********** **B+**

Accredited By NAAC

New Syllabus For

M.Sc. Part I & II

APPLIED MICROBIOLOGY

Syllabus to be implemented from June 2009 onwards.

SHIVAJI UNIVERSITY, KOLHAPUR

Structure of M.Sc. Degree Course for Applied Microbiology

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 2009 – 2010 onwards is as given below,

1) The entire M.Sc. Course in Applied Microbiology shall be covered in 16 (sixteen) theory papers, 7 (seven) practical courses (semester I, II, III, IV) and a project work (in lieau of one practical courses of semester IV) for each semester there shall be four theory papers each carrying 100 marks and for first three semester viz. semester I, II and III, there shall be two practical courses each. Each practical course shall carry 100 marks. However, for semester IV there shall be a research project work of 100 (one hundred) marks in lieau of one practical course in addition to four theory paper and one practical course.
2) Semesterwise theory papers and practical courses shall be as shown below,
   Semester I : Four theory papers and two practical courses compulsory to all students.
   Semester II : Four theory papers and two practical courses compulsory to all students.
   Semester III : Four theory papers and two practical courses compulsory to all students.
   Semester IV : Four theory papers and a compulsory research project work and one practical course for every student.
3) Each theory paper will be covered in four lectures per week. Each practical course shall be covered in three practical turns of three clock hours practical periods per week.
4) For university practical examination the duration should be as shown below
   For every semester there shall be three days practical examination per batch (at least six and half hours duration each day)
5) Each candidate must produce a certificate of 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 has been properly maintained. Every candidate must have recorded his/her observation 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 journal at the time of practical examination. There shall be twenty marks for each journal for semesters I, II and III each.

There shall be one compulsory seminar of minimum half an hour delivery per year for each student and at the time of practical examination every student must submit the certificate from Head of the Department in his/her college stating the he/she has satisfactory completed the seminar work.

Students shall have to undertake an academic tour to visit at least two places of academic interests like industries/research instruction / R & D departments during semester II and semester IV each. The student should submit the report of their visit at the time of practical examination. The report should be duly certified by the Head of Department. There shall be twenty marks for tour report.

Student is to undertake a research project / industrial training (as part of the semester IV in lieu of Practical Course VIII) which is to be started in the beginning of semester III so as to give enough time for duly completion of project. In the project student is to study research methodology (Introduction, Aims and Objectives, Material and methods, Results and Discussions, Conclusion and Bibliography). 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. The evaluation of remaining fifty marks done by concerned supervisor of the student as an internal evaluation during research project work in progress.

***Note : The Standard of passing and other rules are applicable as per other M.Sc. Courses.**

In industrial training –

1) The supervisor of student should locate the industry and depute the student in the industry for the period at least of three weeks.
2) Student should complete his/her industrial training cum industrial project in the vacation period after semester II.
3) Student should study microbial aspects in industry and submit its report in the form of dissertation duly signed by the concerned authority, concerned supervisor and Head of the Department of Microbiology.
4) The method of evaluation of ‘industrial training’ should be as formulated for ‘project work’ being an option for project work the industrial training will carry 100 marks.

M. Sc. Part I
Semester I

MIC(A) 101 : Morphology and Taxonomy of Microorganisms

UNIT I **6**

Bacterial Taxonomy :

1) Bergey's Manual of Determinative Bacteriology – History
2) Approaches to bacterial taxonomy

i. Chemotaxonomy : Cell wall component, lipid composition, isoprenoid quinines, amino acid sequence of proteins, proteins profiles, cytochrome composition.

UNIT II **6**

Genetic approach to bacterial taxonomy :

Genetic methods : PCR & DNA finger printing as identification tools for bacteria, DNA base composition and hybridization, 16S rRNA sequencing.

UNIT III **5**

Computational methods of taxonomy ; Cluster analysis, clustering algorithms, principle component analysis.

UNIT IV **7**

Archaebacteria - General characteristics, morphology, taxonomic features.

Rickettsia - General characteristics, morphology, taxonomic features, importance.

UNIT V **6**

Actinomycetes - General characteristics, morphology, importance and classification.

UNIT VI **8**

Cyanobacteria - Morphology, importance, general characteristics, Morphological methods in taxonomy.

Algae : Classification, distribution, structure, nutrition and metabolism, reproduction, importance of algae.

UNIT VII **5**

Yeasts : Distribution, structure, reproduction characteristics as criteria for classification. A system of yeast classification.

UNIT VIII **5**

Molds : Classification, distribution, structure, nutrition and metabolism, reproduction, importance of fungi. 16S rRNA, nucleotide sequencing based classification of fungi.

Reference:

1) Breed and Buchanan, Bergey's Manual of Determinative bacteriology 9th edn.
2) Sykes G. and F. A. Skinner (Eds) Actinomycetables : Characteristics and practical importance. Society for applied bacteriology symposium series No. 2 Academic press.
3) Lodder, The yeas – A Taxonomic Study – North Holland Publishing.
4) Illustrated genera of imperfect fungi – Burgess publishing Co. Minnesota.
5) Barnett J. A. / R. W. Payne and D. Yarrow (1979) A guide to identifying and classifying yeast, Cambridge Uni. Press, Cambridge.
6) Campbell L. (1974). Method of numerical taxonomy for various genera of yeasts in Aurances in Applied Microbiology ed. By D. Perlman A.P. N.Y. 17 : 135 – 156.
7) Hawksworth D. L. (1974) Mycologists Handbook, CMI

MIC(A) 102 : VIROLOGY

UNIT I **8**

Bacterial viruses

a) One step growth experiment, single burst experiment.
b) Productive cycle of λ and φ (phi) x 174.
c) Lysogeny of Mu1, comparative study of lysogeny, in P1, P2, P22
d) RNA Phages.

UNIT II **8**

Animal viruses –

Productive cycle of

a) DNA viruses – Parvo, Adeno
b) RNA viruses – Reo, Rhabdo, Picorna, Influeza, Retro viruses.

UNIT III **8**

Cultivation of viruses : i) embryonated egg, experimental animals and cell clines. ii) Enumeration of viruses – Electron microscopic method, Plaque method, end point method.

UNIT IV **8**

Plant viruses

a) Classification
b) Transmission (vector and nonvector)
c) Effect of viruses on plants.
d) Common viral diseases of plants. TMV

UNIT V **8**

Viral diseases

a) Nature of viruses reservoirs
b) Animal models to study viral pathogenesis
c) Common viral diseases – Polio, mumps, measles.

UNIT VI **8**

a) Emerging viral diseases
b) Viroids and prions

UNIT VII **8**

Laboratory diagnosis of viral infections :

a) Principles of viral diagnosis
b) Collection and transport of specimen
c) Laboratory techniques
d) Reporting of results
e) Quality assurance and accreditation

UNIT VIII **8**

1) Viral vaccines :

i) Types of vaccines
ii) Conventional rDNA vaccines
iii) New generation vaccines

Reference :

1) Microbiology : Third edition
Bernard Davis, Renato dublecco, HN NEisen and Harold S Ginsberg.
2) Basic Virology : 3rd edition, Edward Wagner, Martinez J Hewlett, David Bloom, David Camerini,
Blockwell Publishing USA.

3) International students edition –
Mackie and McCartney - Practical Medical Microbiology, J. G. Collee, J. P. Duguid, A. G. Fraser, B. P. Marmion.
13th Edition – Churchill Livingstone.
4) Zinsser Microbiology : 15th Edition
W. K. Joklik David T. Smith.
Appleton – Century – Crofts / New York.
A Publishing Division of Prentice Hall Inc.
5) Virology by Luria – General virology
6) Genetics of bacteria and viruses – William Hays
7) Introduction to Plant Virology – Bos I. (1983) Longman, London & New York.
8) Animal Virology – Fenner F. & White D. O. (1976) Academic Press Inc. New York.
9) Chemistry of Viruses 2nd Edn. Knight C. A. (1975) Springer Vaerlag Inc. New York.
10) Virology by Delbecco & Ginsgergs (1980) Harper & Ravi Publishers, New York.

