

SOLAPUR UNIVERSITY SOLAPUR
Microbiology Syllabus (CBCS)
M.Sc. Part II(Semester III & Semester IV)
(With effect from June 2016)

Semester III

Paper No.	Type of course	Name of the Subject	Total Marks	Total Hours	Total Credits	Hours/ Week
MIC 301	Core	Molecular Biology and Genetic Engineering	100	60	4	4
MIC 302	Core	Immunology and Immunotechnology	100	60	4	4
MIC 303	Core	Bioprocess Technology and Fermentation Technology	100	60	4	4
MIC 304	Elective	A. Bioinformatics and Biometry OR B.Skills in Scientific writing	100	60	4	4
MIC 305 A	Core	Practical Course V (Based on MIC 301.	50	60	2	4
MIC 305 B	Core	Practical Course V (Based on MIC 302,	50	60	2	4
MIC 305 C	Core	Practical Course V (Based on MIC 303.	50	60	2	4
MIC 306 A/B	Elective	Practical Course VI (Based on MIC 306 A /B	50	60	2	4
		Seminar	25		1	1
			625		25	33

Semester IV

Paper No.	Type of course	Name of the Subject	Total Marks	Total Hours	Total Credits	Hours/Week
MIC 401	Core	Health care and Diagnostic Microbiology	100	60	4	4
MIC 402	Core	Waste Management Technology	100	60	4	4
MIC 403	Core	Agricultural Microbiology	100	60	4	4
MIC 404	Elective	A. Food and Dairy Microbiology OR B. Pharmaceutical Microbiology	100	60	4	4
MIC 405 A	Core	Practical Course V (Based on MIC 401,402,	50	60	2	4
MIC 405 B	Core	Practical Course V (Based on MIC 402,403.	50	60	2	4
MIC 405 C	Elective	Practical Course V (Based on MIC404 A/B	50	60	2	4
MIC 406		Project Work/Industrial Training	50	60	2	4
		Seminar	25		1	1
			625		25	33

General Guidelines for Choice Based Credit System (CBCS)

M.Sc.II (Sem.III&IV)

A prime objective to maintain updated curriculum and providing therein inputs to take care of fast paced developments in the knowledge of Microbiology in relation to international context, a two year program is formulated for M.Sc. Microbiology to develop competent microbiologist to achieve desirable placements in the country and abroad. The program obliges students to read original publications and envisages significant inputs in the laboratory work, communication skills, creativity, planning, execution and critical evaluation of the studies undertaken. In addition to disciplines like Virology, Immunology, Genetics, Molecular Biology, Enzymology, Biostatistics, Bioinformatics, Scientific Writing, Computer Science, Industrial Microbiology and waste management etc., topics introduced in the course of two year are in the field of Biochemistry and Biotechnology.

1. The University follows Semester system
2. An academic year shall consist of two semesters
3. Each M.Sc. course shall consist of TWO years i.e. FOUR semesters.

Eligibility for Admission: Candidate who passed a degree course **B.Sc. Microbiology /Biotechnology** or Candidate who has Microbiology/ at subsidiary level and passed the entrance examination in Microbiology conducted by university shall be held eligible for admission to M.Sc. Microbiology postgraduate degree course.

Work Load per Week for M.Sc. I and II (Semesters I, II, III and IV)

Work Load per Week for M.Sc. I and II (Semesters I, II, III and IV)

THEORY	16 hours
SEMINARS	02 hours
ORAL EXAM.	02 hour
TOTAL	20 hours
*PRACTICALS	16 hours Per Batch

****PRACTICALS; Maximum number of students per batch;10**

The overall structure of the course to be implemented from the academic year 2016-17 onwards is as given below:

The entire M.Sc. Course in Microbiology shall be covered in 16 (Sixteen) theory papers, 7 (Seven) Practical Courses (Semester I, II, III, IV) and a project work (in lieu of one practical course of semester IV).

