

**SOLAPUR UNIVERSITY  
SOLAPUR**

**M.Sc. Part II**

**Semester III & Semester IV**

**Microbiology**

**Syllabus 2012**

# SOLAPUR UNIVERSITY SOLAPUR

M. Sc. Part - II Sem III and Sem IV

Syllabus

(With effect from June2012)

Paper No.	Subject Code	Name of the Subject	Total Marks
		SEMESTER-III	
Paper IX	MIC 301	Molecular Biology and Genetic Engineering	100
Paper X	MIC 302	Health care and Diagnostic Microbiology	100
Paper XI	MIC 303	Bioprocess Technology and Fermentation Technology	100
Paper XII	MIC 304	Food and Dairy Microbiology	100
PR:V	MIC 305	Practical Course V	100
PR:VI	MIC 306	Practical Course VI	100
		SEMESTER-IV	
Paper XIII	MIC 401	Immunology and Immunotechnology	100
Paper XIV	MIC 402	Bioinformatics and Biometry	100
Paper XV	MIC 403	Waste Management Technology	100
Paper XVI	MIC 404	Agricultural Microbiology	100
PR:VII	MIC 405	Practical Course VII	100
PR:VIII	MIC 406	Practical Course VIII (Project Work/Industrial Training)	100

**M.Sc.MICROBIOLOGY (SEM.III)****Paper IX****MIC 301: MOLECULAR BIOLOGY AND GENETIC ENGINEERING****UNIT – I 10L**

**1.Methods of studying DNA:** Southern blotting, Northern blotting, labeling-radioactive and non-radioactive labeling, and Isopycnic separation.

**2. DNA sequencing:** Direct sequencing, indirect sequencing, Maxam and Gilbert method, Sanger's Method, RNA sequencing, PCR sequencing.

**3. Nucleic acid hybridization:** Design and construction of probes, nick translation, chemical synthesis, hybridization, liquid hybridization, solid hybridization, determination of stringency conditions. Applications of nucleic acid hybridization.

**UNIT – II 10L**

**1. Mutations** – Nature and types, mutagenic agents- physical, chemical and biological. Phage mediated mutagenesis, site directed mutagenesis. Fluctuation test and replica plate technique, isolation of mutants, mutagenicity and carcinogenicity testing (Ames test, inductive test and muta test).

**2. Gene transfer in bacteria** transformation, transduction, conjugation, transfection, protoplast fusion, electroporation, restriction and modification of DNA, recombination enzymes involved.

**UNIT-III 8L**

**1.** Molecular biology of Oncogenesis, Neoplastic transformation, theories of Oncogenesis

**2.** Molecular biology of Nitrogen fixation.

**3.** Law of DNA constancy and redundancy, dosage compensation, genetic load, C-value paradox, Cot curves and DNA reassociation constant.

**UNIT – IV 10L****General Strategy of gene cloning**

**1.** Vectors in Genetic engineering

**a. Plasmid vectors** – Use of natural plasmids as vectors, artificial plasmid vectors, pSC101, R1, pBR322, pUC18, Ti plasmid vectors.

**B.Bacteriophage vectors** – Insertion vectors, replacement vectors, Cosmid vectors, phagemid vectors, shuttle vectors, M13 based vectors.

**2. Restriction endonucleases** – Type I, II and III, restriction mapping, RFLP and RAPD

**3. Constructions of recombinant DNA-** selection of DNA fragment for cloning, cDNA synthesis, chemical synthesis, gene synthesizers, ligation with RES, homopolymer tailing, blunt end ligation, linkers, monitoring restriction and ligation.

**4. Insertion of recombinant DNA** – Host selection, transformation, transfection, electroporation, lipofection.

**5. Screening of recombinants****6. DNA libraries** –Genome libraries and cDNA libraries.**UNIT – V Protein engineering & Metabolic engineering: 10L**

1. Proteins- cellular storage and secretions, protein sequencing and protein Engineering – Methodology and Applications, Metabolic engineering-Essence of metabolic engineering, examples of pathway manipulations, metabolic engineering in practice, metabolic flux analysis and its applications, synthesis low molecular weight compounds

2. Applications of Genetic engineering & legal aspects in genetic engineering.

**References:**

1. Turner P.C. et al, 2001, Instant notes on Molecular Biology, Viva Books Pvt.Ltd.
2. Gerard Krap, 1999, Cell and Molecular Biology, John Wiley & Sons Inc. New York.
3. Miller G., et al, 1996, An Introduction to genetic analysis, Freeman & Co., New York.
4. Glick & Pasternak 1998, Molecular Biotechnology and Applications of Recombinant DNA, ASM Press.
5. Hyoue – Myong Enn. 1996, Enzymology Principles for Recombinant DNA Technology, Academic press.
6. Watson J.D. et al, 1992, Recombinant DNA, Scientific American Books.
7. Desmond S.T. & Nicoll, 1994, An introduction to Genetic Engineering Cambridge Univ. Press.
8. freifelder D. & Malacinski G.M., 1993, Essentials of molecular Biology, Jones & Bartlet Publ. Inc.
9. Glazer & Nikaido, 1995, Microbial Biotechnology – Fundamentals of Applied Microbiology, Freeman publ.
10. Nicholl D.S.T.1994, An Introduction to Genetic Engineering, Cambridge Univ. Press.
11. Old R.W. & primrose S.B., 1986, Principles of Gene Manipulations, Blackwell Sci. Publ.
12. Brown T. A. Ed.Homes B.D. & Richwood D. 1998 Molecular Biology: LABFAX, Academic press.