MIC(A) 103 : Biomolecules and Bioenergetics

UNIT I **6**

Biomolecules :

Amino acids

i) Classification of amino acids – Neutral, acidic, basic and aromatic .
ii) Zwitterions and Isoelectrical pH of amino acids, acid-base nature of amino acids.
iii) Henderson and Hasselbadh equation, pK values of aminoacids.
iv) Ninhydrin reaction and its significance.

UNIT II **7**

Proteins : Classification and structure of protein

A) Classification based on –
i) Shape of proteins – globular, fibrous
ii) Composition and solubility – simple, conjugated and derived.
iii) Biological functions – Enzyme, regulation, structural transport, toxin, defense, etc.

B) Structure of proteins –
i) Peptide bond and its nature
ii) Ramchandran plot
iii) Structural levels of proteins –
a) Primary structure
b) Secondary structure – alpha helix, beta pleated structure, B-turn, triple helix (collagen) and super secondary structures.
c) Tertiary structure – meaning forces involved in maintaining tertiary structural levels
- Folding/unfolding experiment
- Importance of chaperones in protein folding.
d) Quaternary structure – meaning forces involved in stabilizing quaternary structure

UNIT III **7**

Determination of protein structure

1) Amino acid sequencing – N-terminal and C-terminal methods
i) Sanger method
ii) Dansyl chloride
iii) Debsyl chloride
iv) Edman degradation method.
v) Enzymatic cleavage of protein to determine the structure.
vi) Prediction of conformation of protein structure from amino acid sequence.

UNIT IV **5**

Carbohydrates

Classification, structure and functions of
a. Monosaccharides – Glucose, fructose, mannose, galactose
b. Oligosaccharides – Lactose, maltose, sucrose.
c. Polysaccharides – Starch, cellulose

UNIT V **5**

Vitamins and bacterial hormones

A) **Vitamins** – Structure and function of
a. Fat soluble vitamins – A, D, E, K

b. Water soluble vitamins – Vit C and B-complex vitamins

B) Microbial hormones and their significance

UNIT VI **7**

Bioenergetics :

1) The laws of thermodynamics – First law, second law

2) Thermodynamic consideration – Oxidation, reduction, standard electrode potential, Redox couples, phosphate group transfer potential

3) Role of ATP in metabolism

4) Mitochondria and ATP generation

a. Architecture, chemical activity of mitochondria, ETC, sequence of electron carriers and site of oxidative phosphorylation, ATP generation, proton motive force, Heme and non-heme iron, protein

b. Theories of oxidative phosphorylation, mechanism of oxidative phosphorylation (chemical coupling hypothesis)

c. Uncouplers and inhibitors of ETC.

UNIT VII **6**

Plant Photosynthesis

a. Chloroplast evolution from endosymbiotic bacteria.

b. Architecture of chloroplast.

c. Basic equation of photosynthesis

d. Chemical activity of chloroplast, Hill reaction

e. Photosystem I and II – Location, reaction, photophosphorylation and reduction of CO_2, light harvesting complexes, plastocyanin, carotenoids, calvin cycle.

UNIT VIII **5**

Bacterial photosynthesis

a. Photosynthesis reactions in bacteria.

b. Sources and reactions of 'H' donor in bacterial photosynthesis.

c. Bacterial light absorbing pigments – Bacterio rhodopsin in hallophiles, structure and reaction.

References :

1) Biochemistry by Zubey
2) Biochemistry by Lubert Stryer
3) Outlines of Biochemistry – Chon and Stumph
4) Principles of Biochemistry – White & Smith
5) Lehninger's Principles of Biochemistry – Nelson & Cox
6) Biochemistry by Voet
7) Practical Biochemistry – David Plummer
8) Laboratory Mannual in Biochemistry – Jayaraman
9) Elements of Biochemistry – Shrivastava.
10) Practical Biochemistry for Students – Malhotra.
11) Biochemical methods – Sadasivam

MIC (A) 104 : Genetics

UNIT I **7**

Mendelism :

i) Monohybrid crosses and Mendels' Principle of segregation.
ii) Dihybrid crosses and Mendelian principle of independent assortment
iii) Epistasis
iv) Statistical analysis of Genetic data. The Chi-square test.
v) Multiple alleles – ABO blood groups.
vi) Essential genes and lethal genes.
vii) The environment and gene expression

UNIT II **7**

The Global structure of chromosomes:

a) Lampbrush chromosomes
b) Drosophila, polytene chromosomes
c) Heterochromatin.
d) Heterochromatin – defense against mobile DNA elements.
e) Mitotic chromosomes – their patterns

UNIT III **7**

Chromosomal DNA and its packaging in the chromatin fiber :

i) Procaryotic and eukaryotic chromosome
ii) Nucleusome cole particle – Histon, non-histon
iii) ATP driven chromatin remodeling machines.
iv) Covalent modification of Histon tails
v) Split genes – Exon, Intron, detection of intervening sequences β-chains of haemoglibin, ovalbumin.
vi) Splicing mechanism a) Autocatalytic RNA, b) Spliceosome

UNIT IV **7**

DNA replication

a) Mechanism of replication
b) Enzymes involved – DNA ligase, DNA gyrase, topoisemerase I, DNA polymerase I, DNA polymerase III, Helicase.
c) Proof reading, strand directed Mismatch repair
d) Replication in prokaryotes (*E. coli*) and Eucaryotes and organelle DNA replication, chloroplast and mitochondria.

UNIT V **6**

Gene transfer in bacteria

a) **Transformation** – Discovery, mechanism, mapping by transformation and other uses of transformation.
b) **Conjugation** – insertion of F into E. coli, chromosome, Hfr transfer, mapping of Hfr insertion, isolation of F plasmids. Use of Tn10 transposon for Hfr mapping Rec Mutants.

UNIT VI **4**

Transduction – Generalized co-transduction and linkage specific transfer of a lysogen. Protoplast fusion, electroporation.

UNIT VII **6**

Plasmids :

a) Detection, purification of plasmid DNA, stages in transfer, fertility inhibition. Tra genes, plasmid replication, control of copy number.
b) Plasmid amplification, in compatibility replication inhibition.

UNIT VIII **4**

c) Properties of plasmids
d) Colicinogenic plasmids, Agrobacterium plasmid Ti.

Refernces :

1) Principles of Genetics – Gardener
2) Genes by Lewin – V and IX
3) Microbial Genetics – Friefielder
4) Gene – Watson
5) Genetics – Klug & Commings.

Practical Course : I

1) Isolation and Morphological Studies of Algae – *Spirulina scenmedesmus* spp.
2) Examination of Blue Green Algae (BGA)
3) Isolation and Morphological Studies of Fungi – *Aspergillus*, *Penicillum*, *Rhizopus*, *Tricoderma*, and *Saccharomyces*.
4) Isolation and Morphological Studies of Protozoa – Euglena, Paramoecium and Plasmodium.
5) Mycorrhiza – VAM fungi – demonstration.
6) Studies of Lichen – Demonstration.
7) Study of Archebacteria.
8) Isolation and Morphological Studies of Actinomycetes – Different cultivation techniques for actinomycets.
9) Isolation, titration and high titre stock preparation of *E. coli* phages from sewage.
10) Phage typing of *E. coli* and Salmonella strains.
11) Isolation of plaque morphology mutants of *E. coli* phages using U.V. and replica late technique.
12) Egg inoculation technique and cultivation of animal viruses in embryonated egg.
13) Isolation of TMV from tobacco leaves.
14) Induction of ascospore in yeasts of *Saccharomyces cerevisiae*.
15) Phage protein isolation by electrophoresis.
16) Study of different instrument in lab : Laminar air flow, microfuge, U.V. spectrophotometer, incubator shaker, cooling incubator, deep freeze, pH meter, lyophilizar.

Reference :

1) Lab techniques in Biochemistry and Biotechnology by R. P. Tiwari et. al., Abhishek Publications, Chandigarh (India), 1st Edition 2004.

