SHIVAJI UNIVERSITY, KOLHAPUR.

Revised Syllabus For

Master of Science Part - II

APPLIED MICROBIOLOGY

To be implemented from June, 2014

(Applicable to affiliated colleges only)

SHIVAJI UNIVERSITY, KOLHAPUR

M. Sc. II APPLIED MICROBIOLOGY REVISED SYLLABUS

To be implemented from June, 2014

(Applicable to affiliated colleges only)

A. ORDINANCE AND REGULATIONS:

1. Ordinance: O. M. Sc. 1 -

1.1 Any person who has taken the degree of B. Sc. of this University or the degree of any other statutory University recognized as equivalent and has kept four terms in the University as a post-graduate student be admitted to the examination for the degree of Master of Science (M. Sc.) in Microbiology.

1.2 A student shall be held eligible for admission to the M. Sc. Applied Microbiology Course provided s/he has passed the B. Sc. examination with Microbiology as a principal subject or with a subsidiary/interdisciplinary/applied/allied subjects and has passed the entrance examination conducted by the University.

1.3 The students with B. Sc. from other universities shall be eligible if they qualify through the entrance examination and they score minimum 55percent B+ marks in the subject at the B. Sc. examination.

1.4 While preparing the merit list for M. Sc. admission, the performance at B. Sc. III (Microbiology) and the performance at the entrance examination will be given equal weight age (50:50)

2. Regulation: R. M. Sc. 2 –

The M. Sc. degree will be awarded only after successful completion of written and practical university examinations.

R. M. Sc. 4 –

4.1 The entire course of M. Sc. shall be of 2400 marks so that each semester shall have 600 marks i.e. 400 Theory + 200 Practical. There shall be internal evaluation of 20% for theory papers.

4.2 The examination shall be split up into four semesters.

4.3 The commencement and conclusion of each semester shall be notified by the University from time to time.

4.4 There shall be a University examination for theory and practicals at the end of each semester. The evaluation of theory and practicals examination be done by internal and external examiners (50:50).

4.5 In each semester, there shall be four theory papers and two practical courses

4.6 A student who has passed in semester examination shall not be allowed to take the examination in the same semester again

4.7 Each theory paper in each semester as well as each practical course shall be treated as separate head of passing

4.8 The student is allowed to keep terms in the III semester even if s/he has failed in three papers

4.9 The result shall be declared at the end of each semester examination as per University rules

B. REVISED SYLLABUS FOR MASTER OF SCIENCE (M. Sc. II):

1. **Title: Subject:- APPLIED MICROBIOLOGY**

   Compulsory under the Faculty of Science

2. **Year of implementation:**
   New syllabus will be implemented from June, 2014 onwards

3. **Preamble: (Applicable to University affiliated college centers)**

Total number of semesters	:	**02**
Total No. of papers	:	**08**
Total no. of practical courses	:	**04**
No. of theory papers per semester	:	**04**
No. of practical courses per semester	:	**02**
Maximum marks per paper (practical)	:	**100**

Distribution of marks –

Internal evaluation	:	**20**
External evaluation (Semester exam)	:	**80**

Total marks for M. Sc. Degree

Theory papers	:	**1600**
Practical course	:	**800**
		2400

General Objectives Of The Course:

A prime objective to maintain updated curriculum and providing therein inputs to take care of fast paced developments in knowledge of Applied Microbiology and in relation to international context, a two year programme is formulated for M.Sc. Applied Microbiology as per UGC guidelines and to develop competent microbiologists to achieve desirable placements in the country and abroad. The programme obliges students to read original publications and envisages significant inputs in the laboratory work, communication skill, creativity, planning, execution and critical evaluation of the studies undertaken. In addition to disciplines viz. Virology, Immunology, Genetics, Molecular Biology, Enzymology, Biostatistics, Bioinformatics, Scientific writing, Computer Science etc. The overall structure of the course to be implemented from the academic year 2013 – 2014 onwards is as given below,

Students are required to undertake a research project in Semester IV (in lieu of Practical Course MIC (A)4006)at the Department/any University/Industry/Institution. In the project, the student is expected to study research methodology that includes literature survey, experimental work and report writing following the IMRAD (Introduction, Aims and objectives, Materials and Methods, Results and Discussion) system.

Students shall compulsorily deliver one seminar/research paper per year and submit a certificate from the Head of the Department regarding satisfactory completion of the same at the time of the practical examination (Sem. – II and Sem. – IV),

Students are also required to undertake a compulsory educational tour organized by the Department in each year (M. Sc. I and M. Sc. II) to various places of Microbiological interest and

submit a `tour report' duly signed by the Head of the Department, at the time of the Sem – II and Sem. – IV practical examinations respectively.

4. Fee Structure:

- **Course Fee** : as prescribed by Shivaji University, Kolhapur

5. Medium of instruction **:** English

6. Structure of M. Sc. II course

Semester III

The students shall opt for three core papers and one elective from among the two

Theory Courses:

Core papers:

MIC (A) –3001 – Microbial Ecology and Extremophiles.

MIC (A) –3002 –Biostatistics, Bioinformatics and Scientific writing.

MIC (A) –3003 – Gene Manipulation and Tissue Culture Technology.

Elective papers:

MIC (A) –3004 (Elective-I) – Medical and Pharmaceutical Microbiolgy.

MIC (A)– 3004 (Elective-II) – Mycology

Practical Courses:

MIC (A) –3005 – Practical Course - V

MIC (A)–3006 – Practical Course – VI

600 marks

Semester IV

The students shall opt for three core papers and one elective from among the two

Theory Courses:

Core papers:

MIC (A) –4001 –Industrial Microbiology.

MIC (A) –4002 – Bioprocesses.

MIC (A)–4003 – Food and Agricultural Technology.

Elective papers:

MIC (A) –4004 (Elective-I) – Quality Management System In Industry.

MIC (A) – 4004 (Elective-II) – Industrial Waste Management and Microbial Bioremediation.

