology, digestion, fermentation and detoxification by microbes, factors influencing rumen microbes. Beneficial interactions of microbes with plants: Rhizosphere, rhizoplane, siderophore, Biofertilizer: types and applications; Mycorrhizae: classification and significance.

### **Unit III**

Role of microbes in biogeochemical cycles: Carbon cycle, Nitrogen Cycle, Phosphorus cycle, Sulphur cycle, Iron and Manganese cycle. Environmental impact of biogeochemical cycles. Eutrophication: Definition, causes of eutrophication and microbial changes in eutrophic bodies of water induced by various inorganic pollutants. Effects of eutrophication on the quality of water environment, factors influencing eutrophication, Algae in eutrophication, algal blooms, their effects and toxicity. Physico-chemical and biological measures to control eutrophication. Corrosion by microbes, desulphurization of coal.

### **Unit IV**

Microorganism in the ecosystem (air, soil and water), Soils profiles, major physiochemical and biological characteristics, soil microflora: distribution and contribution to ecosystem. Assessment of air quality for microbial loads; Brief account of air borne transmission of

  
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microbes - viruses - bacteria and fungi, their diseases and preventive measures. Microbial assessment of water quality, potability of water, microbes as bio-indicators, brief account of major water borne diseases and their control measures, treatment of municipal water, Microbial pest control, Biofilm formation and its ecological implication. Metagenomic approaches for the identification of microorganisms.

#### **Practicals:**

1. Isolation and identification of air borne microbes –Indoor & outdoor.
2. Isolation and identification of soil microflora.
3. Determination of soil texture and Humic acid.
4. Isolation and identification of microbial flora of water.
5. Soil microbes interaction *in vitro* by dual culture method.
6. Isolation, identification and enumeration of Rhizosphere and Rhizoplane microorganisms.
7. Isolation of Rhizobium from roots of leguminous plant.
8. Slides as per syllabus.

#### **Suggested Books:**

1. Agate, A. D. ,1982, Basic Principles of Geomicrobiology, MACS, Pune.
2. Atlas R.M. and Bartha R.,1998, Microbial Ecology: Fundamentals and Applications..4<sup>th</sup> edition. Benjamin /Cummings.
3. Baker K.H. and Herson D.S. ,1994, Bioremediation. McGraw Hill Inc. N.Y
4. Barton L. L. and Northup D. E.,2011, The Microbial Habitat: An Ecological Perspective. Wiley.
5. Barton L.L. and Northup D.E., 2011, Microbial Ecology. Wiley-Blackwell.
6. Bertrand J-C.,Caumette, P.,Lebaron P.,Matheron R., Normand P. and Sime –Ngando T., 2015, Environmental Microbiology: Fundamentals and Applications. Microbial Ecology. Springer, Netherlands.
7. Campbell, R.,1983, Microbial Ecology. Blackwell.
8. Connell, D.W. and Miller, G.J. (Eds.) ,1984, Chemistry and Ecotoxicology of pollution. Wiley Interscience Publications.
9. De A.K. Environmental chemistry, Wiley Eastern Ltd., New Delhi
10. Forster. C. F. and Wase, D.A.J. (Eds.),2001, Environmental Biotechnology. Ellis Harwood Ltd. Publication. Longman Inc California.



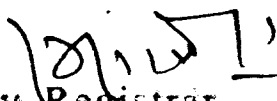
11. Madigan M. T., Martinko J. M., Bender K. S., Buckley D. H., Stahl D. A., Brock T., 2014. Brock's Biology of Microorganisms. 14<sup>th</sup> edition, Pearson.
12. Maier R.M., Pepper I.L. and Gerba C.H., 2009, Environmental Microbiology. Academic Press, Elsevier.
13. Maier, R.M., Pepper, I.L. & Gerba, C.P., 2009, Environmental Microbiology. 2<sup>nd</sup> Ed. Academic Press.
14. Mitchell, R., 1992, Environmental Microbiology. John Wiley & Sons.
15. Oladale O., 2005, Microbial Diversity. Blakewell Publishing.
16. Osborn M. and Smith C., 2005, Molecular Microbial Ecology. Taylor & Francis.
17. Richards, B.N., 1987, Microbes of Terrestrial Ecosystem. Longman.
18. Ronalds M, Atlas Microbial Ecology: Fundamentals and applications, , fourth edition, An imprint of Addison Wesley
19. Trivedy, R. K., 1998, Advances in Waste Water Treatment Technologies. Volumes I and II, Global Science Publication.
20. Wicket, L. P. and Hershberger, C. D., 2000, Biocatalysis and Biodegradation: Microbial transformation of organic compounds. ASM Publications.