Practical Course : II

1) Paper chromatographic separation and identification of amino acids from binary mixture.
2) Separation and identification of amino acids by TLC.
3) Estimation of protein by Biuret method.
4) Isolation of casein from milk.
5) Determination of isoelectrical point of casein.
6) Paper chromatographic separation and identification of carbohydrates from binary mixture.
7) Isolation of and characterization of starch from potatoes.
8) Estimation of glucose from blood by folin Wu method.
9) Estimation of reducing sugar by dinitrosalicylic acid method (DNSA).
10) Isolation of bacterial plasmids (amplification, curing and purification)
11) Isolation of yeast plasmids (amplification, curing and purification)
12) Isolation of RNA from yeast and DNA from bacteria.
13) Estimation of RNA by Bial's orcinol method.
14) Study of transduction.
15) Study of conjugation.
16) Isolation of lysozyme from egg and formation of protoplasts.
17) Visit to research institute or industry – Report of the visit.
18) Isolation and estimation of photosynthetic pigment Chlorophyll 'a' and 'b' from plant.
19) Separation of photosynthetic pigment (Chlorophyll & Caretonoid) by adsorption chromatography.

M. Sc. Part I,
Semester II
MIC (A) 201 : Bio-instrumentation

UNIT I **7**

Technology Fundamentals (Life Science) :

General scheme for purification of bio-components. Methods for studying cells and organelles. Sub cellular fractionation and marker enzymes. Methods for lysis of plant, animal and microbial cell. Ultrafiltration, freeze drying and fractional precipitation. Use of detergents in isolation of membrane proteins.

UNIT II **6**

Chromatography :

Basic principles and applications of ion exchange chromatography, gel filtration, affinity chromatography, Gas Liquid Chromatography (GLC), High Performance Liquid Chromatography (HPLC).

UNIT III **6**

Centrifugation :

Introduction, types of centrifuges – small bench, large capacity refrigerated, high speed refrigerated and ultra centrifuge.

Types of centrifugation – 1) Analytical centrifugation, 2) Preparative centrifugation – differential centrifugation, density gradient centrifugation, molecular weight determinaiton, centrifugal elutriation. Safety aspects in the use of centrifuges.

Ultracentrifugation - velocity and buoyant density determination.

UNIT IV **6**

Electrophoresis :

Introduction, General principles, Support media.

Types – Moving boundary and zonal.

Basic techniques. Polyacrylamide, starch agarose gel electrophoresis and capillary electrophoresis, pulse field gel electrophoresis. Use of SDS/urea, iso electric focusing.

UNIT V **7**

Radioisotopic techniques :

Introduction, Radioisotopes, Biochemical applications of radioisotopes, radiation dosimetry, measurement of α, β and γ radiations.

Radioisotopic techniques – Radiodating, radio active tracer technique, radio immuno assay.

Detection and measurement of radioactivity – Autoradiography, cerenkov counting, Geiger-Muller counter, Scintillation counter. Safety aspects.

UNIT VI **5**

Spectroscopy :

Introduction, General principles of electromagnetic radiations. Principles and applications of – UV, Visible, X-ray diffraction, NMR, ESR,

UNIT VII **5**

Atomic absorption spectroscopy,
CD/ORD, mass spectroscopy and
plasma emission spectroscopy.

UNIT VIII 6

Safe use of laboratory equipments :

Electrical equipment, centrifuge, UV light, radiation exposure.

Hazards in laboratory – Chemicals, corrosive irritant substances, toxic compounds, flammable substances, explosives, ionizing radiations, non ionizing radiations.

Waste disposal – Biological, Chemical waste and radioactive waste disposal.

References :

1) Bioinstrumentation – L. Veerakumari, MJP Publishers, Chennai.
2) Tools in Biochemistry – David Cooper.
3) Protein purification by Robert Scopes, Springer Vevlog Publicaiotn, 1982.
4) Centrifugation D. Rickwood.
5) Methods of Protein and Nucleic Acid Research.
6) Principles and techniques of biochemistry and molecular biology 6^{th} edn. – Wilson & Walkar.
7) Enzymes – Biochemistry, Biotechnology, Clinical Chemistry – Trevor, Palmer. Affiliated East-West Press Pvt. Ltd.
8) Analytical Biochemistry (Biochemical Techniques) – Dr. P. Asokan, Chinnaa Publications.

MIC (A) 202 : Molecular Biology and Genetics

UNIT I **5**

Genetic Code : Deciphering genetic code and its importance; Wobble Hypothesis. Contribution of Neirenberg & Khorana. Natural variations in genetic code, altered code in mitochondria, induced variations in genetic code.

UNIT II **7**

Transcription in Procaryotes and Eucaryotes ;

a) RNA Polymerase – Structure and function.
b) Transcription – Initiation, elongation, termination.
c) Post transcriptional modifications and structures of mRNA, rRNA, tRNA, antisense RNA.
d) Translation - Activation of amino acids, Initiation, Elongation, Termination.
e) Translational frame shifting, RNA editing, Ribozyme, inhibition of transcription, reverse transcriptase. Fighting AIDS with inhibitors of HIV reverse transcriptase.

UNIT III **5**

Regulation of Gene Expression :

Basic elements in gene expression, Structural and regulatory gene, mechanism of activation of gene expression. 1) Investigation of transcription and translation using gene fusion, protein mediated expression of translation, mechanism of suppression of non-sense and frame shift mutations, post translational modifications, membrane mediated regulation of gene expression, DNA – protein and studying techniques. An interaction, overview of autocatalytic slicing, colinearity of genes and open modeling.

UNIT IV **6**

1) Operon models lactose, arabinose, Tryptophan. Transcriptional control in Eucaryotes Zinc finger motifs, Leucine Zippers Sterioid, receptors, regulation of ribosomal protein and role of DNA inversion in regulation, alaromones, anti termination, multioperon repression in λ Bacteriophage regulation, induction of SOS response, regulation of gene expression in eukaryotes.

UNIT V **7**

Mutability and repair in DNA :

i) Causes of mutation – i) Spontaneous, ii) Induced mutations, iii) Mutational hot spots, iv) Natural exposure to mutations.
ii) Types of mutations – i) Point mutations, ii) Splice site mutations, iii) Deletions and insertions, iv) Pseudogenes & transposons revisited, v) Expanding repeats.
iii) Importance of position – i) Globin variants, ii) Susceptibility to Prion disorders.
iv) Alteration of proteins through Mutations i) β-globulin gene, ii) Disorders of collagen, iii) Early onset of Alzheimer
v) Factors reducing effect of mutation.
vi) Mutation rate and control of mutation by proof reading, repairs in DNA, photolyase, methyl quinine methyl transferase glycosidase, proof reading by DNA polymerase, A. P endonuclease, recombination repair, SOS mismatch repair, post transcriptional repair mutation, use of Lad System in the study of mechanism of mutagenesis. Exclusion and mismatch repair and their relation to human cancer.

vii) DNA repair disorders in Human beings.

UNIT VI **5**

Restriction and modifications systems :

Discovery of restriction – modification system in bacteria, types of restriction system, anti-restriction system, modification systems encoded by P1, Mu & other bacteriophages.

UNIT VII **7**

Oncogenes and cancer :

a) Characteristics of cancer cells, origin of cancer cells, genes and theories associated with cancer, tumor suppressors, cellular regulatory proteins, transforming viruses.
b) Sequence of genetic changes in : i) Brain tumor, ii) Colon cancer.
c) Environmental causes of cancer-carcinogens.
d) Methods for study of cancer.
e) Human genome data Tailor Diagnosis and treatment.

UNIT VIII **6**

Molecular techniques and microbial genome sequencing :

PCR, LCR, DNA sequencing. Maxam Gilbert & Sanger's methods. 16S rRNA technique, DNA fingerpringing & footprinting, microbial genome sequencing.