Practical Courses:

MIC (A) –4005 – Practical Course - VII

MIC (A) –4006 – Practical Course – VIII (Project work)

600 marks

7. **System of Examination:** applicable to University affiliated college centers

1. **Scheme of examination:**

- Semester exam (both theory and practical examination) will be conducted by the University at the end of each term (Semester)
- Theory paper of the external examination will be of 80 marks
- The internal evaluation test for 20 marks will be conducted by the Department
- There will be **two** tests for each course paper in the middle of the Semester
- They will be `Surprise tests' during theory lectures.
- There will be no re-examination
- The two practical course examinations will be of 100 marks each
- Question paper will be set in view of the entire syllabus and preferably covering each unit of the syllabus

2. **Standard of passing:**
   As per the rules and regulations of the university for the M. Sc. course

3. **Nature of question paper and scheme of marking:**

a) External/University examination Theory paper: Maximum marks – **80**

- Total number of questions – **07**
- All questions will carry equal marks.
- Out of the seven questions, five are to be attempted of which Question 1 will be compulsory
- Question No. **1** will be of an objective type
- Total No. of bits – **16**, Total marks – **16**
- Nature of questions - multiple choice, fill in the blanks, definitions, true or false
- These questions will be answered along with the other questions in the same answer book
- Remaining six questions will be divided into two sections, I and II.
- Four questions are to be attempted from these sections in such a way that not more than two questions are answered from each section.
- Both sections are to be written in the same answer book

b) Internal Examination Theory paper: Maximum marks – **20**

- Objective- Multiple choice/True or false/ fill in the blanks/match the following
- Total number of questions will be **10** each carrying **01** mark

c) Practical Examination (External only) Maximum marks – **100**

- Equal weight age shall be given to the two units of the practical course
- Total number of questions – **06**
- All questions will be compulsory
- Questions 1 to 4 will have at least two **(02)** internal options

C. INTAKE CAPACITY:

1. 15 + 10 % Extra every year on the basis of entrance examination

2. The above includes 10 % students from other Universities

D. CREDIT SYSTEM:

1. **Definition of CREDITS:**

It is the workload of a student in College activities. This includes:

1. Lectures
2. Practicals

3. Seminars
4. Private study work in the Library/Home
5. Examinations
6. Other activities

2. Credits by lectures and practicals:

- Total instructional days as per norms of UGC = **180**
- One (**01**) credit is equivalent to **12** contact hours
- There are four (**04)** theory papers with **04** hours teaching per week
- Each theory paper consists of **04** units
- There are two (**02**) practical courses of **09** hours duration per week
- Each practical course consists of **02** units
- Therefore the distribution of credits (per semester) is –

Course type	**Contact hours**	**Credits**
Theory paper		
Unit – I	**12**	**01**
Unit – II	**12**	**01**
Unit – III	**12**	**01**
Unit – IV	**12**	**01**
	Total =	**04**
Practical course		
Unit – I		**02**
Unit – II		**02**
	Total =	**04**
Total credits per semester = 24		
Theory course -	**04 × 04 =**	**16**
Practicals course -	**02 × 04 =**	**08**

- As there are four (**04**) semesters to the M. Sc. course, the total credits form lectures and practicals will be - **04 × 24 = 96** credits

3. M. Sc. Course Work (credit system) for a student:

- A student has to take **96** credits to complete the course
  Theory courses : **16 × 04 = 64** credits

  Practical/Project : **08 × 04 = 32** credits

  (Project at the Department/any University/Industry/Institution: **04**;

  Practical course at the Department: **04**:

- Student can opt for 1 credit to 32 credits each Semester
- Time course: **02** years minimum **or** till **96** credits are completed.

4. Examination:

<u>Theory Examination</u>:

External: 80 marks per theory paper (examination at the end of the Semester)

- This will be conducted by the University as specified in section B.7

Internal: 20 marks per theory paper

- This will be conducted by the Department as per the norms specified in section B.7.3b above

Practical Examination:

- This will be conducted only by the University as specified in section B.10

Project evaluation:

External: 50 marks by the university examiners through observation of the oral presentation and assessment at the time of the Semester IV Practical examination

Internal: 50 marks by the concerned project supervisor as the internal Examiner during progress of the project work.

5. **Courses available in the Department:**

Semester-I:

Theory courses: - MIC (A)-1001, MIC (A)-1002, MIC (A) - 1003, MIC (A)-1004

Practical courses: MIC (A) - 1005, MIC (A)-1006

Semester-II:

Theory courses: - MIC (A)-2001, MIC (A)-2002, MIC (A)-2003, MIC (A)-2004

Practical courses: MIC (A)-2005, MIC (A)-2006

Semester-III:

Theory courses: - MIC (A)-3001, MIC (A)-3002, MIC (A)-3003,

MIC(A)-3004 – Elective -I , MIC(A)-3004 –Elective –II

Practical courses: MIC (A)-3005, MIC (A)-3006

Semester-IV:

Theory courses: - MIC (A)-4001, MIC (A)-4002, MIC (A)-4003,

MIC (A) - 4004 Elective – I , MIC (A)- 4004 Elective – II

Practical courses: MIC (A)-4005, MIC (A)-4006 (Project)

Equivalence

Class	Paper No	Old	Paper No	New
M.Sc. Part-I Semester-I	MIC(A) 101	Morphology and taxonomy of Microorganisms.	MIC(A) 1001	Morphology and taxonomy of Microorganisms.
	MIC(A) 102	Virology	MIC(A) 1002	Virology
	MIC(A) 103	Biomolecules and Bioenergetics	MIC(A) 1003	Biomolecules and Bioenergetics
	MIC(A)	Genetics- I	MIC(A) 1004	Genetics- I

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Semester-II	MIC(A) 201	Bio- instrumentation	MIC(A) 2001	Bio- instrumentation
	MIC(A) 202	Genetics- II	MIC(A) 2002	Genetics- II
	MIC(A) 203	Microbial Biochemistry	MIC(A) 2003	Microbial Biochemistry
	MIC(A) 204	Medical Microbiology	MIC(A) 2004	Immunology
M.Sc. Part-II Semester-III	MIC(A) 301	Microbial Ecology and Extremophiles	MIC(A) 3001	Microbial Ecology and Extremophiles.
	MIC(A) 302	Biostatistics, Bioinformatics and Scientific writing.	MIC(A) 3002	Biostatistics, Bioinformatics and Scientific writing.
	MIC(A) 303	Genetic Engineering.	MIC(A) 3003	Gene Manipulation and Tissue Culture Technology
	MIC(A) 304	Immunology.	MIC(A) 3004 Elective - I	Medical and Pharmaceutical Microbiology.
			MIC(A) 3004 Elective - II	Mycology
Semester-IV	MIC(A) 401	Industrial Microbiology.	MIC(A) 4001	Industrial Microbiology.
	MIC(A) 402	Bioprocesses.	MIC(A) 4002	Bioprocesses.
	MIC(A) 403	--	MIC(A) 4003	Food and Agricultural Technology.
	MIC(A) 404	Quality Control Management in Industry.	MIC(A) 4004 Elective - I	Quality Management System In Industry.
		Industrial Waste Management and Microbial Bioremediation.	MIC(A) 4004 Elective-II	Industrial Waste Management and Microbial Bioremediation

LIST OF EQUIPMENTS

1.Replica plating units.