### MBC 1003: Industrial Microbiology

**Max.Marks : 100**

#### **Unit:I**

Historical account of microbes in industrial microbiology; Components of a fermentation process; Sources and characters of industrially potent microbes: their isolation, primary and secondary screening and purification; Strain improvement for the selected organism: mutation and screening of improved cultures, random and strategic screening methods; Microbial growth kinetics in batch, continuous and fed batch fermentation process; Preservation and maintenance of microbial cultures.

  
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## Unit: II

Types of fermentation processes: Solid state and submerged fermentations: their advantages and disadvantages; Design of a basic fermenter: bioreactor configuration, design features, individual parts: baffles, impellers, foam separators, sparger, culture vessel, cooling and heating devices, probes for on-line monitoring, computer control of fermentation process; Factors affecting fermentation process (pH, aeration, agitation, temperature, etc); Types of Bioreactor: Stirred tank reactor, Bubble column reactor, Airlift reactor, Packed bed reactor, Fluidized bed reactors, Photo-bioreactors; Raw materials used in industrial fermentation media. Media formulation, sterilization and optimization.

## Unit III

Immobilisation of microbial enzymes and whole cells and their applications in industries; Downstream processing; Production of recombinant molecules in heterologous system, various steps for large protein purification; Brief idea of Patenting: Concept and its composition & protection of right and their limitation and intellectual property rights (IPR).

## Unit IV

Microbial commercial production of organic acids (citric acid); amino acids (glutamic acid and lysine); vitamin (vitamin B12); Industrial enzymes (cellulases, xylanases, amylases and proteases and their applications); Biofuels (ethanol and methane) from organic residues; Biomass (Baker's Yeast and Single Cell Proteins); Antibiotics (penicillin); Biofuels (Ethanol and Methane); Recombinant proteins (Insulin).

### Practicals:

1. Study of growth curve of microorganism/s.
2. Production of Baker's yeast.
3. Primary Screening techniques (crowded plate).
4. Secondary screening techniques.
5. Amino acid production using *E. coli* mutant strains.
6. Use of growth & production media for citric acid production.
7. Isolation of industrially important microorganisms for amylase production.
8. Isolation of protease producing microorganisms.
9. Enzyme immobilization.
10. Production of biofuels by microorganism/s.

### Suggested Books:

1. Casida L. E. J. R., 2015, *Industrial Microbiology*. New Age International, New Delhi
2. Crueger W and A. Crueger., 1991, *Biotechnology. A Textbook of Industrial Microbiology*, Sinauer Associates.

3. Reed G., Prescott S. C., Dunn C. G., 1987, Prescott and Dunn's Industrial Microbiology, 4th edition CBS, New Delhi.
4. Shuler M.L. and F. Kargi., 2001, Bioprocess Engineering Basic Concepts. (Prentice-Hall International Series in the Physical and Chemical Engineering Sciences) Prentice Hall.
5. Stanbury P. F., Whitaker, A. and Hall S. J., 2003, Principles of Fermentation Technology, 2<sup>nd</sup> edition, reprinted. Butterworth-Heinemann.
6. Vogel H.C., Todaro, C.L. and Todaro, C.C., 1997, Fermentation and Biochemical Engineering Handbook: Principles, Process Design, and Equipment. Noyes Data Corporation / Noyes Publications.

### **MBE 1001: Genomics and Proteomics**


**Max.Marks : 100**

#### **Unit 1**

Genome, genomics. Omics and importance; Structural organization of Prokaryotic and eukaryotic genomes; Evolution and structure of mitochondrial genomes; gene identification, Genome databases, genome diversity: Taxonomy and significance of genomes –bacteria, yeast, *Caenorhabditis*, *Homo sapiens* and *Arabidopsis*; Repetitive and transposable elements and their significance in the genome: Tandemly repeated DNA and interspersed genome-wide repeats; DNA and RNA Transposons.