Reference Books

1) Genes Lewin VII
2) Molecular Cell Biology by Lodish
3) Mtsudaira Baltimore, Darnell 4th edn. 2000.
4) Oncogenes and cancer Bombay University
5) Molecular Biology – F Weaver – 1999 WCB / McGraw Hill 1 SB No – 697 14750 – 9
6) Microbial Genomes – D. A. Real man & E. Strauss 2000 – American Academy of Microbiology (http : //www.ASMU SA.ORG/ A C A B R C / A C A 1 . HTM)
7) Molecular biology of gene 4th Edn. Benjamin & Cummings USA 1987.
8) An introduction of Genetic Analysis 5th Edn. Freeman 1993.

MIC (A) 203 : Microbial Biochemistry

UNIT I 5

pH and buffers :

a) Ionisation of water, weak acid and weak bases.
b) pH – pH scales, Bronsted Lowery concept of acids and bases.
c) Buffer – Buffer solutions, Henderson Hasselhalch equation.
d) Biological buffer system – Phosphate buffer system, bicarbonate buffer system, proteins, amino acids

UNIT II 6

Enzymes :

a) Structure and function of
   i) Pyruvate dehydrogenase
   ii) Fatty acid synthetase
   iii) ATPase
b) Allosteric enzymes
   i) Concept of allosterism
   ii) Positive and negative cooperativity.
   iii) Structural aspects of allosteric enzymes and their significance in regulation.
c) Mechanism of action of enzymes.
   i) Single displace reaction.
   ii) Double displace reaction.

UNIT III 7

a) **Enzyme kinetics**
   i) Historical aspects.
   ii) Methods used for investigating the kinetics of enzyme catalysed reactions – initial velocity studies, rapid reaction technique, nature of enzyme catalysis.
   iii) Michaelis Menten equation and its significance.
   iv) Alternative plots – Line weaver Burk Plot, Eadie Hofstee plot.
b) **Enzyme inhibition** – Competitive, uncompetitive and mixed.

UNIT IV 6

Aerobic growth of E. coli on the substrate other than glucose :

1) Overview of glucose metabolism
2) Fructose and lactose as substrate
   a) Enzyme status.
   b) Fructose metabolism.
   c) Transport and breakdown of lactose, utilization of galactose.
3) Acetate, pyruvate, malate as a substrate
   a) Enzyme status.
   b) Reactions
   c) Relation with TCA and glyoxylate bypass.
4) Gluconeogenesis

UNIT V **5**

Microbial response to stress –

Microbial stress response, stress proteins, and their roles, cold and heat shocks oxidative and starvation stress.

UNIT VI **6**

Signaling and Behaviour in Procaryotes

i) Two components signaling system.
ii) Adaptive responses by facultative anaerobes to anaerobiosis.
iii) Regulatory system, chemotaxis, nitrogen assimilation.
iv) Porin structure.

UNIT VII **6**

Membrane biochemistry :

Components, membrane structural models, and eucaryotic and procaryotic protein transport systems, membrane protein – ion channels K^+, Na^+, Cl^-.

UNIT VIII **7**

Lipid Biochemistry :

Definition and classficaiton of lipids, Fatty acids – general formula, nomenclature and chemical properties, structure, function and properties of simple, complex, acylglycerols, phosphoglycerides, sphingolipids,waxes, terpenes, steroids and prostaglandins.

Beta oxidation – pathway and regulation.

Role of acyl carnitine in fatty acyl transport. Synthesis of fatty acid – structure and composition of fatty acid synthetase complex, pathway and regulation. Synthesis of triacyl glycerides.

Ketone bodies – formation and utilization.

Reference Books

1) Lehninger's Principles of Biochemistry 4th edition – Nelson & Cox.
2) Biochemistry – 2nd edition D. Voet, J. Voet.
3) Biochemistry – 4th edition Lubert Stryer.
4) Fundamental of Biochemistry by Jain.
5) The Nature of enzymology by Foster.
6) Enzymes by Palmer
7) Bacterial metabolism by G. Gottschalk.
8) Biochemistry by Zubay.
9) The Physiology and Biochemstry of Procaryotes by White (Oxford Uni. Press)
10) Introduction to bacterial metabolism – Doelle H. W. (1975) (Academic Press)
11) The microbial world – Stanies
12) Biochemical calculations – Segal
13) General Microbiology – Schlege.

MIC (A) 204 : Medical Microbiology and Immunology

UNIT I **6**

Concepts of Health and Diseases :

I) **Concepts of Health** : Biomedical concept, Ecological concept, psychological concepts, holistic concepts.
II) Definitions of Health – WHO definition.
III) Dimensions of Health : Physical, mental, social, spiritual, emotional, vocational.
IV) Determinants of Health : Heredity, environment, life style, socio-economic conditions, health services.
V) Indicators of health :
   a) Characteristics of indicators.
   b) Mortality indicators.
   c) Morbidity indicators
   d) Disability rates
   e) Nutritional rates indicators
   f) Risk factors of disease

UNIT II **6**

I) **Concept of disease** –
   a) Concepts of causation : Germ theory of disease, epidemiological triad, multiple cause theory.
   b) Natural history of disease, propathogenesis, pathogenesis phases.
II) Concepts of control : Disease control, disease elimination, disease eradication.
III) Concept of prevention : Levels of prevention – (Primordial, primary, secondary, tertiary)
IV) Modes of intervention : Health promotion (health education, environmental modification), specific protection (chemoprophylaxis, immunization), Early diagnosis and treatment.
V) Changing pattern of disease : Infectious diseases.

UNIT III **6**

Principles of Epidemiology and Epidemiologic Method :

I) Epidemiology : Definitions and aims
II) Infectious disease cycle. Characteristics of infectious disease in population.
III) Measurements in Epidemiology :
   c) Rate, ratios and proportions.
   d) Mortality, morbidity, incidence and prevalence rate.
   e) Outbreaks of infection : Nomenclature & types.
IV) Epidemiological methods ;
   a) Descriptive : Time, place, person, distribution.
   b) Analytical : Case control study, Relative risk.
   c) Experimental : Randomised controlled trials and non randomized trials.
V) Uses of Epidemiology
VI) Emerging and reemerging infectious diseases and pathogens.
VII) Global travel and health considerations.

UNIT IV **6**

Recent diagnostic tools & techniques :

I) Principle, working and applications of
   a) Autoanalyser
   b) Biosensor glucometer
   c) Diagnostic kits : ELISA, Western blot

II) Enzymes in medical diagnosis & therapy : Lactate dehydrogenase, aspartate aminotransferase, alkaline phosphatase, creatine kinase, acid phosphatase, cholinesterase.

UNIT V **6**

Hematopoiesis :

Meaning, regulation at genetic level, factors, involved in hematopoietic homeostasis programmed cell death, enrichment of hematopoietic stem cells.

UNIT VI **6**

Experimental immunology :

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

Experimental systems for – Cell mediated immune responses, transplantation & adoptive transfer, cell to cell interaction, functional assays of cytokines.

UNIT VII **6**

Major Histocompatibility system :

Inheritance of HLA system – Location & functions. Structure of MHC molecule Class I & Class II, cellular distribution of MHC molecules, regulation of MHC expression.

Immune response to infectious diseases :

Viral infection and immunity, viral strategies of immune evasion, bacterial infection and immune responses to extracellular & intracellular bacteria and protozoan diseases.

UNIT VIII **6**

Immunodeficiency diseases :

A) Primary immunodeficiency

i) Lymphoid immunodeficiencies - Example - Severe combined immunodeficiency SCID
ii) Selective deficiencies of Ig Classes
iii) Immunodeficiencies of myeloid lineage. Example – Chronic granulomatous disease, reduction in neutrophil count.
iv) Complement defects

B) Acquired or secondary immunodeficiencies AIDS

References :

Medical

1) Park's text book of Preventive and Social Medicine – K. Park (12^{th} edition).
2) Health education and community pharmacy : P. C. Dandiya, Z. Y. K. Zafer, Afifa Zafer.