2.Rotary shaker.

3.Centrifuge (High speed)

4.Cooling centrifuge.

5. Shaker incubator .

6. Hot air Oven.

7.Bacteriological Incubator.

8.Spectrophotometer.

9.Research Microscope.

10.Haemocytometer.

11.Electrophoresis assembly.

12.Laminar Air Flow.

13. Glass distillation assembly.

14.Reflux assembly.

15.Serological Water bath.

16.Colony counter.

17.Deep freeze.

18.Refrigerator.

19.Sieve chromatography unit.

20.Ion exchange chromatography – DEAE – Cellulose.

21.Western ,Southern and Northern blotting technique apparatus.

22.Glucometer.

23.PCR.

24.GLC.

25.Fermenter.

26.U.V.-visible spectrophotometer.

27.Anaerobic jar.

28. Manometer.

Semester- III **Paper - MIC (A) 3001: Microbial Ecology and Extremophiles**	**Number of lectures**
Unit - I	**12**
1.1 Microbial Ecology - Concepts, niche, habitat, ecosystem and applications. Introduction to microbial diversity, types of micro organisms - bacteria, archebacteria, eucarya, interactions between microorganisms, ecological succession . **1.2 Microbial biofilm** – a) Physiology, morphology, biochemistry of microbial biofilm formed in natural environment. b) Mechanism of microbial adherence. c) Laboratory methods used to obtain biofilm (with respect to physiology, growth, special arrangement, depth, surface physico chemistry.) d) Beneficial and harmful role of biofilms. **1.3 Biomimicry** – Concept and applications.	
Unit-II	12
2.1 **Quantitative ecology –** Number, biomass and activities a) Sample collection : Soil, water, air, sediment, biological samples. b) Sample processing. c) Detection of microbial populations – Phenotypic detection, lipid profile analysis, molecular detection. d) Determination of Microbial number -1) Direct count 2) Viable count procedures – i) Plate count ii) MPN e) Determination of microbial biomass – Biochemical assay, physiological approaches to biomass determination. f) Measurement of microbial metabolism – i) Heterotrophic potential. ii) Productivity and decomposition iii) Specific enzyme assay	
Unit-III	12
3.1 Extremophiles. a) Concept of extremophiles versus conventional microbial forms and archaebactria b) Adaptation to environmental conditions. i) Abiotic limitations to microbial growth. ii) Microbial response to adverse conditions- Temperature, starvation, radiation, pressure, salinity, hydrogen ion concentration redox potential,	

magnetic force, antagonism, siderophores, oxygen, cryophile, piezophiles. iii) Survival strategies of microorganisms. c) Habitat in universe , econiche, communities , community association. d) Significance in biogeochemical cycling , fermentation industry.	
Unit- IV	12
4.1 **Extremozyme :-** a) Extremozyme – Characteristics, examples, structure,. biotechnological uses of arche as extremozymes and applications. b) Effect of extreme conditions on membrane structure, nucleic acid & protein. c) Adaptation mechanism in micro organisms for survival in diverse environments. d) Biotechnological, applications of extreme proteins from different groups- methanogens. e) Polyextremophiles – characteristics, examples and uses	

Reference Books :-

i) Concepts of ecology- Edward J.Kormonday

ii) Ecology and the quality of our envt. 2nd edition- Charles H. Southwick

iii) Ecology- N.S.Subrahmanyam, A.V.S.S. Sambamurthy

iv) Fundamentals of Ecology- Odum.

v) Ecology and environmental biology – Dr.K.A.Siddique

vi) Concepts of ecology- N. Arumugam.

vii) Microbial ecology- Fundamentals & applications 4th edition- Atlas and Bartha published by Pearson education ,Singapore.

viii) Extremophiles by B.N.Zonri, Springer verlag,New York.

ix) Microbial diversity by (1999) Colwd, Academic Press.

x) APHA - Ninth edition

xii) Practical Methods in Ecology and Environmental Science by R.K.Trivedi, P.K.Goel and C.N.Pisal

Semester- III **Paper - MIC (A) 3002 : BIOSTATISTICS, BIOINFORMATICS AND SCIENTIFIC WRITING**	**Number of lectures**

Unit - I	12
1. Biostatistics **1.1 Basics of :-** Population, sample, variable, parameter, primary and secondary data, screening and representation of data. Frequency distribution, tabulation, bar diagram, histograms, pie diagram, cumulative frequency curves. Mean, median, mode, quartiles and percentiles, Measures of diversions : range, variance, standard derivation, coefficient of variation, Symmetry : measures of skewness and kurtosis. Sample space, events, equally likely events. Definition of probability (frequency approach), independent events. Addition and multiplication rules, conditional probability, examples, Bernoulli, Binomial, Poisson and normal distribution **1.2 Hypothesis testing :** Hypothesis, critical region and error probabilities. Tests for proportion, equality of proportions, equality of means of normal population when variances are known and when variances are unknown. Chi-square test for independence. P-value. Confidence limits, introduction to way and two way analysis of variance.	
Unit-II	12
2.1 Bioinformatics : **a)** Introduction, History & definition **b)** Scope and goals of bioinformatics **c)** Basic terminology - alignment, accession number, gene annotation, databases. d) Databases **:** 1**)** Definition and database management concept 2) Major databases in bioinformatics 3) Classification of biological databases- nucleotide, protein **2.2 Concepts in bioinformatics** a) Structural databases- visualization of structural data, pattern matching, molecular modeling, b) Mapping databases- Genomic mapping, types of maps. c) Introduction to genomics, proteomics, metabolimics, pharmacogenomics & pharmacogenetics. **2.3 Sequence alignment** a) Concept of local and global alignment b) Pairwise sequence alignment and its methods c) Multiple sequence alignments and its applications d) Tools for sequence similarity search and alignments- BLAST and FASTA. e) Phylogenetic analysis : An overview.	
Unit-III	12
Scientific writing What is research? Reflection science and research. Basic and applied research, Essential steps in research. **3.1 Literature collection –** Need for review of literature, review process and bibliography, research reading, discriminative reading, consulting source material, working bibliography, index card and reference card, **3.2 Literature citation –** Different systems of citing references **,** name year	

system, citation sequence system, alphabet number system. **3.3 Research paper and thesis writing :-** Structure of reports , title, authors and their institution, abstract, abbreviations. introduction, materials and methods, results discussion, conclusions, acknowledgement, literature cited (Bibliography) choosing a journal, writing, submitting, responding to referees comments, checking proofs and publication. 3.4 **Review writing –** Introduction, method, example.	
Unit- IV	12
4.1 Poster presentation :- Poster size, preparation of poster- content, designing , printing, display and presenting the poster. **4.2 Oral presentation –** Preparation of the script, timing , using visual aids, preparation style. **4.3 Grant proposal for Research Project** :-Introduction, summery, organization, statement of problem, aim and objective, design of project. Evaluation ,funding and budget proposal.	