**M.Sc.MICROBIOLOGY (SEM.III)**  
**Paper X**  
**MIC 302: Health Care and Diagnostic Microbiology**

**UNIT – I****8L****1 Determinants of microbial pathogenicity**

Infection, Transmission of infection, infection process, Bacterial pathogenicity, Regulation of bacterial virulence factors, Bacterial virulence factors.

**2. Virulence factors:** mechanisms of adhesion, colonization and invasion of host tissues by bacterial pathogens

Microbial toxins: Mode of action and assay (in vivo and in vitro) of - diphtheria, cholera, tetanus toxins and endotoxins of gram negative bacteria

Mechanism of bacterial resistance to host and humoral defenses

**UNIT – II****10L****1 Microbiology pharmacological industries**

Study of major group of Pharmacologically active molecules of plant, animal and microbial origins

Physical and Chemical properties, metabolic activity, identification of drug target / receptors, elucidation of the mechanisms of drug action, Drug interactions, toxicity and adverse reactions, toxicity testing, assays for mutagenicity, carcinogenicity, pyrogenicity and allergy testing, Extraction, Purification and Characterization of bioactive molecules

1) Extraction: Hot and cold extraction methods, solvent extraction

2) Purification: Analytical and preparative techniques

3) Characterization: Physical and chemical characterization methods for alkaloids, steroids, flavanoids, terpenoids, saponins, proteins peptides and amino acids etc. Steps towards commercialization of a drug, Regulation of drugs, FDA.

**UNIT – III****1 Antimicrobial agents and chemotherapy****10L**

1. Antimicrobial assays in liquid media - factors affecting assay techniques

2. Antimicrobial assays in agar media - gradient plate technique, disc /well diffusion techniques, and factors affecting diffusion tests.

3. Susceptibility testing for - anti-mycobacterials, anti-fungal, anti-parasitic, antiviral agents.

4. Laboratory evaluation of new antibiotics:

a) In vitro screening, experimental animal infection, animal models

for activity.

- b) Toxicity, tolerability, carcinogenicity, teratogenicity, and allergy testing.
5. Correlation between in vitro and in vivo sensitivity testing and clinical outcome
6. Lines of evidence to indicate the target of antimicrobial agents, methods for study of the mode of action and resistance to antimicrobial agents:

#### **UNIT-IV**

##### **1 Mechanism of action of antibiotics**

**10L**

- a) Affecting cell wall: Cycloserine, Vancomycin, Cerulenin, beta-lactams.
- b) Affecting cell membrane: Polymyxins, Valinomycins, Monesin
- c) Inhibitors of Nucleic acid and synthesis: Azaserine, DON, Bleomycin, Mitomycin C, Acridines, Chloroquin, Hydrophenyl azopyrimidine, Nalidixic acid
- d) Inhibitors of protein synthesis - Chloromaphenicol, Erythromycin, Fusidic acid, Cycloheximide.
- e) Synthetic antimicrobials: Nitrofurans, INH
- f) Antifungal agents
- g) Antiviral agents
- h) Antiprotozoal agents

#### **UNIT V**

**10L**

##### **1. Methods used in Diagnostic Microbiology**

Use of various Antigen-antibody detection method/technologies used in medical diagnostics –Agglutination, Precipitation, Complement fixation test (CFT),PCR, real-time PCR, PCR Sequencing, Enzyme Linked Immunosorbant Assay (ELISA), Radioimmunoassay (RIA), Florescence In Situ Hybridization (FISH), Immunohistochemistry (IHC),Flow cytometry

##### **2. Quality control in Microbiology laboratory**

Role of microbiology laboratory, Specimen handling, laboratory records, safety regulation, basic procedure of diagnostic microbiology laboratory, Rapid methods for identification of microorganisms, Principles, working and applications of instruments in medical microbiology.

