Choice Based Credit System Syllabus
(w.e.f. June 2015-16)

SOLAPUR UNIVERSITY, SOLAPUR

STRUCTURE OF M.Sc. DEGREE COURSE FOR MICROBIOLOGY

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.

The overall structure of the course to be implemented from the academic year 2011 onwards is as given below:

1) 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). For each semester there shall be four theory papers, each carrying 100 marks and for the first three semesters viz. semester I, II and III, there shall be two practical courses each. Each practical course carries 100 marks. However, for Semester IV there shall be a research project of 100 (One hundred) marks in lieu of one practical course and there shall be four theory papers and one practical course.
2) Semester wise theory papers and practical courses shall be as shown bellow :
   Semester I: Four theory papers and two practical courses are compulsory to all students.
   Semester II: Four theory papers and two practical courses are compulsory to all students.
   Semester III: Four theory papers and two practical courses are compulsory for all students.
   Semester IV: Four theory papers, a research project and one practical course are compulsory to all students.
3) Each theory paper shall be covered in four lectures per week and each practical batch shall be covered in four practical turns of four clock hours practical periods per week.
4) The university practical examination shall be of four days per batch per semester (at least of five hours duration each day).
5) 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.
6) 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 20 (Twenty) marks for the tour report.

7) 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

8) **Project Work*/Industrial Training** (In Iieau of MIC-406)**

*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 one hundred 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.

1. **The guide of student should locate the industry and depute the student in the industry for the period of one month
2. 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.

9) 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

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

11) Titles of Theory and Practical (Laboratory) Courses in the Semesters.

M.Sc. - Semester I:

- MIC – 101: Cytology and Taxonomy of Microorganisms
- MIC – 102: Microbiological Techniques and Scientific Writing
- MIC – 103: Recent trends in Virology
- MIC – 104: Microbial Chemistry and Enzymology
- MIC – 105: Practical Course I
- MIC – 106: Practical Course II

M.Sc.I - Semester II :

- MIC – 201 : Microbial Genetics
- MIC – 202: Microbial Physiology and Metabolism
- MIC – 203: Biophysics and Bioinstrumentation
- MIC – 204: Microbial Ecology and Diversity
- MIC – 205: Practical Course III
- MIC – 206: Practical Course IV

M.Sc.II-Semester III :

- MIC – 301: Molecular Biology and Genetic Engineering
- MIC – 302: Health care and Diagnostic Microbiology
- MIC – 303: Bioprocess Technology and Fermentation Technology
- MIC – 304: Food and Dairy Microbiology
- MIC – 305: Practical Course V
- MIC – 306: Practical Course VI

M.Sc.II-Semester IV :

- MIC – 401 : Immunology and Immunotechnology
- MIC – 402: Bioinformatics and Biometry
- MIC – 403: Waste Management Technology
- MIC – 404: Agricultural Microbiology
- MIC – 405: Practical Course VII
- MIC – 406: Practical Course VIII: Project Work / Industrial Training

M.Sc.Microbiology syllabus

Semester I

MIC 101: Cytology and Taxonomy of microorganisms.

No. of lectures.

UNIT: I

1) Surface properties of bacteria and significance 7
2) Cell division, Cell cycle and differentiation of *Bacillus, Azotobacter, Candida ,Aureobasidium* 7

UNIT: II

1) General characteristics and outline classification of Rickettsias , Chlamydia 5
2) Outline classification of algae, micro algae, algal cell structure and reproduction and Classification and structure of Cyanobacteria 7

UNIT: III

1) Outline classification of fungi, structure of fungal cell- hyphae and nonmotile unicells, motile cells and spores. 4
2) General characteristics of Lichens and Mycorrhizae. 4

UNIT: IV

1) General characteristics and classification of Actinomycetes. 4
2) General characteristics and molecular architecture of Mycoplasmas. 2

UNIT: V

1) Bacterial nomenclature and classification: 10
   A) Classification of prokaryotic organisms – an overview, Introduction to Bergey's manual of Determinative Bacteriology and Bergey' Manual of Systemic Bacteriology
   B) Principles of bacterial nomenclature
   C) Numerical taxonomy, chemotaxonomy, phylogenetic and serological Methods used in classification.

MIC102: Microbiological Techniques and Scientific Writing

Microbiological Techniques

UNIT: I

MICROBIOLOGICAL TECHNIQUES: 5

1) Principles and methods of enrichment and isolation of bacteria, fungi, algae, protozoa and viruses.