References

BIOSTATISTICS

1. Biostatistics A foundation for Analysis in the Health Sciences, by Wayne Daniel (7th Ed) Wiley-India edition
2. Biostatistics by N. Gurumani MJP Publishers
3. Statistical Methods for the Analysis of Repeated Measurements by C. S. Davis
3. Statistical Method in Biological Assays by D. J. Finney
4. Statistical Methods for Rates and Proportions by Fleiss, Joseph L., Levin Bruce and Paik Myunghee Cho
5. Fundamentals of Biostatistics (2nd Ed) Irfan Ali Khan and Atiya Khanum, Ukaaz Publications, Hyderabad.
6. Design and analysis of experiments by D.C. Montgomery, John Wiley & Sons.
7. Sampling methods by M.N. Murthy, Indian Statistical Institute, Kolkata.
8. Warollaw A. C. (1925), Practical Statistics for Experimental Biologists-Waco John Wiley and Sons Ltd.
9. Dixit J. V. (1996) Principles and Practice of Biostatistics 1t Edn. M/s Banarasidas Bharot (Publisher)
10. T. Bhaskarrao (2002) Methods of Biostatistics, Paras Publishing.
11. Bailey N. T. J. (1995), Statistical methods in biology 3rd Edition Cambridge law price edition Cambridge University Press.

BIOINFORMATICS

1. Bioinformatics – A Primer by (P. Narayan) (25043)

2. Essential Bioinformatics by (Jin Xiong) (25772) Genomics and protomics (with practical exercises)
3. Computational Biochemistry, by C. Stan tsai, A John Wiley & Sons, Inc., Publication
4. Bioinformatics – Databases & Algorithms by N. Gautam (25447) blue book for basis.
5. Bioinformatics – David Mount
6. Basedra S. K. (1998) computers today, Galgotia Publications.
7. Bergeron B. (2003). Bioinformatics computing. Prentice Hall Inc. Eastern Economy Edition.

SCIENTIFIC WRITING

1. How to write and publish a scientific paper by R. A. Day
2. Writing Scientific Research Articles – Strategy and Steps by Margaret Cargill and Patrick O'Connor. Wiley Black well
3. From Research to Manuscript – A Guide to Scientific Writing by Michael Jay Katz, Springer.
4. Scientific thesis writing and paper presentation – N. Gurumani - MJP Publishers. Chennai.

Semester- III **Paper - MIC(A) 3003 : Gene Manipulation and Tissue Culture Technology**	**Number of lectures**
Unit - I	**12**
1.1 Manipulating DNA in microbes. **a) Cloning in bacteria (other than *E. coli*)** i) Cloning in *Bacillus subtilis*. ii) Cloning in Gram negative bacteria . iii) Vectors used for cloning - Derived vectors, specialist vectors **b) Cloning in *S. cerevisiae.*** i) Vectors used - - YE_P ,YAC, specialist multipurpose vectors. ii) Yeast promoter systems. 1.2 **Generation of Genomic DNA libraries**. i) Vectors used - Simple vectors, sophisticated and high capacity vectors. ii) Generation of $_C$ DNA library- Screening of libraries. iii) Applications.	
Unit-II	12

2.1 **2.1 Manipulation of Gene expression in prokaryotes.** a) Strategies to isolate functional promoters. b) Gene expression from strong and regulatable promoters. c) Developing fusion proteins and separation of cloned protein by protease induced cleavage. d) Genetic manipulation to increase recombinant protein stability and secretion using signal sequences. **2.2 Directed mutagenesis and protein engineering** i) Types of directed mutagenesis. ii) Protein engineering – a) Technique. b) Altering multiple properties. c) Application.	
Unit-III	12
3.1 Plant tissue culture :- Micropropagation. i) Callus culture and suspension culture- Bioreactor systems and models for mass cultivation. ii) Somaclonal variation. iii) Anther culture and dihaploids. iv) Somatic hybrids and cybrids. v) Protoplast fusion and culture. b) Applications of – i) Germplasm conservation. ii) Production of secondary metabolites. iii) Biotransformation. iv) Transgenic plants and uses. v) Artificial seeds. **3.2 Strategies for gene transfer in Plants.** a) Agrobacterium mediated Transformation. i) T- DNA. ii) Ti-plasmid derivatives. b) Direct DNA transfer to plants. i) Protoplast transformation ii) Particle bombardment iii) Chloroplast transformation iv) Use of plant viruses. c) Gene targeting in Plants.	
Unit- IV	12

4.1 Animal Tissue Culture. i) Types. ii) Cell lines - CHO dhfr -, COSa / COS7, HeLa, Vero, Myeloma cell lines, BHK 21. iii) Identity testing. iv) Detection of contaminate. v) Culture media. vi) Tissue culture surfaces. vii) Scale up- factors, types. **4.2 Stem cells –** i) Types of stem cells. ii) From stem cells to functional tissue. iii) Stem cells cloning. iv) Therapy using stem cells. 4.3 **Gene transfer in Animal cells.** i) Strategies for gene transfer. ii) Selective markers developed for animal cells. iii)) Bacterial and viral vectors .	

Reference Books :-

i) tem cells Hand Book – Edited by Stewart Sell Human Press TotowaNew Jersey
ii) Principles of Biotechnology and applications – Glick and Pasteunack
iii) Clinical Cell culture by Ian Freshney.
iv) Plant biotechnology – Springer verlag , Hammond, Mcgarvey.
v) Plant Biotechnology – The genetic manipulation of plants- Slater, Scott, Flower.
vi) Animal biotechnology.