**References**

1. Jawets, Melnick and Adelberg's Medical Microbiology 24<sup>th</sup> Edition (2001)
2. Yu VL, Merrigan TC, Jr. Barrier SL (editors) – Antimicrobial Therapy and Vaccines, Williams and Wilkins, 1999.
3. R. Ananthnarayana, C.K. Jayaram Panikar's Text Book of Microbiology, 4<sup>th</sup> Edition 1992.
4. P. Chakraborty – A text book of Microbiology, 1<sup>st</sup> Edition, 1995.
5. Greenwood, D. Black RCB, Peutherer JF (Eds) 1992, Medical Microbiology 14<sup>th</sup> Edition, Edinburgh – Churchill Livingstone.
6. Ross PW, Peutherer JG 1987, Clinical Microbiology, Edinburgh – Churchill Livingstone.
7. Sleigh JD, Tmbury MC 1990, Medical Bacteriology 3<sup>rd</sup> Edition Edinburgh – Churchill Livingstone.
8. Parker MT. Collier LH (Eds) 1990) Topley and Wilson's Principles of Bacteriology, Virology and Immunology 8<sup>th</sup> Edn, London – Edward Arnold.
9. Wilson JD, Braunwald E, Esselbacher KJ, Petesrdorf RG, Martin JB, Fanci AS, Root RK, 1991, Harrison's Principles of Internal Medicine Vol 1 12<sup>th</sup> Ed, New York McGraw-Hill, Inc.
10. Salyers AA, Whitte DD, Bacterial Pathogenesis, 2<sup>nd</sup> Ed. American Society for Microbiology, 2002

**M.Sc. MICROBIOLOGY (SEM.III)****Paper XI****MIC – 303 Bioprocess technology and Fermentation Technology****Unit-I****10L**

## 1. Bioreactor Design and Operation.

- a) Design aspects, the dimensional ratio of the outer shell and operational aspects such as working volume, baffles and impellers. The configuration (placement) of impellers in vessel and different types of impellers.
- b) Different types of fermenters.
- c) Facilitation for maintaining all parameters during fermentation. Aeration, Agitation.
- d) Sterilization of fermenter and other mechanical system of fermentor

## 2. Monitoring of process variables.

- a) Fermentation broth rheology and power requirement for agitation. Concept of Newtonian and Non-Newtonian fluids, effect of broth rheology on heat, nutrient and oxygen transfer, Reynolds number, power number, Aeration number, working out examples with different softwares.
- b) Use of various types of sensors and biosensors for maintaining environmental parameter (pressure, pH, temperature, DO, DCO<sub>2</sub>)
- c) Operational modes bioreactor, batch, feed batch, continuous.
- d) Automation in fermentation industry.

**Unit-II****10 L**

## 1. Growth and product formation concept during fermentation.

- a) Concept of primary and secondary metabolites and their control, kinetics of growth and product formation.
- b) Control of metabolic pathways, environmental and genetic control.
- c) Effect of type of growth on fermentation.
- d) Mycelial pellet form, mycelial filamentous form, free cells, cell producing exopolymers, affects mass transfer of nutrients, oxygen and heat: as cell proliferation.

2. Development of microbial processing.
  - a) Fermentation media and microbial growth, media composition, types of media, sterilization of media, screening of media.
  - b) Growth and development of microorganisms, synchronous and synchronized, growth yield, effect of limiting factors.
  - c) Screening, strain improvement, scale up, inoculums preparation, stock culture maintenance, contamination problems

**Unit-III****8L**

1. Downstream processing and Quality control.
  - a) Product recovery and purification. Centrifugation, Filtration, Precipitation, Solvent extraction, Chromatography, Ultra Filtration, Crystallization and whole broth processing.
  - b) Quality control in fermentation industry. Assay testing, Sterility testing, Pyrogenicity testing, Toxicity and Allergy, Carcinogenicity testing.

**Unit-IV****10L**

Industrial production of

- 1) Streptomycin, Amylase, Vitamin B<sub>12</sub>, L-Lysine,
- 2) Microbial transformation of antibiotics and steroids.
- 3) Microbial production of nucleosides, nucleotides, pigments.
- 4) Production and applications of biopolymers, Xanthan gum, dextran, pullulan, mannan, curdlan and Alginate.
- 5) Production of Mushroom, production steps, harvesting and preservation, nutritive value
- 6) Industrial production of distilled alcoholic beverages. Whisky and Brandy.

**Unit-V****10L**

1. Biosafety, Bioethics and IPR
  - a) Guidelines for safety in microbiological processes, Good manufacturing practices, biosafety levels of infectious agents.
  - b) Regulatory practices, process validation, Quality assurance.
  - c) Bioethics – concept, case study, stem cells, GM foods and Nanobiotechnology.

- d) Intellectual property rights. Basic concept, patents, trade secrets, Copyrights, Trademarks. Patent regulatory bodies at National and International level.

