S.R.T.M.U. NANDED
PROPOSED PAPER TITLES FOR M.Sc MICROBIOLOGY
REVISED SYLLABUS 2014

SEMESTER: I			**Marks**
MB	101	BIOINSTRUMENTATION	[100]
MB	102	ADVANCES IN VIROLOGY	[100]
MB	103	CELL BIOLOGY AND MICROBIAL PHYSIOLOGY	[100]
MB	104	FOOD, DAIRY AND AGRICULTURAL MICROBIOLOGY	[100]
SEMESTER: II			
MB	201	BIOPROCESS ENGINEERING	[100]
MB	202	ENZYME TECHNOLOGY	[100]
MB	203	MICROBIAL METABOLISM	[100]
MB	204	MOLECULAR BIOLOGY AND MICROBIAL GENETICS	[100]
SEMESTER: III			
MB	301	BIOSTATISTICS, COMPUTER APPLICATIONS AND RESEARCH METHODOLOGY	[100]
MB	302	MOLECULAR IMMUNOLOGY	[100]
MB	303	MICROBIAL DIVERSITY AND EXTREMOPHILES	[100]
MB	304	RECOMBINANT DNA TECHNOLOGY	[100]
SEMESTER: IV			
MB	401	BIOINFORMATICS, PROTEOMICS AND GENOMICS	[100]
MB	402	MEDICAL AND PHARMACEUTICAL MICROBIOLOGY	[100]
MB	403	ENVIRONMENTAL MICROBIOLOGY	[100]
MB	404	FERMENTATION TECHNOLOGY	[100]

S.R.T.M.U. NANDED
PROPOSED PRACTICAL PAPER TITLES FOR M.Sc MICROBIOLOGY
REVISED SYLLABUS 2014
100 MARKS FOR EACH LAB COURSE & PROJECT

SEMESTER I			**Marks**
LAB COURSE I		**(Theory Based)**	[100]
MB	101	BIOINSTRUMENTATION	
MB	102	ADVANCES IN VIROLOGY	
LAB COURSE II		**(Theory Based)**	[100]
MB	103	CELL BIOLOGY AND MICROBIAL PHYSIOLOGY	
MB	104	FOOD, DAIRY AND AGRICULTURAL MICROBIOLOGY	

SEMESTER II			
LAB COURSE III		**(Theory Based)**	[100]
MB	201	BIOPROCESS ENGINEERING	
MB	202	ENZYME TECHNOLOGY	
LAB COURSE IV		**(Theory Based)**	[100]
MB	203	MICROBIAL METABOLISM	
MB	204	MOLECULAR BIOLOGY AND MICROBIAL GENETICS	

SEMESTER III			
LAB COURSE V		**(Theory Based)**	[100]
MB	301	BIOSTATISTICS, COMPUTER APPLICATIONS AND RESEARCH METHODOLOGY	
MB	302	MOLECULAR IMMUNOLOGY	
LAB COURSE VI		**(Theory Based)**	[100]
MB	303	MICROBIAL DIVERSITY AND EXTREMOPHILES	
MB	304	RECOMBINANT DNA TECHNOLOGY	

SEMESTER IV			
LAB COURSE VII		**(Theory Based)**	[100]
MB	401	BIOINFORMATICS, PROTEOMICS AND GENOMICS	
MB	402	MEDICAL AND PHARMACEUTICAL MICROBIOLOGY	
MB	403	ENVIRONMENTAL MICROBIOLOGY	
MB	404	FERMENTATION TECHNOLOGY	
LAB COURSE VIII		**(PROJECT WORK)**	[100]

INFRASTRUCTURE, INSTRUMENTAL, LIBRARY AND OTHER FACILITES REQUIRED FOR M.Sc. COURSE IN MICROBIOLOGY

(For 30 Students INTAKE CAPACITY).

1. Two Laboratories (For Part I and II) each measuring at least 1000 sq.ft with sufficient number of tables and stools. Labs should be provided with basic instruments, such as autoclave, Incubator, oven, pH meter, hot plates, Cyclo-mixers, water bath shakers, colorimeter, fridge, distillation plant, etc.
2. A culture room with a laminar air- flow measuring 300 sq. ft
3. An instrumentation room with double door, air conditioner and inverter, power generator for sophisticated instruments measuring 500 sq. ft.
4. Two lecture halls (For Part I and Part II) with overhead projector facility and measuring 400 sq. ft with tables and chairs.
5. A media preparation and storeroom measuring at least 400 sq. ft.
6. A computer and Bioinformatics laboratory with four to five computers (PIV) with printer and Internet facility.

LIST OF BASIC INSTRUMENTS REQUIRED FOR M.SC. PRACTICALS.