Semester- III **Paper - MIC(A) 3004 Elective – I : Medical and Pharmaceutical Microbiology**	**Number of lectures**
Unit - I	**12**
1.1 Community Medicine: a) Introduction. b) Definition of health, dimensions of health. c) Determinants and indicators of health. d) Concept of well- being. **1.2 Concept of disease:** a) Concept of causation : Germ theory, Epidemiologycal triad, multifactorial causation, web of causation.	

b) Natural history of disease- prepathogenesis and pathogenesis phase. c) Changing pattern of disease.	
Unit-II	**12**
2.1 Novel mechanisms for disease: a) Introduction. b) Multifactorial disorders. c) Mitochondrial DNA and Genetic disorders. d) Genomic imprinting. **2.2 Non Communicable diseases:** a) Introduction - definition and risk factors b) Hypertention. c) Diabetes mellitus.	
Unit-III	**12**
3.1 Principles of Epidemiology. a) Introduction. b) Epidemiology and clinical medicine. c) Measurement in epidemiology – Mortality rates and ratios. d) Immunization and adverse events following immunization. e) Disposal of biomedical waste. **3.2 Clinical development of biologicals.** a) Regulatory authorities for introduction of medicines in market – Role of food and Drug Administration, FDA guidelines for drugs, biologicals, validation (GMP,GLP,GCP.) b) Clinical studies : Phase I, Phase II, Phase III and Phase IV of clinical trials- Objectives, Conduct of trials, Outcome of trials. c) Delivery systems – formulations, targeted drug delivery, Sustained release drugs. d) Drug distribution in body , bio-availability and pharmacokinetic studies.	
Unit- IV	
4.1 Drug discovery & drug metabolism Historical perspective –Paul Ehrlich's postulates, Case studies of development of Drugs e.g. sulpha drugs, arsenicals a) Current approaches to drug discovery : Rational Drug design, receptor / target concept in drug designing ,Introduction to pharmacogenomics. Combinational chemistry ,High Throughput Screening. b) Phases of drug discovery : Bioprospecting, Principles of Extraction, Purification and characterization of bioactive molecules from natural resources, Lead discovery,	**12**

Lead compound optimization , Candidate drug selection. c) Preclinical development : i) Safety profile of drugs (Pyrogenecity, Toxicity – hepato, nephro, cardio and neutrotoxicity) ii) Toxicological evaluation of drug : LD_{50} Acute, subacute and chronic toxicity. iii) Mutagenecity (Ames test, micronucleus test) , Carcinogenicity and Teratogenecity. d) Drug interactions, Drug metabolism – activation / inhibition of drug in viva adverse drug reactions.	

References :-

1)Park's Text book of Preventive & Social medicine – K.Park.
2)Health Education & Community Pharacy – P.C. Dandiya. Z.Y.K. Zafer.
3)Pharmacology & Pharmaco therapeutics, 15th Edition. R.S. Satoskar, S.D. Phandarkar. S.S. Ainapur (Popular publication)

4)Principles of pharmacology – H.L. Sharma & K.K.Shama (Paras medical publisher)
5)Drug discovery and development Vo.I – Willey – Interscience, USA. Chorghade Mukund S.

6)Principles of Therapeutics – Blackwell Science Pub. O. Ltd. Oxford.
7) Hand book of phase I,II, Clinical drug trials . CRC press – Graly John & Pieter H. Joubert.

Semester- III **Paper - MIC(A) 3004 : Elective –II - Mycology**	**Number of lectures**
Unit - I	**12**
1. Fungal diversity and distribution. **1.1 Origin and phylogeny ; classification.** **1.2 Fungi – Terrestrial and Aquatic.** a) Terrestrial. b) Fresh water and Marine : Coastal – salt marsh, mangrove, Estuarine, Ocean. c) Hypersaline waters – Solar salterns, Salt Lake, Dead Sea. **1.3 Extremophilic Fungi.** a) Oligotrophs b) Alkaliphiles c) Acidophiles d) Barophiles e) Psychrophiles f) Thermophiles g) Halophiles h) Osmophiles i) Xerophiles.	
Unit-II	**12**

2. Physiology and Genetics. **2.1 Physiology of fungi.** a) Growth and development. b) Fungal hormones – attractants, morphogenesis and differentiation. c) Adaptation to extreme environments. d) Microbial interactions. e) Secondary metabolites : antimicrobials , mycotoxins, pigments. **2.2 Fungal genetics.** Neurospora and Saccharomyces : Life cycle, Cross over and tetrad analysis, gene conversion; Deuteromycotina : parasexuality, cytoplasmic inheritance, Karyotyping. **2.3 Identification of fungi**. a) Colonial and morphological characteristics. b) Molecular finger printing.	
Unit-III	**12**
3. Pathogenesis – Antifungal Therapy. **3.1 Pathogenesis.** Mycoses – Systemic, sub- cutaneous , cutaneous and superficial, opportunistic, plant pathogens. **3.2 Antifungal Therapy.** Drugs acting on cell membrane, protein synthesis inhibitors, fungicides.	
Unit- IV	**12**
Importance of fungi - a. Industrially important enzymes. b.Secondary metabolites, pigments, antimicrobials. c. Biodegradation. d. Bioremediation. e. Biocontrol.	

Reference Books :-

1. Alexopoulus.

2. Mehrotra.

3. Ecophysiology of fungi- Cooke and Whipps Deacon.

4.Kendricks.

Practical Course- V

MIC(A) : 3005 (Ecology, Extremophiles & Biostat. , Bioinformatics, Scientific writing)

1) Isolation of thermophiles from Compost heap.
2) Isolation of alkalophilic bacteria from soil/ water.

3) Enrichment & isolation of psychrophilic bacteria .
4) Enrichment & isolation of and Halophilic bacteria.

5) Isolation of endophytic aquatic hypomycetes.

6) Isolation of petroleum degraders and study of the rate of degradation.

7) Adhesion of microorganisnms to surface by dip slide method.

8) Determination of measures of dispersion- Mean deviation, Standard deviation,

Coefficient of verification.

9) Determination of measures of central tendency- Mean, Mode, Median.
10) Estimation of confidence interval for a normal distribution.
11) T Test & chi- square + test on sample data.
12) Representation of statistical data by - i) histograms ii) Pie diagram.iii) Bar diagram – frequency distribution iv) Cumulative frequency curves
13) Searching sequence databases.
14) Use of sequence databases BLAST for sequencing –i) Nucleotide ii) Protein iii) deducing phylogenetics iv) location of gene on chromosome v) determination of protein structure using bioinformatic tools.
15) Writing a conference report.
16) Writing abstract of research paper.
17) Deduction of best path in sequences using global alignment technique.