In semester –III, there will be four papers of 100 marks each for the subject. Similarly, in semester IV there will be four theory papers of 100 marks each for the subject. The scheme of evaluation of performance of candidates shall be based on University assessment as well as College internal assessment as given below.

M.Sc.II (Sem. III&IV)

The internal assessment will be based on Unit tests, Home assignment, viva, practical, Project Work etc as given below. Practical examination of 200 marks for 4 practical courses shall be conducted at the end of IIIrd & IVth semester. The practical examination of 200 marks shall consist of 140 marks for University practical assessment and 60 marks for college internal assessment for each semester.

For University practical examination, there shall be appointment of four examiners two examiners shall be external and two shall be internal appointed by the University. The internal practical assessment shall be done as per scheme given below.

5. Scheme of evaluation:

As per the norms of the **Credit System** of evaluation, out of 100 Marks, the candidate has to appear for College internal assessment of 30 marks and external evaluation (University Assessment) of 70 marks. Assessment scheme is given below.

Semester - III:

Theory: (100 marks)

University Examination (70 Marks): Number of Theory papers: 4 Papers, out of which Three papers MIC 301 MIC 302 MIC 303 are compulsory & **paper no four (MIC 304)** is Choice Based.

Internal Continuous Assessment (30 Marks):

Scheme of Marking: 20 Marks: Internal Test

10 Marks: Home assignment/Tutorials / Group discussion/ Viva/Field visit/.

Seminar 25 Marks

Semester - IV:

Theory: (100 marks)

University Examination (70 Marks): Number of Theory papers: 4, out of which Three papers MIC 401 MIC 402 MIC 403 are compulsory & **paper no four (MIC 404)** is Choice Based.

Internal Continuous Assessment (30 Marks):

Scheme of Marking: 20 Marks: Internal Test

10 Marks: Home assignment/Tutorials/ Group discussion/ Viva/ Field visit.

Practical Examination: University Examination (200 Marks):

No of Practical courses: 4Practicals each course with 50 marks

The university practical examination shall be of four days per batch per semester (at least Of five hours duration each day. Each candidate must produce a certificate from the Head of the Department in his/her college, stating that he/she has completed, in a satisfactory manner, a practical course on the lines laid down from time to time by Academic Council on the recommendations of Board of Studies and that the laboratory journals have been properly maintained. Every candidate must have recorded his/her observations in the laboratory journal and a written report on each exercise performed. Every journal is to be checked and signed periodically by a member of teaching staff and certified by the Head of the Department at the end of each semester. Candidates are to produce their journals at the time of semester practical examination. There shall be 20 (Twenty) marks for each journal of semesters I, II, III each and 10 (Ten) marks for journal of semester IV. Students shall have to undertake an academic tour for the period of 5 to 8 days to visit at least five places of academic interest like industries, research institutions, R & D departments during semesters II and IV each. The students should submit the tour report at the time of practical examination. The tour report should be duly certified by Head of the department. There shall be 10 (Ten) marks for the tour report.

Internal Continuous Assessment (60 Marks):

Internal Test on any four practical, 30 Marks.

Lab Journal/viva, attendance, attitude tour report etc. 30 Marks

4. Project Work*/Industrial Training (In lieu of MIC-406)**

MIC 406: PR VIII: Project Work

*Student is to undertake a research project (as part of the semester IV in lieu of practical course (MIC-406) which is to be started in the beginning of semester III so as to give enough time for duly completion of project. In the first half of project dissertation, student is to write about scientific writing and presentation including basic concepts of preparation of scientific document ,its presentation and publication and in the second half student should prepare dissertation as a report of project in the format of research methodology (Introduction, Aims and Objectives,- Material and Methods, Results and Discussions, Conclusion and Bibliography) and the prepared dissertation of the project shall be submitted to the department 10 (ten) days before the commencement of semester IV examination and it is to be produced by the department at the time of semester IV practical examination. For the research project work out of fifty marks , fifty marks shall be given by university examiners through assessment of dissertation at the time of semester IV practical examination. Out of remaining fifty marks 25 marks shall be for open defense (presentation) conducted and evaluated by university examiners at the time of semester IV practical examination. The remaining 25 marks shall be given by research guide of student as an internal

evaluation during research project work in progress. The method and process of internal evaluation is to be formulated by the research guide and Department.