2) Electron microscopy – basic principles and applications of transmission and scanning electron microscopy, methods of sectioning and staining of specimens for microscopy .

UNIT: II

REGULATORY REQUIREMENTS FOR MICROBIOLOGY LABOROTORY 5

1) Installation qualification (IQ), operational qualification (OQ) and performance qualification (PQ) for laboratory equipments.

2) Methods of validitation and calibration of equipments.

3) Documentation – importance and significance.

4) Current Good Manufacturing Practices (CGMP) and Current Good Laboratory Practices (CGLP).

UNIT: III

BIOCHEMICAL TECHNIQUES: 10

1) Chromatography – principles, materials and applications of

i.)Column chromatography:- Adsorption – hydroxylapatite, ion exchange, affinity chromatography.Partition – normal phase, reverse phase, ion pair reverse phase,chiral , counter Current, molecular exclusion chromatography, High Performance Liquid chromatography(HPLC) Gas Liquid chromatography(GLC)

ii.) Planar chromatography- paper, thin layer chromatography.

2) Electrophoresis – General principles, Moving boundary and zonal electrophoresis, Electroendoosmosis.

i.)Protein electrophoresis- SDS-PAGE, native gels, gradient gels, IEF,2-D PAGE, Cellulose acetate, continuous flow.

ii.)Nucleic acid electrophoresis- DNA sequencing gels, pulsed field gel electrophoresis (PFGE), RNA electrophoresis.

iii.) Electrophoresis of other molecules – polysaccharide and glycoprotein, lipoproteins etc.

UNIT: IV

CENTRIFUGATION 5

1) Basic principles and types of centrifuges and rotors, Principles and methods of differential, density gradient centrifugation, centrifugal elutriation, analytical centrifugation.

2) Microfilm ultrafilteration – principles, materials used and applications.

Nanofilteration, reverse osmosis.

UNIT: V

SCIENTIFIC WRITING

1. History and basic concept of Scientific writing 2
2. Programme of writing-planning, good and scientific English and vocabulary, using dictionaries 3
3. Different types of scientific documents, review paper, book reviews, research paper, thesis, project reports and conference report. 4
4. Components of research paper, IMRAD system, title, authors and addresses, abstract, acknowledgements, references, tables and illustrations, 10
5. Preparation for publications-Submission of manuscript, ordering reprints 2
6. Presentation of research: Oral and poster presentation, presentation in conferences and symposia. 2
7. Preparation and submission of proposals to the funding agencies 2

MIC 103: Recent Trends in Virology

Unit: I

Classification and Morphology of Viruses. 10

Brief outline of discovery of viruses. Classification and nomenclature of animal and plant viruses. Cataloging the viruses through virus classification schemes of ICTV /ICNV. Morphology and ultra-structure of viruses, viroids and prions.

Unit: II

Cultivation and assay of viruses 8

Cultivation of viruses using embryonated eggs, experimental animals and cell cultures (Cell-lines, cell strains and transgenic systems). Purification of viruses by adsorption, precipitation, enzymatic and serological methods – haemagglutination and ELSA.

Assay of viruses – Physical and Chemical methods (Electron Microscopy and Protein and Nucleic acids studies). Infectivity Assays (Plaque and end-point)

Infectivity of plant viruses. Genetic analysis of viruses by classical genetic methods.

Unit: III

Viral Multiplication 12

Bacteriophages – Lytic and lysogenic interactions

Animal viruses – Mechanism of virus adsorption and entry into the host cell, DNA and RNA viruses-Mechanism of genome replication, Transcription, post transcriptional changes, translation, assembly, exit and maturation of progeny virions.

Unit: IV

Pathogenesis of Viruses 12

Host and virus factors involved in pathogenesis, patterns of infection, pathogenesis of animal viruses: Adeno virus, Herpes virus, Picorna virus, Poxvirus and Orthomyxovirus, pathogenesis of plant [TMV], Satellite viruses and their role in plant virus replication. Insect viruses [NPV], Viruses pathogenic to algae and fungi.

Host cell transformation by viruses, oncogenesis by DNA and RNA viruses.

Unit: V

Control of Viruses and Emerging Viral infections 8

Control of viral infections with vaccines and chemotherapeutic agents.

Virus neutralization by antibody and interferons

Structure, genomic organization, pathogenesis and control of Human Immunodeficiency virus. Emerging viral infections.