Practical Course- VI

MIC(A) : 3006 (Gene Manipulation and Tissue Culture Technology)

1. Preparation of Animal Tissue culture medium ,Sterilization and Sterility checking.

2. Viable staining of chick embryo fibroblast culture.

3. DNA amplification by PCR.

4. Purification of DNA fragments from agarose gel.

5. In Vitro seedling growth of Carrot and multiplication of carrot.

6. Callus induction.

7. Cell culture in liquid media. (To obtain disease free plants from single cell.)

8. Determination of blood sugar – Glucometer and advanced method.

9. Survey :- Clinical survey of any common diseases.

10. Determination of – Human Develop Index,

- Mortality Rate

- Morbidity rate

- Genetic problems

11. Determination of MIC of Sulpha drug.

12. Study of Conjugation.

13.Sterility testing by *B. stearothermophilus*.
14.Sampling of pharmaceuticals for microbial contamination & load (Symps. Suspensions, creams, & ointments, ophthalmic preparation)
15. Isolation of etiological agent of dental caries & study its drug sensitivity.

16. Isolation of etiological agent of dental caries & study its drug sensitivity.

17. Testing of chemical for mutagenicity using Ames test.

18. Preparation of plant tissue culture medium.

19. Maize embryo culture.

Semester- IV **Paper -MIC (A) – 4001 Industrial Microbiology**	**Number of lectures**
Unit - I	**12**
1.1 Design of Fermentor- Introduction , scale of operation Lab scale , Bench scale , Pilot scale , production level. Basic functions of Fermentor for microbial cell culture. Body construction material . 1.2 Types of Fermentor - i) Mechanical – Waldhof fermenter. Rotating disc fermenter , Trickling generator ii)Hydrodynamic- deep-jet fermenter. iii) Pneumatic – air lift fermenter, bubble-cap fermenter, cylindro-conical vessels, acetator, cavitator iv) Photo bioreacter, tower and packed tower fermenters, cyclone column . **1.3** Fermentation operation –Aseptic operation & containment i)Sterilization and maintenance of aseptic conditions- vessels , medium, additives , air. Aseptic transfer of inoculum. ii) Common measurement & control system of Fermentor- Speed, Temperature. ,Gas supply, pH, Dissolved oxygen, antifoam control, contamination level, limit test.	
Unit-II	12
2.1 Cell immobilization and its applications : - a) Immobilized cell system- i)Surface attachment of cells. ii)Entrapment within porous matrices iii) Containment behind a barrier iv) Self aggregation of cells b) Design of immobilized cell reactors- i) Mass transport phenomena in immobilized cell system. ii) Reaction and diffusion in immobilized cell system iii) Bioreactor design c) Physiology of immobilized microbial cells. d) Beer production using immobilized cell technology – Case study. **2.2 a)**Probiotics –Probiotic microorganisms associated with therapeutic properties, Criteria associated with probiotic microorganisms. b) Safety issues associated with the use of probiotic cultures for human. Beneficial health effects of probiotic cultures Effective daily intake of probiotic. c) Probiotic dairy products – case study. Factors affecting probiotic survival in food system.	
Unit-III	12

3.1 Solid state fermentation (SSF) :- Introduction, comparison of SSF and submerged fermentation, advantages, disadvantages, problems, types, factors affecting, fermentor design for SSF, Koji manufacturing process, industrial application of SSF d) Amylase production -case study.3.1 3.1 **3.2** Fermentation economics :- Introduction, Philosophy of fermentation manufacture of chemicals by fermentation –Economic objectives. Various aspects influencing fermentation economics – Strain improvement, High yielding strain, Market potential, fermentation media and raw material, fermentation equipments, recovery cost, water uses and recycling, effluent treatment	
Unit- IV	12
4.1 Intellectual property - Introduction - Genesis of Intellectual Property Rights (IPR) , Territorial Nature of Patents , Ownership and Royalties, An overview of Patent System , Requirements for Patentability , Patent Categories. 4.2 Patenting – Information necessary for preparing and filing a patent application ,Patenting procedure and form ,Recent trends in biotechnology and microbiology patents, The Indian Patent Act, Indian Biodiversity Act.	

Reference Books –

i) Industrial Microbiology – L.E.Casida 2012 Reprint

ii) Principles of Fermentation Technology –Second Edition P.F.Stanburg, Whitaker,S.J.Hall

iii) Biotechnology – Wulf Crueger & Anneliese Crueger

iv) Fermentation Technology & Biotechnology – 2nd edition – E.M.T.EL-Mansi,C.F.A.Bryce & A.L.Demain

v) Fermentation Technology- Vol. I & II - H.A. Modi

vi) Microbial technology – Vol.I & II - Peppler H.J. & D. Perlman

vii) Industrial Microbiology – Prescott & Dunn's

viii) Biotechnology – U.Satyanarayana

ix) Modern industrial Microbiology – Okafor Nkuda -2007, NH,USA

Semester- IV **Paper - MIC (A) – 4002 : Bioprocesses**	**Number of lectures**
Unit - I	**12**

1.1 Production– Introduction , Substrate preparation ,C: N ratio , water. Acidity, Temperature , Oxygen. Phase –I and Phase II composting , Spawn production, Mushroom formation, packing. **1.2 Mold modified foods** – Soy sauce, Miso, Hamanatto , Sufu, Tempeh, Ang- Kak.	
Unit-II	12
2.1 **Vaccines** a) Nature and importance of vaccines, body defenses against communicable diseases , traditional and modern methods of Vaccine production b) Production of - i)Virus Vaccines ii) Killed bacterial vaccines iii) Bacterial toxoids Control of vaccines c) r-DNA products- insulin. **2.2 Polysaccharide**s – a) Introduction , Nature of Microbial Polysaccharides , Mechanism of Synthesis . Bacterial ,fungal and yeast Polysaccharides . b) Commercially produced polysaccharides – Xanthan gum , Dextrans, Sclerotium polysaccharide, Zanflo polysaccharide.	
Unit-III	12
3.1 Fermentative production of- a) Organic solvents – Acetone butanol fermentation. b) Organic acids- Lactic acid, Acetic acid, Citric acid, Gluconic acid, Itaconic acid. c) Enzymes –Protease, , lipase, Penicillin acylases , Lactases, Glucose isomerases. d) Vitamin –C	
Unit- IV	12
4.1 **Fermentative production of-** a) Antibiotics – Streptomycin, Bacitracin b) Yeast – Bakers yeast & Brewers yeast, Food yeast ,alcohol yeast. **4.2 Microbial transformation –** Types of bioconversion reaction, procedures for biotransformation, transformation of steroids and sterols, nonsteriod compound, antibiotics and pesticides. **4.3 Synthesis of Nano technological biological products-** synthesis of nano materials, Micro-organisms and plant extracts, use of proteins and	

template like DNA. Applications in various fields.	