1. Laminar Air Flow
2. Compound Microscope
3. Autoclave
4. Incubator
5. Hot Air ovens
6. BOD incubator
7. pH meter
8. Water bath incubator shaker
9. Colorimeter
10. Spectrophotometer
11. Hot plates
12. Cyclomixer
13. Electrophoretic Apparatus

14. Orbital Incubator Shaker
15. High Speed centrifuge (10,000rpm)
16. Distillation Apparatus (single and Double)
17. Refrigerators
18. Paper Chromatography cabinet
19. Rough Balances
20. Bacterial filter assembly
21. General purpose centrifuge
22. Vortex mixers.
23. Magnetic stirrers
24. UV cabinet
25. TLC apparatus
26. Dissolved oxygen meter
27. Metler balance
28. Digital balances
29. Water bath shaker
30. Colony counter
31. Rotary shaker
32. Columns for chromatography
33. Fraction collector
34. Gas Burners
35. LPG cylinders
36. Distillation apparatus

LIST OF SOPHISTICATED INSTRUMENTS REQUIRED FOR THE PRACTICALS

1. UV Visible spectrophotometer
2. Gas chromatography
3. Sonicator
4. High speed refrigerated centrifuge
5. Microprocessor based pH analyzer
6. Horizontal paper electrophoresis unit
7. Vertical electrophoresis

8. Submarine electrophoresis
9. Immuno electrophoresis
10. Power pack with constant voltage/current adjustment
11. PAGE electrophoresis unit
12. DNA sequencer
13. ELIZA reader
14. PCR (Thermal cycler)
15. Gel documentation unit
16. Semidry transfer apparatus
17. Deep freezer (-30 ^{0}c)
18. Fermenter
19. Atomic absorption spectrophotometer
20. COD and BOD analyzer
21. Phase contrast microscope
22. Binocular microscope
23. HPLC
24. Lyophilizer
25. Pentium IV computer with printer
26. Micropipettes
27. CO_2 incubator

OTHER REQUIREMENTS:

The Department should have required chemicals, DEHYDRATED MEDIA, STAINS, ACIDS, SOLVENTS , FINE CHEMICALS, ENZYMES , ANTISERA, IMMUNODIAGNOSTIC KITS, SPECIFIC MICROBIAL CULTURES WITH KNOWN GENETIC MARKERS AND GLASSWARE to conduct the prescribed syllabus . Cold room facility is preferred.

LIBRARY FACILITY

The Library should have ample number of prescribed textbooks , reference books, recommended in the prescribed syllabus and the library should also subscribe national and international journals and scientific magazines.

INSTRUCTIONS

1. M.Sc course of Microbiology is divided in to 4 semesters.
2. Each semester will have four theory and one practical paper , except in the IV semester a research paper equivalent to practical papers i.e. 100 marks.
3. The department should complete a minimum of six practicals of each paper.
4. The workload of Research project will be equivalent to the workload of 1 practical paper.
5. One theory paper will have 4 lectures each of 60 min. Duration per week and practical will be of 6 hours duration.
6. It is mandatory for students to have not less than 75% of attendance in each semester.

MB-101: BIOINSTRUMENTATION

UNIT –I: **(10)**

Laboratory Instruments: Theory, Principle, Working and applications of: pH meter, Laminar-air flow, Centrifuge machine types and Centrifugation: Differential, Rate Zonal, Isopycnic, Density gradient, Rotor types and Ultra centrifugation. Phase Contrast Microscope; Fluorescent Microscope; Scanning and Transmission Electron Microscopy. Cytophotometery and flow cytometery.

UNIT-II: **(08)**

Chromatography Techniques: Theory, Principle and Applications of Paper Chromatography, TLC, HPTLC, Gel Filtration Chromatography, Ion Exchange Chromatography, Affinity Chromatography, Gas Chromatography, and HPLC.

UNIT–III: **(08)**

Electrophoretic Techniques: Theory, Principle and Applications of Paper Electrophoresis, Poly Acrylamide Gel Electrophoresis (PAGE), Agarose Gel Electrophoresis. Principle and Applications of: Iso-electric Focusing, Immuno Electrophoresis, Enzyme-Linked Immunosorbant Assay (ELISA), Southern, Northern and Western Blotting.

UNIT–IV: **(08)**

Radio-isotopic Techniques : Introduction to Radioisotopes and their Biological Applications, Radioactive Decay–Types and Measurement, Principles and Applications of GM (Geiger Muller) Counter, Solid and Liquid Scintillation Counter, Autoradiography, Radioimmunoassay (RIA), Radiation Dosimeters.

UNIT-V: **(11)**

Molecular Biophysics : Theoretical and experimental methods for determination of size of proteins, Physical nature of non-covalent interactions, Conformational properties of proteins, Ramachandran plot, secondary, super-secondary, tertiary and quaternary structures of proteins, Classification of three dimensional structures of proteins (motifs and fold domains) Protein structure/properties determination.

i. UV Absorption spectra of Macromolecules, X-ray crystallography: Isolation and purification of proteins, crystallization of proteins, instrumentation, acquisition of the diffraction pattern, basic principles of x-ray diffraction, Phase determination

ii. NMR spectroscopy: Basic Principles of NMR, Chemical shift, Intensity, Line width, Relaxation parameters, Spin-spin coupling, Nuclear Overhauser Effect, NMR Applications in Biology

iii. Mass spectroscopy: Principles of operation and types of spectrometers, ionization, Ion transport and ion detection, Ion fragmentation, Combination with chromatographic methods, Biological applications, MALDI-TOF

iv Lim's stereochemical method, Chou-Fasman method, Garnier-Osguthorpe-Robson (GOR) method, Neural networks, Homology based methods. (Concept and introduction)