**References:**

1. Principles of Fermentation Technology by Stanbury, P.F., Whitekar A. and Hall. 1995., Pergaman. McNeul and Harvey.
2. Fermentations - A practical approach. IRL.
3. Bioprocess Technology: Fundamentals and Applications. Stockholm KTH.
4. Biochemical Reactors by Atkinson B., Pion, Ltd. London.
5. Biotechnology - A Text Book of Industrial Microbiology by Cruger.
6. Fermentation Biotechnology: Industrial Perspectives by Chand.
7. Biochemical Engineering Fundamentals by Bailey and Ollis, Tata McGraw Hill, N.Y.
8. Biotechnology. Volume 3. Edited by H. J. Rehm and G. Reed. Verlag Chemie. 1983.
9. Advances in Biochemical Engineering by T.K. Bhosh, A.Fiechter and N. Blakebrough. Springer Verlag Publications, New York.
10. Bioprocess Engineering Kinetics, Mass Transport, Reactors, and Gene expressions by Veith, W.F., John Wiley and Sons.
11. Applied Microbiology Series.
12. Industrial Microbiology by L.E. Casida, Wiley Eastern
13. Bioseparation: Downstream processing for Biotechnology by Belter, P.A. Cussler, E.L.and Hu, W.S., John Wiley and Sons, N.Y.
14. Separation process in Biotechnolgy by Asenjo, J.A. Eds. Marcel Dekkar, N.Y.
15. Bioprocess Engineering Principles by Doran, Acad. Press, London.
16. Bioreaction Engineering Principles by Nielsen, J. and Villadsen, plenum Press, N.Y.
17. Fermentation, Biocatalysis and bioseparation, Encyclopedia of Bioprocess Technology by Chisti, Y., Vol. 5, John Wiley and Sons, N, Y.

**M.Sc.MICROBIOLOGY (SEM.III)**  
**Paper XII**  
**MIC – 304: Food and Dairy Microbiology.**

**Unit-I** **10L**

1. General principles underlying spoilage of foods & Food as substrates for microorganisms.
2. Microbiology and food spoilage: Microbiology and spoilage of i) meat and meat products, ii) fish and poultry, iii) fruits and vegetables, iv) sugar and sugar products, and canned foods.
3. Microbial food poisoning and infections, investigation of food born outbreaks, prevention and control

**Unit-II** **8L**

1. General principles underlying food preservation and different methods of food preservation, process of canning.
2. Microbial flavors in food and dairy industry.

**Unit-III** **10 L**

1. Microbiology of Milk and milk products: Composition and nutritive value of milk.
2. Spoilage of milk and milk products: Khoa, paneer, cream, basundi, ice creams,
3. Milk born diseases: Antimicrobial systems in milk, sources of contaminations of milk, prevention and control of milk born diseases.
4. General principles underlying preservation of milk: Pasteurization, Flash Pasteurization, Kinetics of pasteurization & phosphatase test.

**Unit-IV** **10 L**

1. **Fermented milk products:** Types, Production and Defects in: **a)** Cultured butter milk, dahi, butter and cheese, paneer, chakka, shrikhand, creams, basundi and ice creams **b)** Kefir, kumiss, yoghurt, Bulgarian sour milk,
2. **Fermented food products** Types, Production and Defects in: **a)** Jilebi, punjabi warri, dhokla, **b)** lime and mango pickles,

**Unit-V** **10 L**

1. Chemical and microbiological examination of food & milk, grading of food & milk.
2. Food adulterations and contaminations of foods with harmful microorganisms.
3. Food laws and standards, Indian and international food safety laws and standards.

BIS Laboratory Services, BIS product certification and licensing, BIS Quality Systems certification.

4. Quality and safety assurance in food and dairy industry, Sanitation and regulation in food and dairy industry, food and dairy arithmetic standardization of products & costing.

**REFERENCES:**

- 1) The Technology of Food Preservation: 4<sup>th</sup> Edi. Norman N. Potter (1987) CBS Publi.
- 2) Milk and Milk Products: 4<sup>th</sup> Edi. Clasence Hanry. TMH Publications.
- 3) Food Processing: Biotechnological Applications (2000). S.S.Marwaha and Arora. Asiatech publications, New Delhi.
- 4) Food Microbiology: Frazier.
- 5) Food Microbiology: James De and De.
- 6) Dairy Technology : Sukumar De.
- 7) Food Science: 5<sup>th</sup> Edi, Norman N. Potter (1996). CBS Publications and distributors.

**MIC- 305: PR V: PRACTICAL COURSE V**

1. Detection of polytene chromosomes chromosomal bands in chironomus larval salivary gland cells
2. Determination of Genetic transformation in Bacteria
3. Study of transformation, transfection, conjugation, transduction, electroporation and protoplast fusion in bacteria
4. Isolation of restriction endonucleases from bacteria
5. Estimation of mutation rate in bacteria, site directed mutagenesis
6. Fluctuation test
7. Isolation of thiamine requiring mutants of *E.coli* using replica plate technique
  8. Antibiotic sensitivity tests by Kirby-Bauer method.
  9. Antibiotic sensitivity tests by Stocks comparative diffusion method
  10. Determination of MIC (Minimal inhibitory concentration) by tube, disc and plate method.
  11. Detection of MIC 50 and MBC of an antibiotic.
  12. Isolation and Identification of pathogen belonging to Enterobacteriaceae at species level
13. Demonstration on animal inoculation by various routes.