3) Medical Microbiology : Eds. David Greenwood, Richard Slack and John Peuthever (15th edition).
4) Medical cell biology : C. J. Flickinger, J. C. Brown, H. C. Kutchai, J. W. Ogilvie.
5) A Textbook of biotechnology : R. C. Dubey
6) Fundamentals of biochemistry : Dr. A. C. Deb (7th edition)
7) Prescott, Harley and Klein's Microbiology : Willey Jonnae, Linda M. Sherwood.
8) Enzymes : Biochemistry, Biotechnology, Clinical Chemistry : Trevar Palmer.

Immunology :

1) Richard A. Goldsby, Kindt, Osborne, Janis Kuby.
2) Immunology – C. Vaman Rao
3) Basic & Clinical Immunology – Daniel P. Stites, John Stobo, H. Fundenberg, J. Wells.
4) Text Book of Immunology – Barret James D.
5) Immunology – Roitt Evan.
6) Essentials of Immunology – Roitt I. M.
7) Principles of Molecular & Cellular Immunology – Austyn J. M. & Wood K. J.
8) Handbook of Immunology – G. P. Talwar..

PRACTICAL COURSE III

1) Separation and identification of amino acid mixture by paper electorphoresis technique.
2) Separation of DNA by agarose gel electrophoresis.
3) Separation of proteins by using molecular sieve chromatography.
4) Preparation and determination of invertase activity from immobilized cells of *Saccharomyces cerevisiae*.
5) Determination of capacity of ion exchange resin [Dowex – 50].
6) Purification of protein by ion exchange chromatography (DEAE cellulose chromatography).
7) Identification and assay of amylase cellulose invertase, alkaline phosphatase.
8) Determination of effect of activators and inhibitor on amylase activity.
9) Determination of Km.
10) Verification of Beer & Lambert's law, extinction coefficient and molar extinction coefficient.
11) Blotting techniques – Western, Northern, Southern Blotting.
12) Carbohydrates. Estimation of protein by Lowrys method.
13) Plasmid curing using agents like Ethidium bromide, Acridine orange, Mito mycin C, Plumbagin.
14) Estimation of mutation rate in bacteria.
15) Fluctuation test.
16) Isolation of thymine requiring mutatants of E. coli.
17) Testing of chemical for mutagencity using Ames test and λ induction test.

PRACTICAL COURSE IV

1) Preparation of buffers.
2) Quantitative estimation of Siderophore produced by Pseudomonas sps.
3) Detection of types of siderophores produced by given organisms.
4) Isolation and detection of fusaric acid from Fusarim oxysoporum.
5) Estimation of a.a. by ninhydrin.
6) Estimation of total sugar conteny by phenol H_2SO_4 method.
7) Titration curve of glycine.
8) Studies of organisms subjected to nutrient stress. (Carbon & phosphate)
9) Studies of organism subjected to chemical stress (chlorine as a test system.)
10) Detection of specific antigen by using ELISA technique.
11) Demonstration and working of autoanalyser.
12) Determination of blood sugar by glucometer.
13) Immunoelectrophoresis.
14) Estimation of β-galactosidase produced by E. Coli.
15) Complement fixation test.
16) Purification and assay of Staphylococcal toxins.
17) Transformation of plasmid DNA using $CaCl_2$

LIST OF EQUIPMENTS

1) Replica plating units of genetics experiments
2) Rotary shaker for fermentation experiments
3) Centrifuge (High Speed)
4) Cooling centrifuge
5) Incubator shaker
6) Hot air oven
7) Bacteriological Incubator
8) Spectrophotometer
9) Research Microscope
10) Haemocytometer
14) Electrophoresis assembly
15) Laminor air flow cabinet
16) Distillation assembly
17) Reflux assembly
18) Serological Water bath
19) Colony counter
20) Deep freeze
21) Refrigerator
22) Sieve chromatography unit
23) Ion exchage chromatography – DEAE – cellulose.
24) Western and Southern-Northern blotting technique apparatus.
25) ELISA Kit
26) Glucometer
27) Complement fixation kit.

M. Sc. Part II
Semester III

MIC (A) 301 : Microbial Ecology & Extremophiles

UNIT I **6**

Microbial evolution and biodiversity

The origin of life

Chemical evolution, cellulose evolution

Ribosomal RNA analysis for tracing microbial evolution. Evolution of organelles, genetic basis of evolution.

Evolution of physiological diversity.

Microbial biodiversity : Bacterial biodiversity, Archael biodiversity

Significance of biodiversity

UNIT II **6**

Microbial communities

Development of microbial communities

Microbial community Dynamics

Population selection within communities r & k strategies.

Succession within microbial communities

Succession within biofilm communities.

Genetic exchange in microbial communities

Diversity and stability of microbial communities.

Risk of introducing genetically modified microorganism.

Species diversity indices.

Genetic / molecular diversity indices.

UNIT III **5**

Ecosystem -

Experimental ecosystem models,

Mathematical model.

UNIT IV **6**

Qualitative 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 biomass – Biochemical assay, physiological approaches to biomass determination.

UNIT V **6**

Microorganisms in different environments and their interactions

a) Microorganism in marine, fresh water, terrestrial environment, hydrothermal vents, sewage and waste water.
b) Interaction among microbial population – Interaction between microorganisms and plants. Rhizosphere, mycorrhiza, root nodule bacteria. Microbe animal interaction.

UNIT VI **7**

Extremophiles

Adaptation to environmental conditions.

i) Abiotic limitations to microbial growth

ii) Microbial response to adverse conditions – Temperature, starvation, radiation, pressure, salinity, hydrogen, ion concentration (pH), redox potential, magnetic force, antagonism, siderophores.
iii) Survival strategies of microorganisms.

UNIT VII **6**

Microbial diversity in anoxic ecosystem.

a) Methanogenic Archae bacteria general characteristics
b) Mechanisms of reduction of iron, sulphur, manganese, nitrate and oxygen.
c) Bioleaching of precious metals from ores.

UNIT VIII **6**

Microbial biofilm

Physiology, morphology, biochemistry of microbial biofilm formed in the natural environment.

Mechanism of microbial adherence

Laboratory methods used to obtain biofilm (w.r.t.)- Physiology, growth, special arrangement, depth, surface physiochemistry.

Beneficial and harmful role of biofilm, Biofouling.

Reference:

1) Extremophiles (2000) by B. N. Johri, Springer Verlag, New York.
2) Microbial diversity by (1999) Colwd, Academic Press.
3) Microbial life in extreme environments (1978) by D. S. Kushner, Academic Press Inc. New York.
4) Microbial Ecology (1979) by J. M. Lynch and M. J. Poole, Blackwell Scientific Publications Oxford.
5) Brock Biology of Microorganisms (2000) 9th Edition by M. T. Madigan. J. M. Martinko and Jack Parker.
6) Biology of Microorganisms, 6th edition, Thomas D. Brock, Michael T. Madigan.
7) Microbial Ecology – Fundamentals and Applications, 4th editions – Atlas & Bartha, Published by Pearson education, Singapore.

MIC (A) 302 : BIOSTATISTICS, BIOINFORMATICS AND SCIENTIFIC WRITING

UNIT I **5**

Biostatistics

Basic terms, measures of central tendency and dispersion :

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.

UNIT II **6**

Probability and distribution

Sample space, events, equally likely events. Definition of probability (frequency approach), independent events. Addiction and multiplication rules, conditional probability, examples, Bernoulli, Binomial, poisson and normal distribution. Mean and variance of these distribution (without proof). Sketching of p.m.f. and p.d.f. Use of these distribution to describe in biological models. Model sampling and stimulation study.

UNIT III **6**

Hypothesis testing

Hypothesis, critical region and error probabilities. Tests for proportion, equality of proportions, equality of means of normal population when variance known and when variances are unknown. Chi-square of test for independence. P-value of the statistic. Confidence limits, introduction to way and two way analysis of variance.

UNIT IV **7**

Scientific writing

1) General aspects :

2) Reporting practical and project work :

Structure of reports – Title, authors and their institution, abstract summary, list of contents, abbreviations.