MIC 104: Microbial Chemistry and Enzymology

Unit-I

Microbial chemistry

1. Protein Chemistry 4
    a) Amino acids- Classification, structural features and Chemical reactions.
    b) Reverse turns, Ramchandran plot, helix coil transition.
2. Carbohydrates Chemistry- Nomenclature, types and structures. 2
3. Lipid Chemistry 4
    a) Fatty acids- types and nomenclature.
    b) Types of lipids and structural aspects.
    c) Steroids, Terpenes and Prostaglandins.
4. Vitamins 2
    a) Water and fat soluble.
    b) Structures and functions of vitamins.
5. Chemistry of Porphyrins, Chlorophylls, Cytochromes, Haemoglobin, leg haemoglobin and Bacteriorhodopsin. 3

Unit-II

Enzymology: Basic Concepts

1. Nomenclature and Classification of Enzymes 2
2. Basic concepts, types of specificities-Substrate and product, bonds, group relative of absolute. 2
3. Factors responsible for specificity 3
    a) Physical structure of enzymes- monomeric and oligomeric enzymes.
    b) Concept of active site- Ogston’s experiment, lock and key and induced fit hypotheses.

Unit-III

Kinetics of Enzyme activity 9

a) Introduction of Chemical kinetics.

b) Kinetics of Single substrate enzyme catalyzed reactions-Wilhelmy’s and Brown’s work, Henri and Michaelis and menten derivations, Briggs and Halden modification.

c) Significanceof the M-M equation and Km.

d) Modification of M-M equation- Lineweaver- Burk, Eadie- Hofstee, Hanes and Eisenthal and Cornish-Bowden.

e) Kinetics of multi substrate reactions.

f) Inhibition- Basic concepts, kinetics, examples and significance of reversible and irreversible inhibition. 4

Unit-IV

Catalytic power of enzymes: 10

1. Basic concept of catalysis-activation energy barrier and the transition state theory
2. Catalytic mechanism in chemistry and in enzymes- acid –base, covalent and electrochemical reactions.
3. Factors enhancing the catalytic efficiency of enzymes proximity and orientation, orbital steering, distortion and strain.
4. Functional groups involved in the catalytic mechanism-
    a) Amino acids
    b) Co factors- Prosthetic groups, coenzymes, co substrates.
    c) Metal ions in enzyme function.- hteir role, metal activated and metallo enzymes, ternary complexes.
5. Methods used to identify functional groups in the active site.
6. Some examples of enzyme function- Chymotrypsin, Lysozyme, Triose phosphate, Isomerase.

Unit-V

Regulation of Enzyme function: 5

1. Control of enzyme activity by-
    a) Changes in covalent structure- irreversible and reversible
    b) Ligand induced conformational changes-Allosteric enzymes- Basic concepts Cooperativity, model proposed to explain the mechanism of functioning (MWC and KNF) structural aspects of aspartate carbomyl transferase, role of allosteric enzymes in metabolic regulation (feed back inhibition).
2. Enzymes in organized systems and their role in control function
    a) Multienzyme system- Basic concepts, significance and types with examples, structural aspects of pyruvate dehydrogenase and fatty acid synthesis.
    b) Isoenzymes- basic concepts, types with examples and their significance to the cells and to the medical fields.

M.Sc.Microbiology syllabus

Semester II

MIC 201 Microbial Genetics

Unit-I

Classical genetics:

1. Origin of life, Organic evolution Darwinism and Mendelism 6

2. Genetic Material: a) Evidences of Nucleic acid as genetic material 5
b) Watson and Cricks model of DNA structure,
Alternative forms of DNA

3 Split genes and Overlapping genes 2

4. Evolution of One cistron one polypeptide theory, genetic complementation,
Cis- Trans test of genetic function. 3

Unit-II

Duplication of Chromosomes and DNA 5

a) DNA replication in *E. Coli* – rules and enzymes involved, Mechanism of DNA replication, theta and rolling circle model.

b) Chromosome duplication- Taylor's experiment, Dupra's folded fiber and alternative folded fiber model of metaphase chromosome.