Industrial training cum industrial project

**The guide of student should locate the industry and depute the student in the industry for the period of one month. Student should complete his/ Her industrial training cum industrial project in the vacation period after semester II Student should study microbiological aspects in industry and submit its report in the form of dissertation dully signed by industry authority, concerned guide and Head of the Department of microbiology.

5. Seminar: for each semester:

25 Marks

Each student shall present a seminar of at least half an hour at every semester which is to be attended by all the faculty members of the department and a detailed copy of the seminar presentation shall be submitted to the department. The topic of seminar shall preferably be selected from the topics out of the syllabus. The topic of the seminar shall preferably be research orientated so as to inculcate development of research aptitude and independent thinking among the students

6. Passing Standard

The student has to secure a minimum of 4.0 grade points (Grade C) in each paper. A student who secures less than 4.0 grade point (39% or less marks, Grade FC/FR) will be declared fail in that paper (subject) and shall be required to reappear for respective paper. A student who failed in University Examination (Theory) & passed in internal assessment of a same paper (subject) shall be given FC Grade. Such student will have to appear for University Examination only. A student who fails in Internal Assessment and passed in University examination (Theory) shall be given FR Grade. Such student will have to appear for both University examination as well as internal assessment. In case of Annual Pattern/Old Semester Pattern Students/candidates from the mark scheme the candidates shall appear for the same 70 marks paper of the external examination and his performance shall be scaled to 100 marks

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

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 BooksPvt.Ltd.
2. Gerard Krap, 1999, Cell and Molecular Biology, John Wiley & Sons Inc. NewYork.
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. Hyone – 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, CambridgeUniv. Press.
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12. Brown T. A. Ed.Homes B.D. & Richwood D. 1998 Molecular Biology: LABFAX, Academic pres

M.Sc. MICROBIOLOGY (SEM.III) (CBCS)
MIC 302: IMMUNOLOGY AND IMMUNO- (Paper X)

UNIT – I**10L**

1. Immunity: 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 erythematousus, Rheumatoid arthritis, Multiple myeloma.

UNIT – II**10L**

1. Major histocompatibility systems:

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, Freeman hybrid antibodies, immunoglobulin gene libraries, inheritance of MHC antigens

UNIT – IV

10L

1. Experimental Immunology

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

10L

1. Immune system evolution: 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. Short 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, 4th Edition, C.V. Mosby and Co., London.
6. Boyd William C. (1966) Fundamentals of Immunology, Interscience Publishers, NY.
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. and Co.

MIC 303: Bioprocess technology and Fermentation Technology XI**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, DCO₂)
- 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**10L**

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 B₁₂, 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.

MIC 304: Elective I: Bioinformatics and Biometry (XII-A)

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 – I

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

10L

- 1 Probability - definition, elementary properties, types, rules, applications to biological problems, chi-square (χ^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 L, New Delhi-1
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
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5. Lacroix, Z. and Critchlow, T. (Eds.) 2003. Bioinformatics. Managing Scientific Data. Morgan Kaufmann Publishers.
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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.III) (CBCS)
MIC 304: Elective II: Skills in Scientific writing (XII-B)

UNIT – I **10L**

1. History and basic concept of scientific writing.
 Basic grammar: Tenses, Voices, Propositions and conjunctions, Conditional sentences, count and non-count nouns; concord, Punctuations.
 Effective written presentations: Order of sentences in paragraph; sentence connection, cohesion and coherence; Contradiction, tautology, semantic anomaly, circumlocution.
 Using dictionary and the thesaurus
 Spell check, grammar check, logical sequence, connectivity and relevance in scientific writing.