Introduction, materials and methods, results discussion, conclusions, acknowledgement, literature cited (Bibliography) choosing a journal, writing, submitting, responding to refrees comments, checking proofs and waiting for publication.

3) Writing literature surveys :

Selection of topic, scanning the literature and organizing references, deciding structure and content, introduction, main books of the text, conclusion, references, style of literature surveys.

4) Review writing :

Writing review paper, purpose of review, organization of the review, types of reviews.

UNIT V **7**

1) Techniques of oral presentation :

Preparation of summary notes, choice and use of individual technique, voice, pronunciation, punctuation, articulation, audience, content, introductory remarks, the main message, concluding remarks on presentation.

2) Organizing poster display :

Preliminaries, designs, lay out, title text, subtitles and headings, colour content, introduction, material and methods, results and conclusion. The poster session.

3) Research paper writing :

Title, authors and address, abstract, summary, synopsis, key words, introduction, materials and methods, results, discussion / conclusion, acknowledgements, appendices, references/literature cited (Bibliography)

UNIT VI **6**

Bioinformatics

1) Overview of bioinformatics
   a) The scope of bioinformatics, human genome project, goals of human genome project.
   b) Bioinformatics and the internet.
   c) Useful bioinformatics sites on www.
2) Basic principles of computing in bioinformatics.
   a) Running computer software.
   b) Computer operating system.
   c) Software downloading and installation
   d) Database management.

UNIT VII **6**

Databases

a) Definition and nomenclature
b) Data life cycle acquisition, modification, use, archiving, repursoning, disposal.
c) Database technology architecture and management system.
d) Interfaces, software and programming languages.
e) Examples of some bioinformatics database.

Use of Databases

a) Structure databases – visualization of structural data, pattern matching, molecular modeling.
b) Mapping databases – genomic mapping, types of maps.
c) Phylogenetic analysis - an overview
d) Collaboration.

UNIT VIII **5**

Application of bioformatics in the pharmaceutical industry

a) Drug discovery and development
b) Pharm informatics resources

1) Getting on to the internet
2) Opening web sites and web pages
3) Using search engines – yahoo.google medine

References

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.
8) Warollaw A. C. (1925), Practical Statistics for Experimental Biologists 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.

Students are supposed to refer to current contents and periodicals for recent and additional information.

MIC (A) 303 : GENETIC ENGINEERING

UNIT I **6**

Genetic engineering in action

i) Understanding genes and genomes
ii) Analysis of gene structure and function

1) Tools of Gene cloning

Enzymes : i) Restriction endonucleases,
ii) Ligase,
iii) Enzymes to modify ends of DNA molecules.

Alkaline phosphatase, polynucleotide kinase, exonuclease III, DNase I, S1 Nucleases, Reverse transcriptase, DNA polymerases.

Vectors

i) Essential features of vectors.
ii) Types of vectors used – Plasmid, Bacteriphage, cosmid,
iii) Special vectors – Shuttle vectors, expression vectors, amplifiable vectors, integrating vectors, single stranded plasmid vectors, artificial minichromosomes, YAC, BAC.

UNIT II **5**

Isolation of passenger DNA fragment

i) Restriction endonuclease digestion
ii) cDNA preparation
iii) Hybridization method
iv) Chemical synthesis

Host Cells for cloning : Prokaryotic and eukaryotic cells.

UNIT III **7**

Technique of rDNA preparation – cloning methodologies.

(a) Splicing of passenger DNA to vector DNA
i) Ligation of DNA molecules with sticky ends.
ii) Ligation of DNA molecules with blunt ends.

(b) Methods of introduction of DNA into living cells.

(c) Selection of rDNA clones and detection of product of cloned gene.

UNIT IV **5**

Cloning vectors

a) Cloning in *B. subtilis :* Plasmid transformation; transformation by plasmid rescue, transformation of protoplast, vectors for cloning in *B. subtilis.*
b) Vectors for yeast and other fungi
Yeast vectors – YIP, YEP, YRP, YCP
Vectors for fungi -

UNIT V **6**

a) Cloning vectors for higher plants
Plasmid transformation with Ti plasmid of *A. tumifaciens*
Gene cloning using plant viruses
Direct gene transfer.
b) Cloning vectors for mammalian cells.
Selectable maker systems for mammalian expression vectors.
Vectors based on SV40.
Vectors based on papillomaviruses.

UNIT VI **7**

Construction of genomic and cDNA

Buculovirus and vaccinia viruses : libraries and in vivo expression

Making gene library – a) Genomic library

b) cDNA library – screening of library for particular clone.

i) Nucleic acid hybridization,

ii) Colony and plaque hybridisation probing – Abundancy probing, oligonucleotide probing, heterologous probing.

UNIT VII **7**

Manipulation of gene expression in prokaryotes

ii. Gene expression from strong and regulatable promoters – Regulatable promoters, increasing protein production, large scale system, expression in other microorganisms.

iii. Native fusion proteins.

iv. Translation expression vectors.

v. Overcoming oxygen limitations

vi. DNA integration into host chromosome.

vii. Increasing secretion

UNIT VIII **5**

1) Knock out and knock in technology

a) Creating knockout and knock in mice.

b) Inducible gene targeting – cre/lox system, target gen deletion.

c) Applications in immunology

2) Microarrays for analyzing patterns of gene expression.

References :

1) Introduction to genetic engineering – Desmonds T. Nicholl.
2) T A Brown – Gene cloning – An introduction
3) Molecular biotechnology – B. R. Glick and Jack Pasteurnak
4) Molecular biotechnology – Das
5) Genetic engineering – S. Mitra
6) Kuby Immunolgy – Sixth edition

MIC(A) 304 : BIOTECHNOLOGY

UNIT I **6**

Introduction to biotechnology

- A brief history of biotechnology.
- Biotechnology a science of many disciplines.
- Products of modern biotechnology
- Ethics and biotechnology.

UNIT II **7**

Plant Biotechnology :

1) Plant tissue culture and applications

i) Micro propagation.
ii) From callus of plant
iii) Somatil embryogenesis
iv) Somaclonal variation
v) Valuable germ plasm
vi) Chemical from plants
vii) Genetically engineered plants.

Applications

i) Pathogen free plants.
ii) Crop improvement
iii) Herbicide resistance
iv) Insect resistance
v) Virus resistance
vi) Salt and drought resistance.

UNIT III **7**

Animal biotechnology :

1) Animal tissue culture and applications, media, serum free media, primary culture, genetics, cytotoxicity, organo typic culture.
2) Applications : Gene transfer methods in animals

A) i) Micro injection
ii) Embryonic stem cells gene transfer
iii) Retro virus and gene transfer

B) Transgenic Animals
C) Animal propagation
D) Conservation biology

UNIT IV **6**

Genetic disorders :

Neurological and metabolic

1) Gene therapy
   i) Vectors and other delivery systems
   ii) Target tissue of choice for gene delivery system.
   iii) In-Utero gene therepy (IUGT)
   iv) Gene therapy for acquired disease – e.g. Cardovascular disease, cancer.
   v) Nanotechnology and gene therapy.
2) Stem cells
3) Pharmacogenetics

UNIT V **6**

Nanobiotechnology :

1) Introduction, synthesis of nanomaterials – Biological methods – introduction, synthesizing microorganisms and plant extracts, use of proteins and templates like DNA.
2) Properties of nanomaterials and analysis of techniques. Mechanical, structural, melting of nanoparticles, electrical conductivity, optical properties, magnetic properties.
3) Application – Medical field and environment
4) Synthetic biology – Introduction

UNIT VI **5**

Biotechonology in food fermentation :

1) Introduction
2) Nutritional contribution of fermented foods in human health.
3) General composition, process and starter organisms for – idli, dhokala, pickles, curd, butter mil preparation.
4) Starter cultures – Types, nature

UNIT VII **5**

Biopreservation

1) Concept of biopreservation
2) Bacteriocins – Types, nature, mode of action and spectrum.
3) Antimicribial activity of spices.
4) Naturally occurring antimicrobial enzymes.