PRACTICAL PAPER BIOINSTRUMENTATION (100)

1. Studies on pH titration curves of amino acids/acetic acid and determination of pKa values and Handerson-Hasselbach equation.
2. Separation of bacterial lipids/amino acids/sugars/organic acids by TLC and Paper Chromatography.
3. Study of UV absorption spectra of macromolecules (protein, nucleic acid, bacterial pigments).
4. Quantitative estimation of hydrocarbons/pesticides/organic Solvents/methane by Gas chromatography.
5. Staining of PHB/Nuclear material using Phase contrast microscope.
6. Paper Electrophoresis of proteins.
7. Separation of Proteins/Nucleic acids by Gel electrophoresis.
8. Density gradient centrifugation.
9. Study of macromolecular structures using ball stick models/ computer simulation.

REERENCES :

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006) *Biochemistry.* 6th Edition. Freeman,New York.
2. Cotterill, R. M. J. (2002) *Biophysics: An Introduction.* John Wiley & Sons, England.
3. Drenth, J. (2007) *Principles of protein X-ray crystallography.* 3rd Ed. Springer,Germany.
4. Garrett, R. H. and Grisham, C. M. (2004) *Biochemistry.* 3rd Ed. Brooks/Cole,Publishing Company, California.
5. Keeler, J. (2002) *Understanding NMR Spectroscopy.* John Wiley & Sons, England.

6. Mount, D. W. (2001) *Bioinformatics: sequence and genome analysis.* Cold SpringHarbor Laboratory Press, New York.
7. Nölting, B. (2006) *Methods in Modern Biophysics.* Second Edition. Springer,Germany.
8. Pattabhi, V. and Gautham, N. (2002) *Biophysics.* Kluwer Academic Publishers, NewYork and Narosa Publishing House, Delhi.
9. Wilson Keith and Walker John (2005) *Principles and Techniques of Biochemistry and Molecular Biology*, 6th Ed. Cambridge University Press, New York.
10. Cavanagh John *et.al.* (1995) *Proteins NMR Spectroscopy: Principles and Practice,*Academic Press
11. Daune M. and W. J. Duffin (1999) *Molecular Biophysics: Structures in Motion*, Oxford University Press.
12. Nalting B. and B. Nalting (2003) *Methods in Modern Biophysics* Springer Verlag
13. Voit E. O. (2000) *Computational Analysis of Biochemical Systems* Cambridge University Press.
14. Freilder, D., ed., Physical Biochemistry: Applications to Biochemistry and Molecular Biology, Freeman, San. Francisco, 1976
15. Robyt, John F.; White, Bernard J. Biochemical Techniques: Theory and Practice Waveland Press, Inc., U.S.A. Published: 1990
16. Douglas A. Skoog, F. James Holler, Timothy A. Nieman: Principles of Instrumental Analysis (Saunders Golden Sunburst Series) published by Wadsworth Pub Co. 2007
17. Upadhyay A, Upadhyay K, Nath N: Biophysical chemistry. Principles and techniques. Himalaya Publishing House, Mumbai.1997.
18. ATTIX, F.H., Introduction to Radiological Physics and Radiation Dosimetry, Wiley, New York (1986).
19. An Introduction to Centrifugation, by TC. Ford and J.M. Graham (1991). 118 pages. BIOS Scientific Publishers, Ltd. ISBN 1 872748 40 6
20. D. Rickwood, J.M. Graham (2001) Biological Centrifugation, Springer Verlag; ISBN: 0387915761
21. Paper Electrophoresis as a Quantitative Method for serum proteins by W. P. Jencks, Mera r. Jetton and E. L. Durrum. Biochemistry (Journal) 1955 Vol:60pp 205-215
22. Electrophoresis of proteins on filter paper by Henry G. Kunkel and Arne Tiselius. The Journ. of Gen. Physiol. (1951) pp 89-118

MB-102: ADVANCES IN VIROLOGY

Unit I : Foundations of Virology [08]

Virus prehistory, Discovery of Viruses., Definitive properties of Viruses, Cataloging of Viruses through Virus classifications scheme of ICTV ICNV, Morphology and ultra structure of Viruses.

Unit II : Virus cultivation, Detection & Genetics. [10]

Introduction, Cultivation of viruses, Cell culture, embryonated egg, laboratory animals, Detection of viruses in the host, measurement of infectious units, measurement of virus particles and their components, the one step growth cycle, assay of viruses, physical and chemical methods (Electron microscopy and protein and nucleic acid studies), infectivity assay, genetic analysis of Viruses. Classical genetic methods, engineering mutations in to viruses, engineering viral genomes, viral vectors.

Unit III: Virus attachment & Entry into host cell [10]

Introduction, Architecture of cell surfaces, Interaction of Viruses with cell receptors, uptake of macromolecules by cells, Mechanism of Virus entry into cells, Transport of Viral genome into the cell nucleus .Genomic replication of Viruses (DNA/RNA).mRNA production by animal viruses, mechanism of RNA synthesis, transcription mechanism and post transcriptional processing. Translation of viral protein, assembly, exit and maturation of progeny virions, multiplication of bacteriophages.