Reference Books -

i) Industrial Microbiology – L.E.Casida 2012 Reprint

ii) Principles of Fermentation Technology –Second Edition P.F.Stanburg, A.Whitaker,S.J.Hall

iii) Biotechnology – Wulf Crueger & Anneliese Crueger

iv)Fermentation Technology & Biotechnology – 2nd edition – E.M.T.EL-Mansi,C.F.A.Bryce & A.L.Demain

v) Fermentation Technology- Vol. I & II - H.A. Modi

vi) Microbial technology – Vol.I & II - Peppler H.J. & D. Perlman

vii) Industrial Microbiology – Prescott & Dunn's

viii) Biotechnology – U.Satyanarayana

ix) Modern industrial Microbiology – Okafor Nkuda -2007, NH,USA

x) Nanobiotechnology – Kulkarni.

Semester- IV Paper- MIC (A) 4003 : Food and Agricultural Technology	Number of lectures
Unit - I	**12**
1.1 Food Fermentation a) Fermented milk products- Acceptance criteria for milk (Platform tests), Starter culture : Types, Nature, Fermented milk products : Composition, Starter, Method of preparation of Cultured, buttermilk and Cheese. b. Nutritive value of fermented foods : Curd, Cultured buttermilk, Idli, Tofu, Wine **1.2 Biopreservation** a. Bacteriocins : Types, Nature , Mode of action, Spectrum, Use b. Antimicrobial activity of spices c. Naturally occurring antimicrobial enzymes	
Unit-II	12
2.1 Food Safety a) Principles of food safety as per WHO b) New Methods for ensuring food safety **2.2 Qualitative and quantitative analysis of foods and food products as per food safety standards of India** a.Vegetables and fruits b.Bakery. c.Meat and poultry	
Unit-III	12
3.1 Neutraceuticals a. Neutraceuticals as science b.Criteria for neutraceuticals c. Food as remedies d. Antinutritional factors present in food e. Properties, structure and functions of neutraceuticals : Glucoseamine Lycopene, Carnithine **3.2 Production of Glucoseamine, Lycopene, Carnithine, Isoflavonoids , Phytosterols.**	
Unit- IV	12

4.1 Plant pathology : Diseases of Potato, Soybean, Grapes and Sugarcane caused by Bacteria, Nematodes, Fungi a) Bacteria affecting potatoes – *Ralstonie solanacearum* b) Bacteria affecting sugarcane – *Xanthomonas oxanopodis* c) Bacteria affecting Soyabean – *Pseudomonas amygdale* d) Nematode affecting Potatoes – *G. rostochiensis*, Pale cyst nematode, *Globodera pallida.* e) Nematode affecting sugarcane – (*Meloidogyoe* sp.) root knot. f) Nematode affecting soyabean – *Heterodera glycines.* g) Fungus affecting Potatoes – *Colletotrichum, Coccodes, Fusarium sp.,Arvenaceum* h) Fungus affecting Sugarcane- *Thanatephorus, Cucumeris, Ceratocystis adipose*. i) Fungus affecting Soyabean – *Alteraria sp., Cercpspora sojina, Peronospora manshurica.* **4.2 Biodegradation of-** Pectin, Lignin and Xylan **4.3 Plant growth hormones** : Production, Applications of IAA, Giberellic acid. **4.4 Siderophores** : Detection, Production, Applications.	

References :-

1) Clinical dietetics & nutrition – 4th Ed. 1997. – Anita F.P. Oxford Uni. Press.
2) Essentials of food & Nutrition – 2nd Edition. M. Swaminathan. Ganesh & Co.
3) Hand book of neutraceuticals & functional food Edi. by Robert E.C. Wildman, Routledge publisher.
4) Neutraceuticals – L. Rapport & B. Lockwood. Pharmaceutical Press.
5) Methods of analysis for functional foods & neutraceuticals – Edi. by W. Jeffrey, Hursts, Routledge publishers.
6) Manual of methods of Analysis of foods – Microbiological testing – Food safety & Stds.Authority of India, Ministry of Health & family welfare government of India New Delhi-2012.
7) Comprehensive dairy Microbiology – Yadav J.S., Sunita Grover, Y.K. Batish 1993.
8) Biotechnology – food Fermentations Vol.I & II Eds. V.K.Joshi , Ashok Pandey.
9) Bacteriocins – Konisky.
10) Handbook of Food Preservation : M.Shafiur Rahman.
11) Agricultural Microbiology – Ranga Swami. 2 nd Edition.
12) Soil Microbiology- Alexander .

Semester- IV **Paper- MIC (A) 4004 Elective – I : QUALITY MANAGEMENT SYSTEM IN INDUSTRY**	
Unit - I	**12**
1.1 Healthy microbial practices - Scope and aims. The advisory committee on Dangerous pathogens. Laboratory facilities design -Work flow, Size and shape of rooms, Benches ,Floors, walls and ceilings, Heating, lighting and ventilation Microbiological safety cabinets. Sitting and maintenance ,Other laboratory equipment Sterilization, disinfection and decontamination . Personnel and training, Documentation - Standard operating procedures, Quality systems **1.2 Biosafety** - Introduction . Biosafety considerations in fermentation technology. Containment – Physical containment, Biological containment. Biosafety during industrial production. Biosafety guidelines in India. Guidelines and regulations	