Unit-III

Transposons and Plasmids

1. Mobile elements in Prokaryotes and Eukaryotes- Insertion sequences, transposons, transposable elements and their properties, detection and significance, retrosposons, J. Shapire's model of replicative transposition. **5**

2. Plasmids- Nomenclature, classification, general properties and types. Detection and purification, amplification and rearrangements, replication and transfer process, plasmids in Yeasts. **4**

Unit-IV

Molecular aspects of gene regulation and expression 9

a) Genetic code- Deciphering of genetic code and important properties of genetic code

b) Transcription in Prokaryotes and Eukaryotes- Structure of r RNA, t RNA and mRNA, antisense RNA and its significance, post transcriptional process.

c) Translation in Prokaryotes and Eukaryotes- Operon models Lactose, tryptophan and arabinose, Britten and Davidson's model, post translational process.

Unit-V

Techniques in genetics, Terratogenesis and DNA damage and Repair

1. Techniques- PCR, LCR, RFLP, DNA foot printing and finger printing, 5
Chromosome walking, blotting techniques, gene sequencing and mapping,
DNA melting, gene targeting, Cloning (animal, Human Genome project)
2. Terratogenesis- Genetic disorders and differential gene activity, Genetic counseling **3**
3. DNA damage and repair- types of damages, damaging agents, 3
Repair mechanisms- Photoreactivation, dark repair, post replication recombination repair, SOS repair, role of conservation of genetic integrity, relationship to lifespan and Ageing process, mechanism of ageing.

MIC 202 Microbial Physiology and Metabolism

Unit-I 8

Transport in Bacteria

1. Transport mechanism of Nutrients across the cell membrane- Simple diffusion, facilitated diffusion, group translocation and Active transport and Passive transport.

2. Permeation – different permeation systems in *E.coli* amino acid permeases transport of inorganic ions physiological consequences and significance of permease mechanism.

Unit-II

Electron transport chain and TCA Cycle **8**

1. ETC: Concept, components involved electron transport and oxidative phosphorylation, theories of ATP formation.

2. Bacterial Electron Transport Chain- photosynthetic and non photosynthetic, aerobic and anaerobic bacterial ETC.

3. Mitochondrial ETC: structure of mitochondria, mitochondrial ETC, shuttle systeme across membrane, Atkinson`s energy change.

4) Citric acid cycle: steps involved, amphibolic nature, anapleurotic reaction. 3

Unit-III

Biosynthesis 15

a.) Purines and pyrimidines by de novo synthesis.

b.)Saturated fatty acids.

c) Amino acid synthesis pathways

Unit-IV

Oxidation of hydrocarbons and Drug metabolism: 5

a.)Alkanes and alkenes – alpha, beta, and omega oxidation.

b.) Aromatic hydrocarbons – beta keto adipate pathway, valerate pathway, gentisate pathway.

c) Drug metabolism and detoxification. 3

Unit-V

Osmosis, Oxygen toxicity and Microbial hormones

1. Osmosis – definition, microbial response to osmotic stress, avoidance of osmotic stresses, responses of microbial – plasma – membrane –to- osmotic – stresses. Reverse osmosis. 3

2.Oxygen toxicity – catalase, peroxidase, super oxide dismutase, mechanism of O_2 toxicity 3

3. Microbial hormones and their significance. 2

MIC- 203: Biophysics and Bioinstrumentation

Unit-I Biophysical Techniques **10**

i) X-ray diffraction analysis and crystallography.

ii) Circular dichroism and optical rotary dispersion spectroscopy.

iii) Infra red and Raman spectroscopy.

iIv) Electron spin and nuclear magnetic resonance spectroscopy.

Unit-II

Analytical techniques 10

a) Immunochemical techniques – general principles and applications of immunodiffusion, immunoelectrophoresis, radioimmunoassay, enzyme linked immunosorbent assay, fluorescence immunoassay, immunoblotting, immunohistochemistry.

b) Radio isotopic techniques- nature of radioactivity, methods of detection and measurement, methods of application – tracer, autoradiography.

Unit-III

Spectroscopy 12

c) Spectroscopy – general principles of electromagnetic radiation spectroscopy.

d) Principles, instrumentation and applications UV – visible spectrophotometry, turbidimetry and nephelometry, fluorimetry, luminometry, atomic absorption and mass spectroscopy.

Unit-IV Electrochemical Techniques **8**

e) Electrochemical techniques – electrochemical cells, potentiometry and voltametry .

f) Principles and applications of ion selective and gas sensing electrodes, pH, oxygen electrodes and redox couples.

g) Principles, apparatus, functioning and applications of nanometry.