Unit IV: Viral pathogenesis [08]

Host and virus factors involved in pathogenesis, patterns of infection, pathogenesis of animal viruses, Adenovirus, Herpes virus, Hepatitis virus, Picorna virus, Poxivirus and Orthomyxovirus,

pathogenesis of plant (TMV) and insect viruses (NPV). Host cell transformation by viruses and oncogenesis of DNA and RNA viruses.

Unit V: Prevention and control of viruses. [09]

Introduction, Vaccines, proven best defence against virus, preparation of vaccine, New vaccine Technology, Antiviral drugs, small molecules that block viral replication. Virus evolution and emergence of new viruses.

PRACTICAL PAPER RECENT TRENDS IN VIROLOGY (100)

1. One step growth curve for determination of virus titer.
2. Phase typing of *E.coli* bacteriophages.
3. Induction of lambda lysogen by UV radiations.
4. Studies on Specialized transduction.
5. Isolation of lambda DNA and their characterization.
6. Amplification of lambda DNA by PCR
7. Cultivation and assay of virus using embryonated eggs and tissue culture Technique.
8. Study of symptoms of plant/animal virus.

Reference:

1. .Medical Virology, 10 Th Edition by Morag C and Tim bury M C 1994. Churchil Livingstone.
2. Introduction to modern Virology 4th Edition by Dimmock N J, Primrose S.B. 1994. Blackwell Scientific publications. Oxford.
3. Virology 3 rd Edition by Conrat H.F. Kimball P.C. and Levy J.A. 1994. Prentice Hall, Englewood Cliff, New Jersey.
4. Text Book on principles of bacteriology, Virology and immunology Topley and Wilsons 1995.
5. Molecular Biology, Pathogenesis and Control by S.J.Flint and Others. ASM Press, Washington .D.C

6. Applied Virology. 1984. Edited by Edonard kurstak. Academic press Inc.
7. Introduction to Modern Virology by Dimmock.
8. Prion diseases by Gaschup, M.II
9. Clinical virology Manual by Steven .S, Adinka R.L, Young.S.A
10. Principles of Virology .2000 by Edward Arnold.

MB-103: CELL BIOLOGY AND MICROBIAL PHYSIOLOGY

Unit –I: Cell Biology and Bacterial chemolithotrops (09)

Structure and function of cells and intracellular organelles (of both prokaryotes and eukaryotes): Mechanism of cell division including (Mitosis and Meiosis and cell differentiation: Cell-cell Interaction;

Physiological groups of chemolithotrops, ammonia oxidation by membrane of Genus Nitro groups, Nitrate oxidation by nitro group of genera. Oxidation of molecular hydrogen by Hydrogenomonas species. Ferrous and sulfur/sulfide oxidation by Thiobacillus species.

Unit-II : Bacterial Photosynthesis (09)

Photosynthetic microorganisms, photosynthetic pigments and generation of reducing power by cyclic and non cyclic photophosphorylation, electron transport chain in photosynthetic Bacteria. Carbon dioxide fixation pathways.

Unit –III : Bacterial respiration (09)

Bacterial aerobic respiration, components of electron transport chain free energy changes and electron transport, Oxidative phosphorylation and theories of ATP formation, inhibition of electron transport chain. Electron transport chain in some heterotrophic and chemolithotrophic bacteria.

Bacterial anaerobes respiration: Introduction .Nitrate, carbonate and sulfate as electron acceptors. Electron transport chain in some anaerobic bacteria. Catalase, super oxide dismutase, mechanism of oxygen toxicity.

Unit –IV: Bacterial permeation (09)

Structure and organization of membrane: (Glyco-conjugants and proteins in membrane system), fluid mosaic model of membrane. Methods to study diffusion of solutes in bacteria, passive diffusion, facilitated diffusion, different mechanisms of active diffusion (Proton motive force, PTS, role of permeases in transport, different permeases in *E.Coli*. Transport of amino acids and inorganic ions in microorganisms and their mechanisms.

Unit –V: Bacterial Sporulation (09)

Sporulating bacteria, molecular architecture of spores, induction and stages of sporulation, Influence of different factors on sporulation .Cytological and macromolecular changes during sporulation. Heat resistance and sporulation.

PRACTICAL PAPER MICROBIAL PHYSIOLOGY (100)

1. Isolation of photosynthetic bacteria
2. Glucose uptake by *E. coli / Sacchromyces cerevisiae* [Active and Passive diffusion]
3. Effect of UV, gamma radiations pH, disinfectants, chemicals and heavy metal ions on spore germination of *Bacillus SP*.
4. Determination of Iron Oxidation Rate of *Thiobacillus ferrooxidans.*
5. Determination of Sulfur Oxidation Rate of *Thiobacillus thiooxidans.*
6. Microbial degradation, decolorization and adsorption of organic dyes (by free and immobilized cells).
7. Estimation of calcium ions present in sporulating bacteria by EDTA method.
8. Demonstration of utilization of sugars by oxidation and fermentation techniques.