UNIT VIII **6**

Marine biotechonology

1) Aquaculture
2) Algal products
3) Algal cell culture
4) Fuels from algae
5) Medicinal applications
6) Probing the marine environment
7) Conservation
8) Terrestrial agriculture
9) Transgenic fish

Reference:

1) Food microbiology – K. Vijaya Ramesh, MJP Publisher, Chennai, 2007.
2) A comprehensive dairy microbiology – Yadav J. S., Sunita Grover, Y. K. Batish 1993.
3) Biotechnology – Food fermentation, Vol. I and II, Eds. V K. Joshi, Ashok Pandey.
4) Modern Food Microbiology Vol. 41, March 2001.
5) Bacteriocins – Konisky
6) Indian food industry – September – October 2001.
7) Introduction to biotechnology – William J. Thieman, Michael A. Palladino.
8) Introduction to biotechnology – K. S. Bilgrami, A. K. Pandey
9) Biotechnology – Prakash S. Lohar
10) Biotechnology – B. D. Singh
11) Genetic Engineering – Shukla.
12) Nanobiotechnology

Practical Course : V

1) Enrichment and isolation of -
   i) Psychrophilic bacteria.
   ii) Halophilic and halotolerant bacteria.
2) Study of various types of microorganism present in –
   i) Hot water spring
   ii) Mangroves
   iii) Garden soil
3) Adhesion of bacteria to surfaces –
   Dip slide method – in situ studies of bacterial adhesion
4) Enrichment and isolation of sulphate reducing bacteria
5) Isolation of pectin degrading organisms.
6) Isolation of alkalophilic bacteria from soil sample.
7) Isolation of thermophilic an aerobic cellulolytic bacteria.
8) Isolation of microorganisms degrading pesticides.
9) Organisation of data frequency distribution tables.
10) Describing a sample measures of central tendency (mean – mode – median) and measures of dispersion (variance and standard deviation) for grouped and ungrouped data.
11) Estimation of confidence interval for a normal distribution.
12) ANOVA – CRD CBD
13) t-Test and Chi-square t-test on sample data.
14) Plotting histograms.
15) Writing review paper and project
16) Writing a conference report (scientific)
17) Book review
18) Useful bioinformatics sites on www.
19) Searching sequence databases
    a) Sequence similarity searches
    b) Amino acid substitution matrices
    c) Database searches
    d) Interactive database searches

Practical Course : VI

1) Preparation of plant tissue culture formulation of media
2) Preparation of animal tissue culture formulation of egg and animal inoculum.
3) Determination of preservative effect of the given preservative.
4) Detection of adultration in food and food products.
5) Detection of adultration in milk and milk products.
6) Sterility test for milk.
7) Preparation of fermented butter milk.
8) Preparation of alcoholic beverages from fruit juice.
9) Analysis of food –
   (A) Chemical : pH, fat, benzoate, protein, sugar, ash, sorbate, and colour.
   (B) Physical analysis of food : Sp. gravity, different tests for grading of milk
   (C) Microbial analysis – MPN, Resazurin.
10) Isolation of Alfa toxin producing organism and detection of alfatoxin.
11) Production of biomass Azatobactor, Rhizobium, Azalla and preparation of biofertilizer from it.
12) Southern hybridization – Demonstration
13) Northern blotting – Demonstration
14) Algal cell culture.
15) Study of antimicrobial activity of two spices.
16) Preparation of rhizobium inoculant and inoculation of seeds.

M. SC. PART II
SEMESTER IV

MIC(A) 401 : INDUSTRIAL MICROBIOLOGY

UNIT I **7**

Fermentors : Design operation and applications

i) Batch fermentation
ii) The main components of fermentor and their uses.
iii) Component parts of typical vessels
iv) Peripheral parts and accessories.
v) Reagent pumps
vi) Alternative vessel design – air lift, fluidized bed, immobilized and solid state system.
vii) Common measurement and control system – speed, temperature, gas, pH, foam, dissolved oxygen.
viii) Additional sensor – redox, air flow, weight, pressure.
ix) Fermentor preparation and use – disassembly of the vessel, cleaning, preparations for autoclaving, autoclaving, set up following autoclaving, inoculation of fermentor vessels, routine, maintenance of fermentor components.

UNIT II **7**

Cell immobilization and its applications :

a) Introduction
b) Immobilized cell system –
   i) Surface attachment of cells.
   ii) Entrapment within porous matrices
   iii) Containment behind a barrier
   iv) Self aggregation of cells
c) Design of immobilized cell reactors
   i) Mass transport phenomena in immobilized cell system.
   ii) Reaction and diffusion in immobilized cell system
   iii) Bioreactor design
d) Physiology of immobilized microbial cells.
e) Beer production using immobilized cell technology – Case study.

UNIT III **7**

Control of fermentation and industrial perspective

i) Requirements for control
ii) Sensors.
iii) Controllers
iv) Design of fermentation control system
v) Fermentor control specification
vi) Control of incubation
vii) Advanced incubation control
viii) Other advanced fermentation control options
ix) Recent trends in fermentation control

UNIT IV **6**

Probiotics

a) Probiotic microorganisms associated with therapeutic properties
b) Criteria associated with probiotic microorganisms.
c) Safety of issues associated with the use of probiotic cultures for humans.

d) Beneficial health effects of probiotic cultures
e) Effective daily intake of probiotic.
f) Probiotic dairy products
g) Factors affecting probiotic survival in food system.

UNIT V **5**

Solid state fermentation (SSF)

Introduction, comparison of SSF and submerged fermentation, advantages, disadvantages, problems, types, factors affecting, fermenter design for SSF, Koji manufacturing process, industrial application of SSF

UNIT VI **5**

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 VII **5**

Intellectual property and patenting :

1) Introduction
2) Genesis of Intellectual Property Rights (IPR)
3) Territorial Nature of Patents
4) Ownership and Royalties
5) An overview of Patent System
6) Requirements for Patentability
7) Patent Categories

UNIT VIII **6**

1) Information necessary for preparing and filing a patent application
2) Patenting procedure and form
3) Recent trends in biotechnology and microbiology patents.
4) The Indian Patent Act.
5) Indian Biodiversity Act.
6) Protection of Plant Varieties and Farmers Rights

References :

1) Fermentation technology H. A. Modi – volume (1) and (2)
2) Fermentation microbiology and biotechnology – 2nd edition. EMTE1 – Mansi – Taylor and Francis, Bocaraton London, New York.
3) Industrial Microbiology – by L. E. Casida. John Wiley & Sons INC.
4) Microbial technology – by H. J. Pepler & D. Pearlman Academic Press INC.
5) Principle of fermentation Technology, Second Edition, P. F. Stanbury & A. Whitaker & S. J. Hall.
6) Industrial Microbiology by Prescott & Dunn 4th edition (1982) by Gerald Reed.

MIC (A) 402 : BIOPROCESSES

UNIT I **6**

Fermentation technology –

Introduction

Concept of fermentation technology

Range of fermentation processes and products – Microbial biomass, microbial metabolites, microbial enzymes, microbial transformation, recombinant products, fermented foods, induced product.

UNIT II **6**

Microbial screening -

i) Introduction
ii) Concept of microbial screening
iii) Selection strategies and techniques
iv) Isolation of industrial important organism –
Criteria important in choice of organism.
Sources of industrial microorganisms.
Principles involved in isolation methods.
v) Secondary screening
vi) Future potential and needs of microbial screening.