**MIC- 306: PR VI: PRACTICAL COURSE VI:**

1. Detection of IAA by *Azospirillum* / *Pseudomonas*. Detection of siderophore production by *Pseudomonas*.
2. Detection of adulteration in common foods
3. Detection of aflatoxin in food and feed.
4. Chemical analysis of foods-pH, benzoate, sorbates and colour.
5. Microbiological Analysis of food- MPN, Resazurin, Chemical-pH, fat, protein sugar and ash,
6. Physical analysis -sp.gravity, different solids, tests for grading of milk.
7. Platform tests in dairy industry- COB, alcohol precipitation, titrable acidity test, quantitative phosphatase, mastitis and BRT tests.
8. Production lactose and casein from milk.
9. Microbiology of butter, cheese and idli batter
10. Laboratory production of *Bacillus thuringiensis* insecticide and testing of its efficiency
11. Production of biomass of *Azotobacter*, *Rhizobium*, *Azolla*, *Azospirillum*, *Blue green algae* and preparation of biofertilizer
12. Bioassay of streptomycin, lovastatin and doxorubicin
13. Biofuel energy –electricity and biogas production

**M.Sc. MICROBIOLOGY(SEM IV)**  
**Paper XIII**

**401 – IMMUNOLOGY AND IMMUNO-TECHNOLOGY**

**UNIT – I**

- 1. Immunity** **10L**  
Innate and acquired immunity, Cells of immune response, Structure, types and functions of lymphoid organs, lymphatic system
- 2. Biology of immune cells:**  
B cells – development, maturation and their surface molecules, T cell structure, development, maturation, and differentiation and their surface molecules, Subsets of T-cells. NK cells, Antigen presenting cells,
- 3 Clinical Immunology**  
Immune response to infectious diseases, viral, bacterial, protozoan and parasitic infections, Immunodeficiency disorders – Phagocytic deficiencies, humoral deficiencies, cell mediated deficiencies and combined deficiencies, complement deficiencies, Autoimmunity, Rheumatic diseases: Systemic lupus erythomatosus, Rheumatoid arthritis, Multiple myeloma.

**UNIT – II**

- 1. Major histocompatibility systems:** **10L**  
The H2 and HLA complex, H-2 haplotypes of mouse strains, MHC and antigen presentation, structure of class I and class II molecules, polymorphism of MHC molecules, MHC and disease association, methods of HLA typing.
- 2. Cytokines:**  
Cytokines – general properties, structure and function (Tumor Necrosis Factor, Interleukins, Interferon etc.), cytokines in disease, immunoregulatory role of cytokines.

**UNIT – III**

- 1. T-Cell Receptor** **10L**  
Structure and function of T cell receptor (TCR), T cell accessory membrane molecules (CD and adhesion molecules), and signal transduction by TCR/CD3.
- 2. Regulation of Immune Response:**  
Antigen as regulatory mechanism, network theory, internal images and anti-images, role of cytokines in regulation of immune response, mechanism of tolerance induction, regulation of complement system,

Immunomodulation – by Biological Response Modifiers (BRMs) and by cytokines

**3. Basis of antibody diversity**

multi gene organization and expression of immunoglobulin genes, immunoglobulin class switching, hybrid antibodies, immunoglobulin gene libraries, inheritance of MHC antigens

**UNIT – IV**

**1 Experimental Immunology**

**8L**

In vitro systems- Principles and kinetics of antigen antibody reactions, detection and quantitation of cytokines, FACS, western blotting, cell culture systems, haemolytic plaque assay.

In vivo systems – Experimental animals in immunology research, models for autoimmunity and other immunopathological conditions.

Experimental systems for: Cell mediated immune responses, Transplantation and adoptive transfer, Cell to cell interactions, Functional assays of cytokines.

**UNIT – V**

**1. Immune system evolution:**

**10L**

Evolution of immune system in invertebrates and vertebrates, Occurrence of immune system components in invertebrate and vertebrates, evolution of immunoglobulin heavy and light chain classes and subclass.

**2. Tumor Immunology:**

Cellular adaptations and properties of cancer cells, escape mechanisms of tumor from host defense, immune response to tumor – role of cells of immune system, Immunosurveillance theory, tumor antigens, cancer immunotherapy, immuno-diagnosis of tumors (detection of tumor markers, e.g. alpha fetoprotein, carcino-embryonic antigen etc.)

**References: IMMUNOLOGY AND IMMUNO-TECHNOLOGY**

1. Chatterji C.C. (1992) Human Physiology Vol. 1 and 2, Medical Allied Agency, Calcutta,
2. Guyton A.C. and Hall J.E. (1996) Text Book of Medical Physiology, Goel Book Agency, Bangalore.
3. Baron D.N. Shhort Text book on Chemical Pathology, ELBS, London.
4. Austyn J.M. and Wood K.J. (1993) Principles of molecular and cellular Immunology, Oxford University Press.
5. Barrel James D. (1983) Text Book of Immunology, 4<sup>th</sup> Edition, C.V. Mosby and Co., London.