REFERENCES

1. Microbial physiology and metabolism by Caldwell D.R.1995 Brown Publisher.
2. Microbial physiology by moat .A.G and foster J.W.1999. Wiley
3. Prokaryotic Development by Burn.W.V. Shimkots I.J 2000. ASM. Press.
4. Advances in microbial physiology. Volumes. Edited by A.H.Rose. Academic Presws.New York.
5. Applied microbial physiology by Rhodes.
6. Biosynthesis by smith.
7. The Bacteria. Volume by I.C. Gunsalus and Rogery Stainer. Academic Press.
8. Microbial physiology by Benjamin.

MB 104: FOOD , DAIRY & AGRICULTURE MICROBIOLOGY

UNIT-I: Food & Dairy Fermentations (10)

Starter cultures & biochemical activities production and preservation of

1) Soy Sauce 2) Saurkraut 3) Sausages 4) Vinegar 5) Beer 6) Wine 7) Cheese 8) Fermented milk products. 9) Tea and coffee 10) Pickles 11) Indian fermented foods (Dosa, Idli and Jilebi).

UNIT – II: Quality Assurance in foods (08)

Quality assurance: Microbiological quality standards of food

Government regulatory practices and policies. FDA, EPA, HACCP, ISI.

Food borne infections and intoxications: Bacterial with type of infection and toxicity-

1) *Clostridium* 2) *Salmonella* 3) *Shigella*,4) *Staphylococcus* 5) *Campylobacter* 6) *Listeria*

-Mycotoxin- Rubratoxin and Alfa Toxins

- Phycotoxins in foods.

UNIT- III : Food Preservation & Advanced Food Microbiology (08)

Radiations- UV, Gamma & Microwave.

-Temperature

-Chemical and naturally occurring antimicrobials.

-Biosensors in food

-Microbial enzymes in food & dairy industry (Proteases, Lipases, Amylases, Pectinase)

-Probiotics and their applications, genetically modified foods

-Mushroom and spirulina

-Utilization of Byproduct .1) Dairy Industry - Whey 2) Sugar Industry - Molasses.

UNIT –IV: Pathogenic Interactions with Plants. (08)

-Plant defence mechanism

-Microbial pathogencity mechanism in virus, bacteria, fungal pathogens

-Genetic basis of plants – pathogen interactions.

-Region- specific plant diseases (Etiology, Symptoms and control) Red rot of sugarcane , Sigatoka diseases of banana , Tikka diseases of ground nut , Black smut of Jawar,Yellow vein mosaic of papaya.

-Strategies for plant diseases management and epidemiology

-Biological control of post harvest diseases- Traditional and Advanced

-Control of plant pathogens by genetic engineering.

UNIT-V Newer approaches in Agricultural Microbiology (08)

-Chitinase & other metabolites, BT, Pseudomonas, Trichoderma

- Integrated plant nutrition through bio fertilizer: PSM, S-SOLUBILISER, N2 fixer

-Phytoremediation- Rhizodegradation

-Rhizosphere engineering

PRACTICAL FOOD, DAIRY & AGRICULTURE MICROBIOLOGY (100)

1. Production and estimation of lactic acid by *Lactobacillus Sp*.
2. Extraction and estimation of Diacetyl.
3. Grape wine fermentation.
4. Isolation of food poisoning bacteria from contaminated food products.
5. Extraction and detection of Afla toxin from infected foods.
6. Preservation of Potato / Onion by UV radiation.
7. Production of fermented milk by *Lactobacillus acidophilus*
8. Rapid analytical technique in food quality.
9. Isolation of microorganism from Rhizosphere/ phylloplane
10. Isolation of VAM spore from soil
11. Nodulation of Legume by Rhizobium using Leonard Jar/ Pot assay
12. Isolation and Characterization of Casein from milk

REFERENCES.

1. Food Microbiology 2nd Edition by Adams.
2. Food Microbiology by Pfrizer
3. Basic Food Microbiology by Banwart J.
4. Food Microbiology : Fundamentals and Frontiers by Dolle
5. Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology. Volume 2 by Joshi.
6. Fundamentals of Dairy Microbiology by Prajapati.

7. Essentials of Food Microbiology Edited by John Garbult, Arnold International Students Edition.
8. Microbiology of Fermented Foods. Volume I & II by Brain J. Wood. Elsevier Applied Science Publication.
9. Microbiology of Foods by John C. Aryes, Orwin Mundt, William E. Sandinee , W.H. Freemen and Co.
10. Dairy Microbiology by Robinson. Volume I & II
11. Modern food Microbiology by James M Jay.4th Edition.
12. Food Microbiology: Fundamentals and Frontiers. 2nd Edition by Michael P. Doyle, Larry R. Beuchat and Thomas I. Montville. (Eds.) ASM Publication.
13. Bacterial Pathogenesis. A Molecular Approach. 2nd Edition by 2001 by Abigail A. Salyers and Dixie D.Whitt. ASM Publications.
14. Advances in Applied Microbiology by D. Pearlman, Acedemic Press.
15. Kumar, HD and Kumar, S (2004) Modern concepts of Microbiology, 2nd edn., Vikas Publishing House Pvt. Ltd.,
16. New Delhi (ISBN: 81-259-1000-X)
17. Hurst, CJ, Crawford, RL, Knudsen, GR, McInerey, MJ and Stetzenbach, LD (2002) Manual of Environmental
18. Microbiology, 2nd edn., ASM Press, Washington DC (ISBN: 1-55581-199-X)
19. Ciancio, A and Mukerji, KG (2007) General Concepts in Integrated Pest and Disease Management, Springer,
20. The Netherlands (ISBN: 978-1-4020-6060-1)
21. Buchnan, BB, Gruissem, W and Jones, RL (2000) Biochemistry and Molecular Biology of Plants, IK
22. International Pvt. Ltd., New Delhi (ISBN:81-88237-11-6)
23. Boland, GJ and Kuykendall, LD (1998) Plant-Microbe Interactions and Biological Control, Marcel Dekker Inc.,
24. NY, USA (ISBN: 0-8247-0043-0)
25. Chincholkar, SB and Mukerjii, KG (2007) Biological Control of Plant Diseases, Haworth Press Inc., London
26. (ISBN: 1-56022-328-6)