Unit-III

Molecular Biophysics **10**

1. Physical and chemical properties of amino acids and polypeptides, theoretical and experimental methods for determination of sizes of proteins, physical nature of non-covalent interactions, conformational properties of proteins, Ramchandran plot, secondary, super secondary, tertiary and quaternary structure of proteins.
2. Protein structure determination by X-ray diffraction.
3. Application of NMR spectroscopy for protein and DNA structure determination. Electron spray mass spectroscopy analysis of biomolecules.

MIC 204: Microbial Ecology and Diversity

Unit-I

Microbial Diversity 6

1) Microbial World : General characteristics and outline classification of Bacteria, Yeasts, Molds, Viruses, Protozoa, Lichens, Mycorrhiza Viroids and Prions and their role in the biosphere

2)Differentiation : In Bacillus ,Azotobacter, Candida, Mycoplasma and Aureobasidium spp. 2

Unit-II

Microbial Ecology **10**

Basic ecological principles, Ecosystems, habitats, ecological niches, gen burst of population and population explosion, community, energy transfer and ecosystem management ,microbe-microbe, microbe-plant and microbe-animal interactions. Endolithic microorganisms of Antarctica.

Unit-III 11

1) Anoxygenic photosynthetic microbes-General characteristic of purple and green sulphur bacteria

2) Oxygenic photosynthetic microbes- General characteristics of Cyanobacteria and Prochlorales

3) Methanogenic Archeobacteria—General characteristics 2

Unit-IV

7) Bioluminescent and nitrogen fixing bacteria- A high energy spending bacteria 4

8) Magnetotactic bacteria 1

9) Microorganisms in prospecting of oils 1

10) Identification of uncultured organisms. 2

Unit-V

B) Extremophiles- 15

1) Acidophilic, alkalophilic, psychrophilic, thermophilic, barophilic, osmophilic and halophilic microorganisms

2) Microbes in toxic environments like acid mine drainage, coal desulphurisation ,wastes containing cyanides, xenobiotics, pesticides and chemicals, heavy metals, hydrocarbons and radio isotopic materials

3) Concept of autotrophy – an example of extreme synthesis

4) Biodeterioration-concept, biodeterioration of wood, stonework, pharmaceutical products, rubber, plastic, paints, lubricants, cosmetics, & control of biodefenoration

5) Microbial fossils

M.Sc. Part – I Practical course

SEMESTER –I PRACTICAL COURSE

MIC – 105: Practical Course I

1.) Demonstration of: Bacterial and yeast DNA

2) Preparation of yeast protoplasts.

3.) Isolation and purification of lysozyme from egg white and preparation of bacterial protoplasts.

4.) Isolation of bacterial cell wall and study of cell wall polysaccharide by chromatographic technique.

5.) Single cell and single spore isolation techniques.

6.) Study of magnetic and electric field on behavior of microorganisms.

7.) Isolation and identification of reserved food material from *Bacillus megaterium*

8.) Isolation and morphological studies of –

i.)Algae –spirulina, scenedesmus spp.

ii.)Fungi- Aspergillus, Penicillium, Rhizopus, Fusarium, Trichoderma and saccharomyces.

iii.)Protozoa – Euglena, Paramoecium and Plasmodium.

iv.)Mycorrhiza – VAM fungi – demonstration.

v.) Lichen- demonstration.

14.) Induction of ascospore in yeasts of *Saccharomyces cerevesiae*.

15) Writing suitable title (Analysis) of research papers.

16) Assignments on search of scientific paper using key words, author etc. on PUBMED

17) Writing abstract for research paper.

18) Search of authors instructions from website of a scientific journal and its analysis/ comparison

19) Assignment on analysis of data/ Results/ Conclusion.

20) Assignment on Google search for scientific purpose.

21) Assignment on search Impact factor of scientific Journal from internet.

22) Assignment of NCBI/ PUBMED.

MIC – 106: Practical Course II

1) Isolation, titration and high titre stock preparation of *E.coli* phages from sewage.

2) Phage typing of *E.coli* and *Salmonella* strains.

3) Egg inoculation techniques and cultivation of animal viruses in embryonated eggs.

4) Study of one step growth curve of phage T4

5) Estimation of total carbohydrates, proteins, lipids, RNA and DNA of bacteria

6) Preparation of Buffers- Phosphate, Acetate, Citrate etc.