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7. Pathak S.S. and Palan V. (1997) Immunology, Essential and Fundamental, Pareer Publications, Mumbai
8. Talwar G.P. (1983) Handbook of Immunology, Vikas Publishing Pvt Ltd, New Delhi.
9. Roitt M. (1984) Essentials of Immunology, P.G. Publishers Pvt. Ltd, New Delhi
10. Roitt M. (1988) Essentials of Immunology, ELBS, London.
11. Kuby J. (1996) Immunology Ed. 3 W.H. Freeman and Co.

**M.Sc.MICROBIOLOGY(SEM IV)**  
**Paper XIV**

**MIC: 402 - Bioinformatics and Biometry**

**UNIT – I**

**10L**

1. **Introduction to Bioinformatics:** Use of bioinformatics in major research areas. Major Bioinformatics Resources: (National Centre for Biotechnology Information (NCBI), European Bioinformatics Institute (EBI), Expert Protein Analysis System (ExPASy). The knowledge of various databases and bioinformatics tools available at these resources, the major content of the databases, purpose and utility in life sciences.
2. **Open access bibliographic resources and literature databases:** Basic concept of open access bibliographic resources related to Life Sciences, the significance and need for such resources, the major content of the databases, how to search and use these resources/databases with special reference to PubMed, PubMed Central, Public Library of Sciences etc.

**UNIT – II**

**10L**

- 1 **Taxonomy and phylogeny:** Phylogenetic analysis algorithms such as Maximum Parsimony, UPGMA, Transformed Distance, Neighbors-Relation, Neighbor-Joining; Probabilistic models and associated algorithms such as Probabilistic models of evolution and Maximum likelihood algorithm.
- 2 Chemoinformatics, Pharmacogenomics – Application of Bioinformatics in drug discovery,

**UNIT – III**

**10L**

**Sequence and Structure Databases:** Knowledge of the following databases with respect to: organization of data, contents and formats of database entries, retrieval of data using text-based search tools, sources of data (e.g. sequencing projects, individual scientists, patent offices etc.), method for deposition of data to databases.

Nucleic acid sequence databases: GenBank, EMBL, DDBJ

Protein sequence databases: SWISS-PROT, TrEMBL.

Genome Databases at NCBI, EBI, TIGR, SANGER

Viral Genomes

Archeal and Bacterial Genomes

**Genomics and Proteomics**

Large scale genome sequencing strategies

Gene networks/basic concepts, computational model such as Lambda receptor and Lac-operon.

**Functional genomics:** application of sequence based and structure-based approaches to assignment of gene functions - e.g. sequence comparison, structure analysis (especially active sites, binding sites) and comparison, pattern identification, etc. Use of various derived databases.

**DNA microarray:** understanding of microarray data and correlation of gene expression data to biological processes and computational analysis tools (especially clustering approaches).

**Protein arrays:** bioinformatics-based tools for analysis of proteomics data (Tools available at ExPASy Proteomics server); databases (such as InterPro) and analysis tools

Prediction of 3D structure of proteins

#### **Unit – IV – Biostatistics**

**10L**

- 1 Biostatistics - Basic concepts, definitions, statistics and biostatistics, sampling methods, merits and demerits of Random, deliberate or nonrandom, stratified, and cluster sampling. scales and variables, data organization, tabulation, graphical representation,
- 2 Collection and presentation of data: primary and secondary data, collection of data – enumeration and measurement, significant digits, rounding of data, accuracy and precision, recording of data. Tabular and diagrammatic presentation – arrays, frequency distribution, bar diagrams, histograms and frequency polygons.
- 3 Descriptive statistics: measures of central tendency, dispersion, skewness and kurtosis, Normal, Binomial and Poisson distribution and their applications, test for goodness of fit. Standard error, Confidence interval

#### **UNIT – V- Probability**

**8L**

- 1 Probability - definition, elementary properties, types, rules, applications to biological problems, chi-square ( $\chi^2$ ) distribution and test.
- 2 Hypothesis testing: definition of hypothesis, hypotheses - null and alternate hypotheses, general procedure, decision about  $H_0$  – one-tailed and two-tailed tests, type I and type II errors
- 3 Analysis of Variance (ANOVA): basic concepts, experimental designs – CRD, RBD, factorial experiment, repeated measures, other designs, general method, F – test, multiple comparison tests.
- 4 Correlation and Regression