SWAMI RAMANANDTEERTH MARATHWADA UNIVERSITY, NANDED

SYLLBUS FOR M.SC II nd SEM

Bioprocess Engineering (MB-201)

Unit-I: Introduction to Industrial Bioprocess Engineering (10)

Definition of bioprocess engineering, bioprocess engineer, biotechnology and bioprocess engineering, approach of biologist and engineers towards research, regulatory constraints of bioprocess.

Batch growth (growth pattern and kinetics in batch culture, environmental factors affecting growth kinetics), Monod's equation, continuous culture, chemostat and turbitostat (construction and working), mixed culture in nature, industrial utilization of mixed culture.

Unit-II : Bioreactors (08)

Design of basic bioreactor, bioreactor configuration, design features, individual parts, baffles, impellers, foam separators, spargers, culture vessel, cooling and heating devices, probes for on-line monitoring computer control of fermentation process, measurement and control of process.

Ideal batch reactor, ideal continuous flow stirred tank reactor, packed bed reactor bubble column reactor, fluidized bed bioreactor, Trickle bed reactor (Their basic construction, working, and distribution of gases).

Unit II: Mass Transfer and Sterilization (10)

Transport phenomena in bioprocess system: Gas liquid mass transfer in cellular systems, basic mass transfer concept, Rate of metabolic oxygen utilization, Determination on oxygen transfer rates, determination of Kla, Heat transfer, aeration / agitation and its importance.

Sterilization of bioreactors, nutrients, air supply, product and effluents, process variable and control, scale – up of bioreactor.

Unit-IV: Upstream processes **(08)**

Inoculum development, formulation of production media, sterilization of media, maintenance of stock culture, scale up of the process from shake flask to industrial level.

Growth of culture in fermentor , choosing cultivation methods , Modifying batch and continuous reactors, immobilization cell systems, active and passive immobilization , solid state fermentation process.

Unit-V: Down Stream Process **(10)**

Down stream processes : Introduction , Recovery of particulates filtration , centrifugation , sedimentation , emerging technologies for cell recovery , product isolation , extraction , solvent extraction , aqueous two phase system , sorption , precipitation , reverse osmosis , ultra filtration.

Product recovery traits: Commercial enzymes, Intracellular foreign proteins from recombinant E. coli, polysaccharide and biogum recovery, antibiotic, organic acids, ethanol, single cell protein.

Practicals:

1. Isolation of Industrially important microorganisms for microbial processes.
2. Determination of Thermal Death Point (TDP) and Thermal Death Time (TDT) of microorganisms for design of a sterilizer.
3. Cultivation and determination of growth curve of bacteria *E. coli* in batch reactor/flask.
4. Continuous cultivation of bacteria in laboratory (Chemostat)
5. Study of mixed culture and its comparison with the pure culture (growth pattern).
6. Designing of batch bioreactor.
7. Determination of Oxygen Absorption rate as a function of flack size.
8. Determination of Oxygen Absorption rate as a function of RPM on shaker.
9. Determination of KLa.
10. Fermentative production and recovery of amino acid (Glutamic acid).
11. Fermentative production and recovery of alkaline protease.

12. Estimation of amino acids.
13. Estimation of Alkaline protease.

References:

1. James E .Bailey and David F Ollis, Biochemical Engineering Fundamentals, McGraw Hill Publication.
2. Shuler and Fikret Kargi, Bioprocess Engineering basic concepts, 2nd edition , Prentice Hall publication.
3. Stanbury PF, Whitekar, A And Hall SJ, Principles of fermentation Technology, Pergamon Press.
4. Peppler and Perlmen , Microbial Technology, Vol I and II , Academic Press.
5. Cruger and Cruger , Biotechnology : A text Book of Industrial Microbiology.

Enzyme Technology (MB-202)

Unit I: Extraction and Purification of Microbial Enzyme. (10)

Importance of enzyme purification, different sources of enzyme. Extracellular and Intracellular enzyme. Physical and chemical methods used for cell disintegration ,enzyme fractionation by precipitation (using temperature, salt ,solvent, pH etc.),liquid-liquid extraction, ionic exchange , gel electrophoresis , affinity chromatography and other special purification methods. Enzyme crystallization technique. Criteria of purity of enzyme. Pitfalls in working with pure enzyme.