7) Studies on enzyme Amylase-

a) Precipitation of enzyme by solvent & salt and partial purification by dialysis.

b) Quantitative estimation of the enzyme and enzyme activity.

c) Effect of following factors on amylase activity

i) Substrate concentration (S_0)- determination of V_{max} and $K_{m.}$

ii) Determination of optimum pH for amylase activity

iii) Determination of optimum temperature for amylase activity.

iv) Metal ions for activity.

d) Immobilization of amylase in Na- alginate and studies on a) Stability- thermal storage - wet and dry b) effect of S_0 temperature, pH on immobilized amylase.

8) Study and detection of levels of lactate dehydrogenase, alkaline phosphatase in serum.

9) Assay of Cellulase and Pectinase.

SEMESTER –II PRACTICAL COURSE

MIC – 205: Practical Course III

1) Isolation of DNA from bacteria and yeasts.

2) Isolation of drug resistant microorganisms.

3) Isolation of RNA from yeasts.

4) Isolation of bacterial and yeast plasmids (amplification, curing and purification).

5) Study of transformation, transfection, conjugation, transduction, protoplast fusion in bacteria

6) Isolation of restriction endonucleases from bacteria.

7) Isolation of thiamine requiring mutants of *E.coli* using replica plate technique

8) Testing of chemicals for mutagenicity by Ames, lambda-muta test and Induct-test

9) T and B rosette tests

10) Study of UV absorption spectra of Macromolecules (Protein, Nucleic Acid and Bacterial Pigments)

MIC – 206: Practical Course IV

1) Enrichment and Isolation of anoxygenic phototrophic bacteria and bioluminescent bacteria.
2.) Isolation of bacteria and other microorganisms producing plant growth promoting substances like Gibberellins and Indol Acetic Acid.
3.) Isolation of organisms producing catalase, peroxidases, superoxide dismutase, alkaline lipase, proteases.
4.) Separation of amino acids, sugars, dyes, plant materials using paper, thin layer and column Chromatographic techniques.
5.) Electrophoretic separation of proteins and nucleic acids by agarose and polyacrylamide gel electrophoresis.
6.) Studies on the principles of light spectroscopy – Beer and Lambert`s laws, extinction coefficient and molar extinction coefficient.
7.) Isolation of chemolithotrophic bacteria like *Nitrosomons* and *Nitrobacter* spp.
9) Different cultivation techniques for Actinomycetes
10) Isolation of Methane bacteria from Biogas slurry
11) Studies on Magnetotactic Bacteria
12) Isolation of Cyanobacteria from water sample
13) Demonstration of ELISA test

List of Reference books recommended.

MIC – 101: Cytology and Taxonomy of Microorganisms

1. Bacterial cell structure by Rogers, ASM publications.
2. General Microbiology by stanier etal, 5th Edn.
3. Microbial Ultra structure by Fuller R.
4. Chemical Microbiology by Rose.
5. Microbial and Plant Protoplasts by Peberdy Etal.
6. Biology of Mycoplasma by Smith P. I.
7. Introduction to Fungi by Alexopolus.
8. Bergy's manual of systemic bacteriology Vol. 1, 2, 4 Williams, Wilkins & Baltimore, Academic Press.
9. A Manual of Soil Fungi – Gilman J. C. (1967) Oxford & JBH Publications.

MIC – 102: Microbiological Techniques and Scientific Writing

1. A Biologist's guide to principles techniques of Practical biochemistry by K. Wilson and K. H. Goulding, Edwward Arnold publications.
2. Chromatographic methods by Brathwaite & White.
3. Analytical Chemistry by Robert B. Dilts, Van Nostrand Publications,
4. Introduction to practical biochemistry by D. Plummer, J. Wiley & Sons.
5. Laboratory methods in biochemistry by J. Jayaraman.
6. Methods in Microbiology by Norris and Ribbons, Academic press.
7. Principles and techniques at practical Biochemistry – K. Wilson and J. Walker, Cambridge University Press.

MIC – 103: Recent trends in Virology

1. Bacterial & Bacteriophage Genetics by Edward A. Birge.
2. Principles of Bacteriology, Virology & Immunity 8th edition (Vol. 4) by Topley & Wilson's.
3. General Virology – Luria.
4. Introduction to Plant Virology – Bos I. (1983) Longman, London & New York..
5. Animal Virology – Fenner, F & White, D. O. (1976) Academic Press Inc., New York.
6. Chemistry of Viruses (2nd edition) – Knight C. A. (1975) Springer Verlag Inc. New York.
7. Virology – Dulbecco R. and Ginsberg H. S. (1980), Harper and Ravi Publishers Inc. New York.