UNIT: II **10L**

Scientific methods: concept, hypothesis, theory, law, Design of experiment; Inductive and deductive reasoning
 Enrichment of vocabulary: words forms and derivations, prefixes and suffixes, other processes of word formation, scientific and technical vocabulary, spellings, and frequently confused words.
 Types of presentations: Oral, poster, written, audio-visual aids.

UNIT: III **10L**

Use of search engines like Google, use of NCBI, PUBMED, DDBJ etc for searching literature
 Literature citation system. Sources of references: Journals, books, bibliographies, abstracting journals; databases
 Preparing and submitting the manuscript. Revising, editing, proofreading
 Quality indicators of scientific journals, Impact factor, citation index etc.

UNIT: IV **10L**

Introduction: Defining the problem, Literature survey; Justification of study.
 Preparing the manuscript, guidelines for authors, The IMRAD format. Title, byline, abstract, keywords
Material and Methods: Contents, sources, sampling, instruments used, protocol, techniques, reproducibility, Units of measurements, metric system and SI units. Basic statistical techniques, confidence limits, tests, probability, significance.
Results: How to present data; Tables and illustrations. Writing captions, labels and legends.
Discussion: components and sequences. Analysis, comparison and integration of data.
 Likely sources of errors in Results; Conclusions and significance. Implications for further study.
Acknowledgements
 Literature citation system. Sources of references: Journals, books, bibliographies, abstracting journals; databases

UNIT: V **10L**

Making oral presentations: Pronunciation, accent, intonation, clarity, speed, fluency, eye contact.
 Power point presentation.
 Poster presentation

MIC- 305: PR V: PRACTICAL COURSE V
(On MIC 301, MIC 302, and MIC 303)

MIC- 305 A (On MIC 301)

50 marks

Practicals:

1. Detection of polytene chromosomes chromosomal bands in chironomonas 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

MIC- 305 B (On MIC 302)

50 marks

Practicals:

1. Antibiotic sensitivity tests by Kirby-Bauer method.
2. Antibiotic sensitivity tests by Stocks comparative diffusion method
3. Determination of MIC (Minimal inhibitory concentration) by tube, disc and *plate method*.
4. Isolation and Identification of pathogen belonging to Enterobacteriaceae at species level
5. Demonstration on animal inoculation by various routes.

MIC- 305 C (On MIC 303)

50 marks

Practicals:

Practicals based on Bioprocess technology and Fermentation Technology

1. Bioassay of streptomycin, lovastatin Chloramphenicol and dounurubicin by plate assay method or turbidimetric assay method
2. Treatment of bacterial cells with cetrimide, phenol and detection of Leaky substances such as potassium ions, aminoacids, purines, pyrimidines and pentoses due to cytoplasmic membrane damage.
3. To determine MIC, LD₅₀ of Beta-lactum/aminoglycoside/tetracycline/ansamycins
4. Sterility testing by *Bacillus stearothermophilus*

MIC- 306A (PRACTICAL COURSE VI (A-Elective)**On MIC: 304- Bioinformatics and Biometry****50 marks****Practicals:**

1. Use of Internet/software for sequence analysis of nucleotides and proteins.
2. Studies of public domain databases for nucleic acid and protein sequences.
3. Determination of protein structure (PDB)
4. Retrieving protein and nucleic acid sequences from databases
5. Assignment on Single and multiple Sequence alignment using BLAST, Clustal and Clustal W
6. Studying protein 3D structure using RASMOL
7. Measures of central tendency – Mean, median and mode, Measures of dispersion – variance and standard deviation
8. Estimation of confidence interval for a normal distribution
9. ANOVA – CRD, RBD
10. Student's t-test and chi-square test on sample data
11. Finding correlation and regression of the data using MS-EXCEL
12. Entering biological data in MS-EXCEL and its use for statistical analysis