#### **Unit II**

Genetic and Physical mapping: Linkage and Pedigree analysis, Markers: Genes, Restriction fragment length polymorphisms (RFLPs), Simple sequence length polymorphism (SSLP's), Amplified fragment length polymorphism (AFLP), Variable number tandem repeat (VNTR), Single nucleotide polymorphisms (SNPs), Restriction mapping, Fluorescent *in situ* hybridization (FISH), Sequence tagged site (STS), DNA finger printing, Radiation hybrid mapping; Genome Project – Human Genome project, Hap Map project, the 1000 genome project, The ENCODE

  
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project. Structural genomics – Assembly of Contiguous DNA sequences- Shot gun meth  
Clone Contig method and whole genome shotgun sequencing.

### Unit III

Protein structure - four levels of organization; Cellular functions performed by protein  
Introduction of proteomics; Protein analysis (concentration, amino acid composition, N- termi  
sequencing). Strategies for protein extraction, solubilization, identification and separation: i  
exchange, size-exclusion and affinity chromatography techniques; Polyacrylamide  
electrophoresis: Isoelectric focusing (IEF); Two dimensional PAGE for proteome analy  
Peptide fingerprinting, . Electro Spray Ionization( ESI), LS/MS-MS for identification of prote  
and modified proteins, Mass spectroscopy (MALDI-TOF), SAGE and differential display  
proteins and modified proteins. Mass finger printing (PMF), 3D structure determination by  
ray and NMR; Protein identification programme – MASCOT, PeptIdent and Protein prospect

### Unit IV

Biological data bases (Classification: Primary secondary and composite, Nucleotide sequen  
Interactomics: Techniques to study protein-protein interactions (Two hybrid interac  
screening); Bacterial protein meta-interactomes predict cross-species interactions and pro  
function; Viral interactomes; Overview of front-line techniques within the field of proteom  
Microarray techniques, Advantage, disadvantage and application of protein microar  
Databases and handling of sequence data, pair-wise alignment, multiple alignment, the po  
SRS and Entrez; Computational methods to study interactomes; Clinical and biomed  
application of proteomics.

### Practicals:

1. Study of Bacterial genome atlas BacMap.
2. Study of retro-transposons.
3. Cot and Rot curve analysis.
4. Ion-exchange chromatography.
5. Size-exclusion chromatography.
6. Affinity chromatography.
7. SDS-Polyacrylamide gel electrophoresis.

### Suggested Books:

1. Brown TA., 2006, Genome III .Garland Science Publishers.
2. Campbell, A.M., Heyer L.J. and Benjamin C., 2007 Discovering Genom  
Proteomics and Bioinformatics. 2<sup>nd</sup> edition. Cold Spring Harbor Lab Press, NY.

3. Lesk A.M., 2007. Introduction to Genomics. Oxford University Press.
4. Liebler D C., 2002, Introduction to Proteomics: Tools for the New Biology, Humana Press Inc.,
5. Lovric J., 2011. Introducing Proteomics. 1st edition, Wiley-Blackwell.
6. Nelson, T D. and Fraser K E., 2004, Microbial Genomes. Humana Press, Inc., USA
7. Pevsner J., 2009. Bioinformatics and Functional Genomics. 2<sup>nd</sup> edition, Wiley-Blackwell.

### **MBE 1002: Agriculture Microbiology**

**Max.Marks : 100**

#### **Unit: I**

Soil microorganisms in agro ecosystems: Types of microbial communities; soil microbial diversity: significance and conservation; Effect of agricultural practices on soil organisms; Chemical transformation by microbes: Organic matter decomposition, nutrient mineralization and immobilization; Transformation of carbon and carbon compounds; Availability of phosphorus, sulfur, iron and trace elements to plants; Biological nitrogen-fixation: Rhizobium-Legume Association; N<sub>2</sub> fixation by non-leguminous plants; Microbial products and plant health: PGPR (plant growth promoting rhizobacteria); significance of mycorrhizae; toxin producing microbes (antibiotics, aflatoxin).