Unit-II	**12**
2.1 Endotoxin testing - Introduction -Endotoxins and pyrogens, Regulatory development, Introduction to LAL test. The gel clot method – Test principle and procedure, Gel clot lysate, sensitivity, Product interference. The chromogenic end point method- Test principle and procedure, Performance characteristics. The kinetic turbidimetric assay- Reagent preparation ,Test procedures, Performance characteristics. Method selection -Water samples, Samples other than water . Depyrogenation **2.2 Disinfection and cleaning** :- General consideration and terminology. Implementation of a cleaning and contamination control programme. Protective clothing and equipment. Selection of cleaning agents and disinfectants. Cleaning practices and application methods. Cleaning, disinfection and sterilization of isolators.	
Unit-III	**12**
3.1 Standard operating procedures.(SOP) – Clean in place (CIP) and sterilization in place (SIP) facilities.Validation-Data and document collection,Analytical methods,Sampling methods,Acceptance criteria Disinfection monographs–Alcohol, Aldehydes, Amphoterics, Chlorine dioxide, Hypochlorites, Peracetic acid, Phenolics, Quaternary ammonium compounds. **3.2 Antimicrobial preservative efficacy testing** – Introduction. The requirement for a biological assessment of preservative activity. Limitations of preservative efficacy tests. Test procedures and factors influencing reproducibility, Selection of viable counting method and demonstration of operator competence., Selection and maintenance of test organisms., Growth, standardization and storage of test inocula.,Test container, product inoculation, mixing and storage. Product sampling and preservative neutralization. Incubation conditions for organisms recovered from inoculated product. Validation. Interpretation of test results. e) Adaptations and alternatives to pharmacopoeial tests : The use of additional test organisms and more precisely defined cultural conditions. Mixed cultures, repeated challenges and variable inoculum concentrations. Rapid methods.	
Unit- IV	**12**

4.1 Microbiological analysis of air . a) Microbial load and identification of air flora in food – Vegetables, fruits, meat, poultry. bakery – Detection and characterization of organisms. b) Pharma and cosmetics – Sterility testing for products, Vitamins assays, antibiotic assay. **4.2 Quality assurance of food and pharmaceutical products-** International standards as per WHO, FPO, ISI . Industrial rules and regulations as per Indian pharmacopea. Detection of compounds using Indian pharmacopeia .Detection of ascorbic acid (tablet), Vit. B2 (Riboflavin) , antibiotics.	

Reference Book :

1) Handbook of Microbiology quality control – Norman A Hodges and Stephen P. Denyer.
2) Fermentation Technology – Dr. H. A. Modi, Vol. 2.
3) Pharmaceutical Microbiology – 6th edition, W. B. Hugo and A. D. Russell.
4) Introduction to Sterilization and disinfection. J. F. Gardner. M. Peel.
5) Laboratory methods in Food and Dairy Microbiology. W. Harngan, M. McCance.
6) Indian Pharmacopia
7) Booklets of ISI standards.
8) Booklets of IPO.
9) Rules and regulations of food and drug administration.

Semester- IV **Paper- MIC (A) 4004 Elective – II : INDUSTRIAL WASTE MANAGEMENT AND MICROBIAL BIOREMEDIATION**	
Unit – I	**12**
1.1 Distillery industry : Introduction, scenario of distillery industry, waste sources in distillery industry, characteristics of waste and effluents, environmental impact, treatment of distillery effluent **1.2 Petroleum industry** : Introduction, scenario of petroleum industry, waste sources in petroleum industry impact of wastes in the environment. Treatment of petroleum waste, biodegradation and bioremediation of petroleum products.	
Unit-II	**12**
2.1 Food and beverage industry : Introduction, scenario of food & beverage industry in India ,process and production, characteristic and impact of food processing industrial waste, treatment of food and beverage waste, industry specific bioremediation. e.g. Edible oil industry, fermentation industry, dairy industry, meat and poultry industry. **2.2 Dye industry** : Introduction, scenario of the industry in India the source origin and characteristics of waste effluent, environmental impact, treatment technologies of dyes, mechanism of colour removal.	
Unit-III	**12**

3.1 Pharmaceutical industry : Introduction, existing scenario, industrial process, waste generation, impact on environment, waste reduction and treatment, environmental standards. **3.2 Pesticide industry** : Introduction, existing scenario of industry, classification of pesticides, process and production, characteristics of waste / effluents, fate and effect of pesticides, pollution, prevention and control, treatment technologies, prospects of photodegradation, bioremediation, environmental standards.	
Unit- IV	**12**
4.1 Microbial bioremediation : I a)Introduction : Current environmental scenario, environmental issue and the public, five R policies for waste mineralization, choice of technology. b) Environmental contaminants : Nature of contaminants, general classification, effect of contaminants of environment, strategies for contaminant management. **4.2 Microbial bioremediation**: **II** General perspective, microbes for bioremediation, bioremediational techniques, bioremediation monitoring and case studies. a) Genetics of microbial bioremediation: Microbial genetic, plasticity, role of plasmid in bioremediation, evolution barriers, enhancement, genetic, metagenomics in bioremediations. b) Bioconversion of specific pollutants : Heavy metal, dioxins, radioactive wastes.	

References:

1) Industrial pollution Vol. I E. Joe middle brooks.
2) Waste water treatment M. N. Rao & A. K. Datta.
3) Water and water pollution handbook Vol. I, Leonard, L. Ciaccio.
4) Industrial pollution, N. Iruving sax, Van Mostrand Rein hold company.
5) Encyclopedia of environmental science & tech. Vol. II Ram Kumav.
6) Bioremediation by Rangaswamy.

4005 (A) :- Practical Course – VII

1. Preparation of cultured buttermilk.

2. Detection of afla toxin.

3. Antimicrobial activity of spices.

4. Estimation of benzoate quantity in food.

5. Milk platform tests.

6. Detection of lactoperoxidases in milk.

7. Estimation of lactic acid from curd.

8. Isolation of Xylan degrading bacteria from soil.

9. Isolation of Lignolytic bacterium from coir waste.

10. Estimation of pectin from plant material.
11. Estimation, purification & valuation of Beta amylase from sweet Poatoes.
12. Production of siderophores.
13. Determination of Thermal death point of microorganisms & thermal death time of microogs for design of a sterilizer.
14. Alkaline protease production by *B. licheniformes* in solid state fermentation.
15. Checking the efficiency of protease enzyme produced by SSF using standard curve of Tyrosine
16. Treatment of bacterial cells with cetrimide, phenol & detection of leaky substances such as Potassium ions, amino acids, purines.
17. Evaluation of sanitary status of aneatery by swab technique.
18. Identification of inhouse isolates obtained by settle plate technique and air sampler.
19. Techniques used in Textile industry - Determination of bio-burden on textile material using AATCC – 100 – 2004 method.
20. Determination of efficacy of isopropyl alcohol by suitable technique.

4006(A) :- **Practical Course – VIII**

Project Work