MIC- 306B (PRACTICAL COURSE VI(B)Elective)**On MIC: 304- Scientific writing****Practicals:**

1. Writing suitable title (analysis) of research paper.
2. Assignments on search of scientific paper using key words, author etc on PUBMED.
3. Writing abstract of research paper.
4. Search of author's instruction from website of a scientific journal and its analysis / comparison, characteristics of journal.
5. Assignment on analysis of Data / Results / Conclusion.
6. Assignment on Google search for scientific purpose.
7. Assignment on search Impact factor of scientific journal from Internet.
8. Assignments on NCBI/PUBMED.
9. Assignment on Google for scientific information search.
10. Assignment on using Pub Med/Medline/Pub Med Central for biological information

Reference books:

1. Day D.A., Sakaduski N, Day N. (2011) Scientific English: A guide for scientists and other professionals. ABC-CLIO Publications.
2. Day R.A. & Gastel B 6th Edition (2006) How to write and publish a scientific paper, Cambridge University Press.
3. Alley M (1996). The craft of scientific writing. Springer Publication.
4. Day R.A. (1988) How to write & publish a Scientific paper, Cambridge University Press.

M.Sc.II (SEM.IV) MICROBIOLOGY (CBCS)
MIC: 401Health Care and Diagnostic Microbiology Paper -XIII

UNIT – I**10L****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 of 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 anti microbial 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. Jawetz, Melnick and Adelberg's Medical Microbiology 24th 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, 4th Edition 1992.
4. P. Chakraborty – A text book of Microbiology, 1st Edition, 1995.
5. Greenwood, D. Black RCB, Peutherer JF (Eds) 1992, Medical Microbiology 14th Edition, Edinburgh – Churchill Livingstone.
6. Ross PW, Peutherer JG 1987, Clinical Microbiology, Edinburgh – Churchill Livingstone.
7. Sleight JD, Tmbury MC 1990, Medical Bacteriology 3rd Edition Edinburgh – Churchill Livingstone.
8. Parker MT. Collier LH (Eds) 1990) Topley and Wilson's Principles of Bacteriology, Virology and Immunology 8th 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 12th Ed, New York McGraw-Hill, Inc.
10. Salyers AA, Whitte DD, Bacterial Pathogenesis, 2nd Ed. American Society for Microbiology,

M.Sc. MICROBIOLOGY (SEM.IV) (CBCS)
MIC: 402- Waste Management Technology Paper. XIV

UNIT –I **10L 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 **10L**

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, 2nd Ed. Edmund D. Besselievere 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) (CBCS)
MIC 403: AGRICULTURAL MICROBIOLOGY Paper. XV

UNIT –I **10L**

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 **10L**

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 **10L**

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 **10L**

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.

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. 4th 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. 2nd 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

M.Sc. MICROBIOLOGY (SEM.IV) (CBCS)
MIC – 404: Food and Dairy Microbiology. (Elective-A-XVI)

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 **10L**

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: 4th Edi. Norman N. Potter (1987) CBS Publi.
- 2) Milk and Milk Products: 4th Edi. Clarence 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: 5th Edi, Norman N. Potter (1996). CBS Publications and distributors.

M.Sc. MICROBIOLOGY (SEM.IV) (CBCS)

MIC: 404: PHARMACEUTICAL MICROBIOLOGY (Elective-B-XVI)

Unit – I

Antibiotic and Synthetic Antimicrobial Agents

Antibiotics and synthetic antimicrobial agents

(Aminoglycosides, β 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

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 Quinolone

Bacterial resistance to Quinolone

Mode of action of non-antibiotics 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 and 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. Vaccine clinical trials.

Unit –IV

Regulatory Practices, Biosensors and Applications in Pharmaceuticals

Financing R & D capital and market outlook, IP, BP, USP.