UNIT III **7**

Fermentative production of –

i) **Organic solvents** – Acetone, ethanol
ii) **Organic acids** – Lactic acid & Acetic acid, citric acid.
iii) Enzymes – Amylase, thermostable protease, lipase

UNIT IV **6**

Fermentative production of -

i) **Antibiotics** – Streptomycin, polymyxin, Bacitracin,
ii) **Vitamins** : Vit. C, Vit. B2

UNIT V **6**

Production of –

i) **rDNA products** – Insulin, Hepatitis B vaccine
ii) Biopesticides
iii) Mashroom production

UNIT VI **5**

Down stream processing –

Solid – liquid separation methods

i) Coagulation,
ii) Flocculation
iii) Flotation – Centrifugation
iv) Filtration – Types of filtration and filters – Plate and Frame filters, Pressure leaf filters, Rotary drum vacuum filters, Depth filtration.

Disintegration methods

i) Mechanical methods – Shear forces, Industrial disintegrators
ii) Non mechanical methods – Drying, Cell lysis – (Physical, chemical enzymatic)

UNIT VII **5**

Down stream processing - Concentration methods

i) Evaporation – types of evaporators
ii) Extraction – Solid liquid extraction, Liquid – liquid extraction, Extraction of proteins.
iii) Ion exchange processes
iv) Membrane filteration
v) Precipitation

UNIT VIII **7**

Product formulation

i) Drying – Contact dryers, convecton dryers, freeze dryers
ii) Crystallization
iii) Whole broth processing
iv) Evaluation of separation process
v) Monitoring of down stream processing
vi) Process integration

References :

1) Fermentation technology, Volume 1 – H. A. Modi.
2) Fermentation technology, Volume 2 – H. A. Modi.
3) Fermentation Microbiology and Biotechnology – Mansi & Bryce.
4) Industrial Microbiology by L. F. Casida John Wiley and Sons INC.
5) Prescott & Dunn - Industrial Microbiology.

MIC (A) 403 : INDUSTRIAL WASTE MANAGEMENT AND MICROBIAL BIOREMEDIATION

UNIT I **5**

Distillery industry :

Introduction, scenario of distillery industry, process and production in distillery industry, characteristics of waster and effluents, environmental impact, treatment of distillery industry effluent.

UNIT II **5**

Petroleum industry :

Introduction, scenario of petroleum industry, processing and products, petroleum waste, impact of waste in the environment. Treatment of petroleum waste, biodegradation and bioremediation of petroleum products.

UNIT III **5**

Food and beverage industry :

Introduction, scenario, process and production, characteristic and impact of food processing on wasters, treatment of food and beverage waste, industry specific bioremediation. e.g. Edible oil industry, fermentation industry, dairy industry, meat and poultry industry.

UNIT IV **5**

Dye industry :

Introduction, scenario, the source and origin of dye, characteristics of waste effluent environmental impact, treatment technologies of dyes, mechanism of colour removal.

UNIT V **8**

1) Pharmaceutical industry :

Introduction, existing scenario, industrial process, waste generation, impact on environment, waste reduction and treatment, environmental standards.

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 VI **6**

Microbial bioremediation :

i) Introduction : Current environmental scenario, environmental issue and the public, five R policies for waste mineralization, choice of technology.

ii) Environmental contaminants : Nature of contaminants, general classification, effect of contaminants of environment, strategies for contaminant management.

UNIT VII **6**

Microbial Bioremediation : General perspective, microbes for bioremediation, bioremediational techniques, bioremediation monitoring and case studies.

UNIT VIII **8**

1) **Genetics of microbial bioremediation** : Microbial genetic, plasticity, role of plasmid in bioremediation, evolution barriers, enhancement, genetic, metagenomics in bioremediations.
2) **Bioconversion of specific pollutants** : Heavy metal, dioxins, radioactive wastes.

Reference:

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.

MIC (A) 404 : QUALITY CONTROL MANAGEMENT IN INDUSTRY

UNIT I **6**

Healthy microbial practices

ii) Scope and aims.
iii) The advisory committee on Dangerous pathogens.
iv) Laboratory facilities design
Work flow
Size and shape of rooms
Benches
Floors, walls and ceilings
Heating, lighting and ventilation
v) Microbiological safety cabinets.
Sitting and maintenance
Other laboratory equipment
vi) Sterilization, disinfection and decontamination
vii) Personnel and training
viii) Documentation
Standard operating procedures
Quality systems

UNIT II **5**

Biosafety

i) Introduction
ii) Biosafety considerations in fermentation technology.
iii) Containment – Physical containment, Biological containment.
iv) Biosafety during industrial productoin.
v) Biosafety guidelines in India.
vi) Guidelines and regulations

UNIT III **7**

Endotoxin testing

i) Introduction
Endotoxins and pyrogens,
Regulatory development,
Introduction to LAL test.
ii) The gel clot method –
Test principle and procedure
Gel clot lysate, sensitivity
Product interference.
iii) The chromogenic end point method
Test principle and procedure
Performance characteristics.
iv) The kinetic turbidimetric assay
Reagent preparation
Test procedures
Performance characteristics
v) Method selection
Water samples
Samples other than water
vi) Depyrogenation

UNIT IV **5**

Disinfection and cleansing :

i) General consideration and terminology.
ii) Implementation of a cleaning and contamination control programme.
iii) Protective clothing and equipment.
iv) Selection of cleaning agents and disinfectants.
v) Cleaning practices and application methods.
vi) Cleaning, disinfection and sterilization of isolators.

UNIT V **5**

i) Standard operating procedures.
ii) Clean in place (CIP) and sterilization in place (SIP) facilities.
iii) Validation
Data and document collection
Analytical methods
Sampling methods
Acceptance criteria
iv) Disinfection monographs
Alcohol
Aldehydes
Amphoterics
Chlorine dioxide
Hypochlorites
Peracetic acid
Phenolics
Quaternary ammonium compounds.

UNIT VI **7**

Antimicrobial preservative efficacy testing

i) Introduction
ii) The requirement for a biological assessment of preservative activity.
iii) Limitations of preservative efficacy tests.
iv) 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.
v) 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 VII **6**

Microbiological analysis of

i) Air – Microbial load and identification of air flora.
ii) Food – Vegetables, fruits, meat, poultry.
iii) Bakery – Detection and characterization of organisms.
iv) Pharma and cosmetics – Sterling testing for products, Vitamins assays, antibiotic assay.

UNIT VIII **7**

Quality assurance of food and pharmaceutical products

i) International standards as per WHO, FPO, ISI
ii) Industrial rules and regulations as per Indian pharmacopea.
iii) Detection of compounds using Indian pharmacopea.
a) Detection of ascorbic acid (tablet)
b) Detection of Vit. B2 (Riboflavin)
c) Detection of 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.

Practical Course : VII

1) Estimation of Streptomycin
2) Bioassay of Vit. B2
3) Estimation of Vit. C by DCPIP (2, 6 – dichloro phenol indophenol) method.
4) Chemical assay of Vit. B2
5) Production of ethanol by shake flask culture.
6) Production of Antibiotics like polymyxin, bacitracin.
7) Mushroom cultivation.
8) Preparation and use of certain probiotic products.
9) Screening vitamin producers.
10) Production of citric acid by *Aspergillus niger.*
11) Lab. Production of *Bacillus thruningensis* insecticide and testing of its efficiency.
12) Fermentative production of lactic acid.
13) Sterility testing of water for injections.
14) Bioremediation of effluents from distillery (isolation of organisms, reduction in BOD, COD, pH, TSS and MLSS)
15) Validation studies for lab equipments functioning of autoclave, oven, thermometer, incubator, balance.
16) Water analysis (used for cleaning, rinsing, as an ingredient, as an effluent) using APHA method.
17) Techniques used in Dairy industry - Milk platform test, phosphatase test, total count, viable count, interpretation with prescribed ISI standard.
18) Techniques used in Food industry - Determination of microbial load of vegetable preparations, milk preparation, ice cream of flight kitchen and present report on the safety of preparation under HACCP plan.
19) Techniques used in Pharma and Cosmetic industry - Sterility testing of pharmaceutical products (pharmacopia)
20) Techniques used in Textile industry - Determination of bio-burden on textile material using AATCC – 100 – 2004 method.
21) Visit to the research institute or industry – Report of the visit.

Practical Course : VIII

1) Project work / Industrial training