Unit –II- Enzyme Kinetics and Enzyme Inhibition. (10)

Enzyme kinetics- Steady state kinetics, Brigs Haldane equation, Michaelis Menten equation, Irreversible, Reversible, competitive, Noncompetitive and Uncompetitive Inhibition with suitable examples and their kinetics studies. Allosteric regulation, types of allosteric regulation and their significance in metabolic regulation and their kinetics study (Hills equation).

Unit-III: Immobilization of Microbial enzymes. (08)

Methods viz. adsorption, covalent bonding, entrapment and membrane confinement, Analytical, therapeutic and industrial application. Properties of Immobilization enzyme.

Unit-IV : Enzyme as a biocatalyst and Enzyme Engineering (10)

Structure of active sites, Role of Ionizable group in catalysts, study on vitamins and co-enzymes:- Structure and functions with suitable examples. Metallo enzymes and metal ions as co-factors and enzyme activators. Chemical modification and site directed mutagenesis to study structure –function relationship of industrially important enzyme.

Unit-V: Application of Microbial enzymes. (08)

Microbial enzymes in textiles, leather, wood industries and detergent. Enzymes in clinical diagnosis. Enzyme sensors for clinical processes and environment analysis. Enzymes as therapeutic agents. Extremozymes, Solventogenic enzymes .

Practical paper:-

1. Microbial production, Extraction, Purification and confirmation of alpha amylase / Lipase.
2. Determination of efficiency of enzyme purification by measuring specific activity at various stages viz. Salt precipitation, dialysis, electrophoresis etc.
3. Studies on enzyme activation and inhibition of extracted alpha amylase / Lipase. Effect of heavy metal ions, Chelating agents activators and inhibitors.
4. Immobilization of cells and enzyme using sodium alginate and egg albumin and measurement of enzyme activity (amylase / Lipase).
5. Studies on impact of immobilization of enzyme activity in terms of temperature tolerance and V_{max} and K_m using various forms of alpha amylase/ Lipase.
6. Determination of molecular weight of enzyme using PAGE technique.
7. Preparation of biosensors of urease and determination of its activity.

References:

1. Methods in enzymology. Volume22-Enzyme purification and related techniques. Edited by William B.Jakoby. Academic press, New York.
2. Allosteric enzymes – kinetic Behaviour. 1982. by B.I Kurganov. John Wiley and sond Inc ., new York.
3. Biotechnology, volume 7 A- enzymes in biotechnology 1983 Edited by H.J.Rehm and G. Reed Verlag Cheime.
4. Hand Book of Enzyme Biotechnology by Wiseman.
5. Enzymes as Drugs Edited by John S. Hoilenberg and Joseph Roberts. John Wiley and Sons New York.
6. Methods of Enzymatic Analysis by Hans Ulrich. Bergmeyer, Academic Press.
7. Methods in enzymology by W. A. AWood. Academic Press.
8. Advances in enzymology by Alton Meister, Interscience Publishers.
9. Topics in enzymes and fermentation biotechnology by L.N.Weiseman, John wiley and Sons.
10. Understanding enzymes by T.Palmer.

11. Enzymes Dixon and Webb. Academic Press.
12. URLS on Internet
13. Enzyme kinetics by Segel. Academic press.

Microbial Metabolism (MB 203)

Unit I : Thermodynamics and Bioenergy transduction (8)

Basic aspects of bioenergetics: - Entropy, Enthalpy
Modes of ATP generation, Hypothesis of phosphorylation.
Chemiosmotic energy transduction, Chemiosmotic theory fundamentals.
Basic morphology of Energy transduction membrane (Mitochondria
& sub mitochondrial particles, Respiratory bacteria & derived preparation,
Chloroplast & thylakoids, Photosynthetic bacteria and chromatophore)
Reconstituted System: - pathway of energy transduction.

Unit II: Carbohydrate Metabolism (10)

Major Carbohydrate catabolic pathway & their regulation:
(EMP, HMP, ED, PKP, TCA, Methyl glycoxal bypass, Anaplerotic
Sequences, Glycerol metabolism, Catabolism of different carbohydrate).
Fermentations: Ethanol, Lactate, Butyrate & Butanol-acetone, Mixed
Acid, 2, 3-butandiol, propionate, succinate, acetate, methane and sulphate.

Unit III: Nitrogen circulation on earth & bacteria **(11)**

Amino acid and Nucleic acid metabolism
Bacterial Nitrification

a) Oxidation of ammonia, hydroxylamine , ETS coupled to
   Oxidation of ammonia, dehalogenation of chloroethylene by bacteria
b) Oxidation of Nitrite.
   i) Nitrite oxidoreductase
   ii) Cytochrome 550(S) & Cytochrome 550 (M)
   iii) Cytochrome c oxidase
   iv) Reconstitution of nitrite oxidation system
   v) Application of nitrifying bacteria.
c) Interaction between ammonia oxidizing & nitrite oxidizing bacteria.
d) Reduction of Nitrite & Nitrogen gas

Biological nitrogen Fixation (*Rhizobia, Azatobactor, Cyanobacteria*)

Unit IV: Lipid Metabolism and Aliphatic, aromatic hydrocarbon catabolism (7)

Microbial degradation of aliphatic hydrocarbon (Monoterminal, Biterminal oxidation).Microbial degradation of aromatic hydrocarbon via catachol, protocatachuate. Metaclevage of catachol, protocatachuate. Homogentisate pathway.