Government regulatory practices and policies, FDA perspective

Reimbursement of drugs and biological, legislative perspective

Rational drug design

Immobilization procedures for pharmaceutical applications (liposomes).

Macromolecular , cellular and synthetic drug carriers.

Biosensors in pharmaceuticals

Application of microbial enzymes in pharmaceuticals

Unit –V

Quality Assurance and Validation

Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry

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)

Chemical and biological indicators

Design and layout of sterile product manufacturing unit

(Designing of Microbiology laboratory)

Safety in Microbiology laboratory

References

1. .Pharmaceutical Microbiology – Edt. By W. B. Hugo and A. D. Russell Sixth edition. Blackwell Scientific Publications.
2. Analytical Microbiology – Edt. By Frederick Kavanagh Volume I and II.
3. Quinolone antimicrobial agents – Edt. By David C. Hooper, John S. Wolfson. ASM Washington DC.
4. Quality control in the Pharmaceutical Industry – Edt. By Murray S. Cooper Vol. 2. Academic Press New York.
5. Biotechnology – Edt. By H. J. Rehm and G. Reed, Vol. 4. VCH Publications, Federal Republic of Germany.
6. Pharmaceutical Biotechnology by S. P. Vyas and V> K. Dixit. CBS Publishers and Distributors, New Delhi.
7. Good Manufacturing Practices for Pharmaceuticals Second Edition, by Sydney H. Willing, Murray M. Tuckerman, William S. Hitchings IV. Mercel Dekker NC New York.
8. Advances in Applied Biotechnology Series Vol. 10, Biopharmaceuticals in transition. Industrial Biotechnology Association by Paine Webber. Gulf Publishing Company Houston.
9. Drug Carriers in biology and medicine Edt. By Gregory Gregoriadis. Academic Press New York.
10. Quality Assurance in Microbiology by Rajesh Bhatia, Rattan lal Ihhpunjani. CBS Publishers and Distributors, New Delhi.

**MIC- 405: PR VII: PRACTICAL COURSE VII:
(On MIC 401, MIC 402, and MIC 403)**

MIC- 405 A (On MIC 401, 402,)

50 marks

1. T and B rosette tests
2. Isolation and cultivation of lymphocytes, animal tissues organ explants and studies on immunomodulation potential of plant material
3. Complement fixation test
4. Precipitation of Immunoglobulins by ammonium sulphate method
5. Serological tests-CRP, RA, ASO, SLE, Coomb's and Australia antigen tests.
6. Enrichment, acclimatization and Isolation of organisms from wastes containing recalcitrant, xenobiotic compounds.
7. Preparation of Activated Sludge.

MIC- 405 B. (On MIC 402, 403.)

50 marks

1. Detection of IAA by *Azospirillum* / *Pseudomonas*.
2. Detection of siderophore production by *Pseudomonas*.
3. Laboratory production of *Bacillus thuringiensis* insecticide and testing of its efficiency.
4. Production of biomass of *Azotobacter*, *Rhizobium*, *Azolla*, *Azospirillum*, *Blue green algae* and preparation of biofertilizer
5. Production of biogas by using different Agricultural wastes and testing of its efficiency.
6. Biofuel energy –electricity .

(PRACTICAL COURSE VII Elective (A))**MIC- 405 C. Elective (A)****50 Marks****On MIC: 404 A- Food and Dairy Microbiology.**

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

PRACTICAL COURSE VII Elective (B)**MIC- 405 C. Elective (B)****50 Marks****On MIC: 404 B- PHARMACEUTICAL MICROBIOLOGY**

1. Spectrophotometric / Microbiological methods for the determination of Griseofulvin.
2. Bioassay of Chloramphenicol 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, aminoacids, purines, pyrimidines and pentoses due to cytoplasmic membrane damage.
4. To determine MIC, LD₅₀ of Beta-lactum/aminoglycoside/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 a chemical compound (Phenol, resorcinol, thymol, formaldehyde) to that of phenol under standardized experimental conditions.