MIC – 104: Microbial Chemistry and Enzymology

1. Biological Chemistry by Melhar H.R. and E.H. Cord 1968 Harper and Row Publisher inc New York
2. Biochemistry by Stryer, L. 1981 2nd edition, W.H. Freeman and company, Sanfrancisco.
3. Biochemistry by Stryer, L. 1988 3rd edition, W.H. Freeman and company, Sanfrancisco
4. Enzyme nomenclature- International Union of Biochemists (IUB) Academic press.
5. Understanding enzymes- Trevor Palmer Ellis Harwood Publications.
6. Fundamentals of Enzymology- N.C. Price and L.Stevenson, Oxford University Press.
7. Enzymes P.Boyer, Academic Press.
8. The Enzymes M. Dixon and E.C. Webb.
9. Advances in Enzymology- Series edited by N.O. Kaplan, Academic Press.
10. Enzyme structure and Mechanism- A. Fershit, Freeman, USA.
11. Biochemistry by Lehninger A.L. Kalyni Publisher, New Delhi
12. Principals of Biochemistry by Lehninger A.L.1984 1st Indian edition, LBS Publisher and Distributor Pvt. Ltd, New Delhi.

13. Basic Biochemistry 2nd Edition – Lehninger, A. L. (1984) Kalyani Publications, Ludhiyan, New Delhi.

14. Textbook of Biochemistry, 4th Edition – West E.S.W.R. Tood, H.S. Mason, J.T.V. Burgen (1966) Macmillan Company, New York.

15. Principles of Biochemistry 5th Edition – White A. P. Handler, Pand E. L. Smith 1973) McGrow Hill Koga Kusha Ltd., Tokyo.

16. Biochemistry – by Zubay

MIC – 201 : Microbial Genetics

1. Molecular Biology of gene – J. D. Watson (2004)

2. Gene expression by Lewin Vol. 5, 6, 7 & 8 John Willey & Sons.

3. Microbial Genetics – Freifelder.

4. Principles of Genetics – Gardner, E. J. (1991) John Willey & Sons Publication, New York.

5. A DNA replication – Kornberg A., Freeman Publications, San Fransisco.

6. Genetics – P.K.Gupta

MIC – 202: Microbial Physiology and Metabolism

1. Bacterial Physiology and Metabolism by R. J. Sokath.

2. Metabolism by Doelle, Academic Press, London.

4. Biochemistry of Microbial growth – by Mandelstam.

5. Methods in Microbiology Vol. 3 A, Norris & Ribbons (eds) Academic Press.

6. Microbial Physiology – Dawes I. W., and Sutherland J. W, (1976) Halsted press

7. Metabolic Pathways 3rd edition – Greenberg D. M, (1976) Springer Verlag, New York.

7. Microbial Physiology - Albert G. Moat, John W. Foster John John Wiley & Sons.

MIC – 203: Biophysics and Bioinstrumentation

1. Principles of Physical Biochemistry – Van Holde, et al., Prentice Hall.

2. Crystallography made crystal clear – G. Rhodes, Academic Press.

3. Introduction to Protein Structure – Branden and Tooze, Garland Publishing Co.

4. Methods in Modern Biophysics -Bengt Nölting, 2nd Edition Springer 2006

5. Biophysics - Vasantha Pattabhi N. Gautham Narosa Publishing House

6. Principles of Protein X-Ray Crystallography - Jan Drenth Third Edition

MIC – 204: Microbial Ecology and Diversity

1. Extremophiles-(2000) By B.N.Johari Springer Verlag,New York.

2. Microbial diversity (1999) by D.Colwd Academic press.

3. Bergy's Manual of Systematic Bacteriology (1984).Vols.I and III .Williams and Wilkins, Baltimore Academic press

4. Microbial life in extreme environments (1978) by D.s.Kushner Academic press Inc.New York

5. Microbial ecology (1979) by J.M.Lynch and N.J.Poole .Blackwell Scientic Publications,Oxford.

6. Brock biology of microorganisms (2000).9th eds.by M.T. Madigan,J.M.Martinko and Jack parker.

7. Biochemistry, Bioengineering and biotechnology Hand book (1991).by B.Atkinson et al.Macmil