#### **Unit: II**

Microbial biofertilizers and biopesticides: Production of bacterial biofertilizer: *Azospirillum*, *Azotobacter*, *Bacillus*, *Pseudomonas*, *Rhizobium* and *Frankia*; cyanobacterial biofertilizers: *Anabaena*, *Nostoc*, *Hapalosiphon*; Mycorrhizal biofertilizers: mycorrhizae - ecto and endo mycorrhizae and their importance in agriculture; Algal and other biofertilizers; Biofertilizers aiding in phosphorus nutrition; Regulation of ethylene production in roots, Secondary metabolite production; Production of microbial herbicides: bacterial insecticides, viral insecticides, entomopathogenic fungi & microbial nematodes.

### Unit III

Disease forecasting and basic principles of plant disease control: Pathology, etiology and control of economically important crop diseases of wheat (Rust, smut), paddy (Blast), barley (Smut), bajra (Ergot), maize (Downy mildew), sugarcane (Red rot), potato (Late blight and early blight) caused by fungi; Management & storage of agricultural products, post harvest diseases, their prevention and control.

### Unit IV

Microbial interactions in animals: Rumen microbiology, microbial contribution to feed digestion; Microbial diseases of farm animals (Anthrax, fowl cholera), their prevention and control. Role of bacteria in agriculture, scavenging, nitrifying, saprophytic, ensilage, feed producing and decomposing; Quorum sensing bacteria; Principles and mechanism of biological control; Commercial production of bio-pesticides with reference to *Bacillus thuringiensis*.

#### Practicals:

1. Isolation and enumeration of bacteria and fungi from soil samples.
2. Rhizosphere micro-organisms.
3. Physico-chemical testing of soil.
4. Microbes in composting.
5. Study of antagonism of micro-organism by dual culture inoculation method.
6. Commercial production of bio-fertilizers.
7. Standard ISI regulations for mass cultivation of bio-fertilizers.
8. Crop diseases caused by fungi listed in the syllabus.
9. Diseases of farm animal (any two).
10. Pheromone traps.
11. Slides as per syllabus.

#### Suggested Books:

1. Agrios G.N., 1997, Plant Pathology. Academic Press, San Diego.
2. Basu A.N. and Giri B.K., 1993, The Essentials of Viruses, Vectors and Plant Diseases. Wiley Eastern Ltd.
3. Glick B. R., Holguin G, Patten C. L., 1999, Biochemical and Genetic Mechanisms Involved in Plant Growth and Bacteria. Imperial College Press.
4. Black J.G., 2008. Microbiology : Principles and Explorations. 7<sup>th</sup> edition, International Student Version edition. John Wiley & Sons

5. Christen J.H., 2001, A Manual of Environmental Microbiology. ASM Publications.
6. Cook R.J. and Baker K.F., 1983, The Nature and Practice of Biological Control of Plant Pathogens. America Phytopathological Society Press, St. Paul, MN.
7. Cooper J. E. and Rao J. R., 2007, Molecular Approaches to Soil, Rhizosphere and Plant Microorganism Analysis. CABI Publication.
8. Dickinson M., 2003, Molecular Plant Pathology. BIOS Scientific Publishers, London.
9. Froster C.F. and John D.A., 2000, Environmental Biotechnology. Ellis Harwood Publications.
10. George N. A., 1997, Plant Pathology. 4<sup>th</sup> edition, Academic Press, New York.
11. Kahn M. S., Zaidi A. and Mussarrat J., 2009, Microbes in Sustainable Agriculture. Nova Science Publishers
12. Liong Min-Tze., 2015, Beneficial Microorganisms in Agriculture, Aquaculture and Other Areas (Microbiology Monographs). 1<sup>st</sup> edition. Springer.
13. Lopez- Real J.M. and Hodges R.D., 1986, Role of Microorganisms in a Sustainable Agriculture. AB Academic Publishers
14. Rao N.S.S., 1999, Soil Microbiology. Oxford & ISH Publishing Co., New Delhi.
15. Sigee D.C., 1993, Bacterial Plant Pathology, Cell and Molecular Aspects. Cambridge University Press.
16. Subbarao N.S and Dommergues Y. R., 2000, Microbial Interactions in Agriculture and Forestry. v. 2 Science Publishers U.S.
17. van Elsas J. D and Trevors J. T., 2006, Modern Soil Microbiology. 2<sup>nd</sup> edition, Cambridge Press / Taylor and Francis Group