## References

### Bioinformatics

1. Bergeron, B. (2003) Bioinformatics Computing, Prentice-Hall of India Private Limited, New Delhi – 110 001
2. Baxevanis, A. D. and Ouellette, B. F. F. (2001) Bioinformatics: A practical guide to the analysis of genes and proteins. Second Edition. John Wiley & Sons, New York.
3. Jean-Michel Claverie and C. Notredame (2003) Bioinformatics: A Beginner's Guide, Wiley Dreamtech India (P) Ltd., New Delhi
4. Khan, I. A. (2005) Elementary Bioinformatics, Pharma Book Syndicate, Hyderabad – 500 095
5. Lacroix, Z. and Critchlow, T. (Eds.) 2003. Bioinformatics. Managing Scientific Data. Morgan Kaufmann Publishers.
6. Mount, D. W. (2001) Bioinformatics: sequence and genome analysis. Cold Spring Harbor Laboratory Press, New York.
7. Narayanan, P. (2005) Bioinformatics a Primer, New Age International (P) Limited, Publishers, New Delhi – 110 002
8. Westhead, D. R., J. H. Parish and R. M. Twyman (2003) Bioinformatics (Instant Notes Series), Viva Books Private Limited, New Delhi, Mumbai, Chennai, Kolkata
9. Zoe L. and Terence C. (2004) Bioinformatics: Managing Scientific Data, Morgan Kaufmann Publishers, New Delhi

### Biostatistics

1. Daniel, Wayne (2007) Biostatistics A foundation for Analysis in the healthsciences, Edition 7, Wiley- India edition.
2. Davis, Charles S.(2002): Statistical Methods for the Analysis of Repeated Measurements
3. Finney, D.J. (1971): Statistical Method in Biological Assays.
4. Fleiss, Joseph L., Levin Bruce & Paik Myunghee Cho (2003): Statistical Methods for Rates and Proportions
5. Irfan Ali Khan and Atiya Khanum, Fundamentals of Biostatistics. 2nd Ed. Ukaaz Publications, Hyderabad.
6. Montgomery D.C. – Design and analysis of experiments, John Wiley & Sons.
7. Murthy M.N. – Sampling methods, Indian Statistical Institute, Kolkata.

**M.Sc. MICROBIOLOGY(SEM IV)**  
**Paper XV**  
**MIC:403- Waste Management Technology**

- UNIT –I** **8L**  
**Types and Characterization of Industrial wastes:** Types of industrial wastes, General Characteristics of different wastes- pH, Suspended solids, volatile solids, BOD, COD, Organic Carbon etc.
- UNIT –II** **10L**  
**Microbiology and biochemistry of waste water treatment:**  
**a.** Introduction, types of biological treatments, impact of pollutants on bio-treatment, bio-augmentation, basic concepts of waste water treatment  
**b.** Microorganisms in waste water treatment: source of organisms, enrichment and acclimatization, isolation, treatability tests, mass scale production, mixed cultures.  
**c.** genetically engineered microorganisms, preservation, applications and future prospects
- UNIT –III** **12L**  
**Working of treatment systems and their analysis:**  
**a.** Reaction and kinetics, mass balance analysis, reactor types, hydraulic characters of reactor, selection of reactor type  
**B.Critical** operation parameters like DO, HRT, Mean Cell Residence Time (MCRT), F/M ratio, tank volume, flow rate, BOD, COD, temperature. Malfunctioning of treatment systems due to shock loading, hydraulic loading and remedial measures adapted.  
**C.Hazardous** waste management, low cost waste treatment systems, treatment of distillery, textile, paper and Pulp and cyanide wastes.
- UNIT –IV** **8L**  
**1.Waste disposal control and regulations:**  
**a.** Water pollution control, regulation and limits for disposal into Lakes, rivers, oceans, and land.  
**b.**Environmental Impact Assessment (EIA), Environmental Audit (EA)  
**c.**Water Tracing: need, tracing problems, criteria for selection of tracer, tracing method, significance.
- UNIT –V** **10L**  
**1 Novel Methods of Pollution Control :** Vermicomposting, treatment using aquatic plants, root zone process  
**2.** Eutrophication, El Nino, global warming, acid rains and significance  
**3.** Enzymes and Pollution – Monooxygenases, aminotransferases, bioenergetic enzymes, other metabolic enzymes, enzymatic Rectifications.

**REFERENCES:**

1. Environmental biotechnology (Industrial pollution Management). Jogdand S.N., Himalaya publishing house.
2. Waste water treatment – Rao M.N. and A.K.Datta
3. Industrial pollution Control, Vol. 1, E. Joe, Middle Brooks.
4. The treatment of industrial wastes, 2<sup>nd</sup> Ed. Edmund D. Besselievre and Max Schwartz.
5. Water and water pollution hand book, Vol. 1, Leonard L., Ciaccio
6. Treatment of Industrial Effluents- A.G. callely, C.F. Foster and D.A. Stafford

**M.Sc. MICROBIOLOGY (SEM IV)**  
**Paper XVI**  
**MIC 404: AGRICULTURAL MICROBIOLOGY**

**UNIT –I** **8L**

**Soil environment:** Physicochemical and biological properties of soil ,soil microorganisms, soil enzymes, organic matter decomposition, microorganisms and soil fertility, biogeochemical cycles-C, N, S and P. Methods used in soil chemistry and microbiological studies, microbial products influencing plant growth

**UNIT –II** **8L**

**Rhizosphere and Phyllosphere** – Rhizospheric effect, nitrogen fixation in rhizosphere, root exudates, influence of rhizosphere on crop productivity, biological control within microbial communities of the rhizosphere, plant growth promoting rhizobacteria, siderophores, role of antibiotics and siderophore in biocontrol of plant pathogens, phyllosphere and microorganisms.