Unit V: Endogenous Metabolism & Microbial growth on C_1 compounds. (10)

Concept of endogenous metabolism, Type, functions of reserve food material.

Microbial synthesis, degradation & regulation of glycogen, poly phosphate, poly β hydroxybutyrate (PHB) production and its futuristic application.

Microbial growth on C_1 compound (Cyanide, methanol, methane, methane, methylated amines and carbon monoxide).

Practical paper:

1) Isolation and identification of Reserve food material (Glycogen / polyphosphate/ PHB) of *B.megaterium* and *Azotobacter sp.*
2) Demonstration of endogenous metabolism in *B.megaterium* or *E.coli* and their survival under saturation condition.
3) Quantitative estimation of amino acid by Rosen's method.
4) Quantitative estimation of sugar by summners method.
5) Quantitative estimation of protein by Folin Lowry /Biuret method.
6) Preparation and analysis of polar lipids from *S. aureus* and *E.coli*.
7) Isolation of autotrophs.
8) Isolation of hydrocarbon degraders.

References:

1) Bioenergetics 3 –Academic press. David G Nicholis & Stuart J.Ferguson.
2) Biochemistry by Lubest stryer.
3) Laboratory techniques in Biochemistry and Molecular Biology by work and work.

4) Biochemistry by Chatwal.
5) Biochemistry by Garrett.
6) Principles of Biochemistry 2 nd Edition by Horton
7) Biochemistry by Voet.
8) Methods of Biochemical Analysis by David Glick. John Wiley and Sons, New York.

Molecular Biology and Genetics (MB- 204)

Unit I: DNA Replication and Repair **10**

Unit of replication, enzymes involved in replication origin and replication fork, fidelity of replication, extrachromosomal replicon, DNA damage and repair; types of damage (deamination, oxidative damage, alkylation, pyrimidine dimmers) repair path-methyl directed mismatch repair, very short patch repair, nucleotide excision repair, excision repair, recombination repair, SOS system.

Unit II: Transcription and Processing **08**

Transcription factors and machinery, formation of initiation complex, transcription activators and repressors RNA polymerases, capping, elongation and termination, RNA processing, RNA editing, splicing, polyadenylation, structure and function of different types of RNA, RNA transport.

Unit III: Translation and Processing **10**

Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, translational proof-reading, translational inhibitors, post-translational modification of proteins.

Unit IV: Regulation of Gene Expression **08**

Regulation of phage, viruses, eukaryotic and prokaryotic gene expression, operon concept, co-ordinated control of structural gene, stringent response, positive regulation (Arabinose operon), negative regulation (Lac operon), trp operon, regulation by attenuation.

Unit V: Genetic Exchange: Mapping and Recombination **10**

Molecular mechanism of genetic transfer and mapping genes in – transformation, conjugation, transduction and sexduction. F plasmid, structure and function, origin of Hfr and $F^{'}$ strain; transducing phages, P_1, T_4, μ, λ. Bacterial transposones, homologous and non-homologous recombination including transposion and side specific recombination. Molecular genetic approaches in bacteria with no natural system.

Practical

1) Purification of chromosomal/plasmid DNA and study of DNA profile.

- Confirmation of nucleic acid by spectral study.
- Quantitative estimation by diphenylamine test.
- DNA denaturation and determination of Tm and G + C contents.
- Agarose gel electrophoresis of DNA.

2) Effect of UV radiations to study the survival pattern of *E.coli* /yeast. Repair mechanisms in *E.coli* / yeast (Dark and Photo reactivation).

3) Isolation of antibiotics resistant mutants by chemical mutagenesis.

4) Ampicillin selection method for isolation of autotrophic mutants.

5) Extraction and purification of RNA from *S.cerevisiae*.

6) Studies on gene expression in *E.coli* with reference to Lac operon.

7) Study of conjugation in *E.coli*.

8) Restriction digestion and Agarose gel electrophoresis of DNA.

9) Generalized transduction in *E.coli* using p1 phage.

References:

1. Microbial Genetics by Maloy. 1994.
2. Molecular Genetics of Bacteria by Dale. 1994
3. Modern Microbial Genetics by Streips and Yasbin. 1991.
4. Molecular Biology of Gene- 4th Edition by Watson. 1987.
5. Gene VIII by Benjamin Lewin. 2007.
6. Bacterial and Bacteriophage Genetics 4th Edition by Brige.
7. Microbial Genetics by Freifelder- 4th Edition.
8. Organization of Prokaryotic Genome by Robert Charlebois. 1999.
9. DNA Repair and Mutagenesis by Errol Friedberg. 1995.
10. Methods of General and Molecular Bacteriology by Philip. 1993.

11. Recombinant DNA by Watson.

12. Essentials of Molecular Biology by Maiacimski.

13. Mobile DNA II by Nanoy Craig.