Frankia Induced Nodulation in Actinorrhizal Plants, Rhizobium-cultivated and wild legume plant root nodulation and significance

**UNIT –III** **8L**

**Recycling of Agriculture and animal waste**

Composting - different methods, anaerobic digestion, merits and the demerits of the processes, saccharification of cellulosic wastes

2) Plant Tissue Culture – Types, formulation of growth media, techniques and applications.

**UNIT –IV** **12L**

**Biofertilizers**

1. Historical development, concept, scope, merits and limitations of Biofertilize Systematic study of major groups of microorganisms as biofertilizers, Nitrogen fixing bacteria, Phosphate solubilizing microbes, blue green algae and mycorrhizae.

2. Production of biofertilizers, screening, selection of potential strains Laboratory and large scale production of bacterial, algal and fungal biofertilizers

3. Methods of application and evaluation of biofertilizers.

Green manure, organic matter, compost and composting, vermi-composting Production, economics and commercial viability of biofertilizers. Latest developments and future prospects of biofertilizer technology.

**UNIT –V****12L****BIOPESTICIDES**

1. Biological control, its importance in crop pests and disease management, merits and demerits of biological control, history, distribution of biopesticides, role and status of biopesticides in pest control.
2. Pest control for crop protection by using biocontrol agents like bacteria (spore formers and non-spore formers) with special reference to *B.thuringiensis* and *B. sphericus*, mosquito control by fungi (culicinomyces, langenidium and coelomomyces), NPV of *Heliothis sp.*
3. Toxin produced by bacteria and fungi, their chemistry, mode of action, pest control and safety.
4. Commercial production of *B.thuringiensis*, NPV, fungal pathogens, their formulations and applications.
5. Development of genetically modified crop plants for control of insect pests, *B.thuringiensis* gene transformation, transgenic crop plants.
6. Economic and future prospects of biopesticides.
7. Biopesticides, their use and significance in the developing era of ecological approaches of insect control and plant protection.

**REFERENCES**

1. Subba Rao. 2000. Soil Microbiology. 4<sup>th</sup> Ed. Oxford & IBH
2. Subba Rao. Biofertilizers in Agriculture. Oxford & IBH
3. Subba Rao. Recent Advances in Biological Nitrogen Fixation. Oxford & IBH.
4. Rangaswamy and Bagyraj. Agriculture Microbiology.
5. Smith S E and Read D J. Mycorrhizal symbiosis. 2<sup>nd</sup> Ed.
6. Alexendra and Bold. 1999. Introduction to Mycology. Academic Press
7. Sundara Rajan S. Practical Manual of Fungi.
8. Saminathan M S. Biotechnology in Agriculture. McMillan.
9. Steinhaus 1963. Insect Pathology. Vol I & II. Academic Press
10. Burges H D and Hussey N W. 1971. Microbial Control of Insect and Mites. Academic Press, New York.
11. Burges H D: Microbial Control of Pests and Plant Disease
12. Soil Microbiology – Alexander Martin.
13. Soil and soil microorganisms – Subbarao,

**MIC 405: PR VII: PRACTICAL COURSE VII**

1. Assignment on Google for scientific information search.
2. Assignment on using Pub Med/Medline/Pub Med Central for biological information
3. Retrieving protein and nucleic acid sequences from databases
4. Assignment on Single and multiple Sequence alignment using BLAST, Clustal and Clustal W
5. Assignment on Gen Bank.
6. Studying protein 3D structure using RASMOL
7. Assignment on study of Nucleic acid and protein sequence data.
8. Measures of central tendency – Mean, median and mode, Measures of dispersion – variance and standard deviation
9. Estimation of confidence interval for a normal distribution
10. ANOVA – CRD, RBD
11. Student's t-test and chi-square test on sample data
12. Finding correlation and regression of the data using MS-EXCEL
13. Entering biological data in MS-EXCEL and its use for statistical analysis
14. Enrichment, acclimatization and Isolation of organisms from wastes containing recalcitrant, xenobiotic compounds.
15. Preparation of Activated Sludge.
16. Production of biogas by using different Agricultural wastes.
17. T and B rosette tests
18. Isolation and cultivation of lymphocytes, animal tissues organ explants and studies on immunomodulation potential of plant material
19. Complement fixation test
20. Precipitation of Immunoglobulins by ammonium sulphate method
21. Serological tests-CRP, RA, ASO, SLE, Coomb's and Australia antigen tests.

**MIC 406: PR VIII: PRACTICAL COURSE VIII****Project Work**