

**NORTH MAHARASHTRA UNIVERSITY,
JALGAON**



SYLLABUS

**Master of Science
in
Microbiology**

**Part-II
(Semester – III and IV)**

w. e. f. June 2013

NORTH MAHARASHTRA UNIVERSITY, JALGAON
MICROBIOLOGY

Syllabus for M.Sc. (Part- II) Microbiology

Effective from June 2013

Subject code	Title of the paper	Duration (Hrs./Wk)	Max. Marks	Exam. Time (Hrs.)
SEMESTER – III				
Theory courses				
MB-301	Applied and Environmental Microbiology	04	100	03
MB-302	Molecular Biology and Bioinformatics	04	100	03
MB-303	Pharmaceutical Microbiology	04	100	03
Laboratory courses				
MB-304	Methods in Biostatistics and Bioinformatics	04+04	100	06
MB-305	Methods in Applied Microbiology	04+04	100	06
SEMESTER – IV				
Theory courses				
MB-401	Fermentation Technology	04	100	03
MB-402	Applied Molecular Biology	04	100	03
MB-403	Agricultural Microbiology	04	100	03
Laboratory courses				
MB-404	Methods in Biotechnology	04+04	100	06
MB-405	Project Dissertation	04+04	100	06

Instructions:

1. Each theory course has to be completed in 50 lectures of 60 min duration each in one semester.
2. Semester II and IV will have THREE theory courses and TWO Practical courses
3. Practical examination of each laboratory course shall be conducted at the end of each respective semester.
4. Each course will be of 100 marks (20 marks internal assessment and 80 marks-external examination) under NMU affiliated colleges and Institutions.
5. Each course will be of 100 marks (25 marks internal assessment and 75 marks-external examinations) in the School of Life Sciences of NMU, Jalgaon.

SEMESTER III

MB-301 Applied and Environmental Microbiology		Lectures
Unit I	<p>Food Microbiology</p> <ul style="list-style-type: none"> • Methods of sampling and investigation • Preparation of dilutions • General viable count • Detection and enumeration of indicator bacteria • Pathogenic and toxigenic microbes • Mycotoxins • Microbiological examination of specific foods <ul style="list-style-type: none"> ○ Meat and meat products ○ Milk and milk products • Food intoxications <ul style="list-style-type: none"> ○ Causes, pathogenesis and prevention of food spoilage and preservation 	10
Unit-II	<p>Microbiological treatment of waste water</p> <ul style="list-style-type: none"> • Principles and need for biological waste water treatment • Conventional treatment process <ul style="list-style-type: none"> Primary- Sedimentation or settling Biological- <ul style="list-style-type: none"> - Aerobic suspended-growth, - Aerobic attached-growth (TF, RBC, PBR), - Anaerobic suspended growth - Anaerobic attached growth • Advanced tertiary process <ul style="list-style-type: none"> - Solids removal - Biological nitrogen removal - Biological phosphorus removal - Disinfection • Waste water treatment for distillery, tannery & antibiotic industries • Solid waste management <ul style="list-style-type: none"> ○ Composting: Principle, chemistry and biology of composting, technology of composting, criteria of compost maturity, applications of compost ○ Biomethanation: Feedstocks, BMP, microbiology of biomethanation, biochemistry of methane synthesis. 	10
Unit- III	<p>Biological conversion of Lignocellulosic waste</p> <ul style="list-style-type: none"> • Composition and structure of lignocelluloses • Pretreatment of lignocellulosic material • Biological conversions • Liquid-state fermentation • Solid-state fermentation (SSF) • Utilization of lignin component of lignocelluloses 	10

	<ul style="list-style-type: none"> • Problems of lignocellulose bioconversion 	
Unit- IV	Bioremediation and biodegradation of xenobiotics	10
	<ul style="list-style-type: none"> • Concept of biodegradability and bioconversion • Principles for measuring biodegradability • Mechanism of biodegradation / bioremediation • Methods for bioremediation <ul style="list-style-type: none"> ○ Intrinsic ○ Biostimulation ○ Bioaugmentation (selection and screening of microbial strains) ○ Impediments to microbial degradation of compounds • Biodegradation of xenobiotics (Pesticides, halogenated compound etc.) <ul style="list-style-type: none"> ○ Conventional microbial enumeration ○ Biochemical/ physiological approach ○ Molecular techniques ○ Toxicological risk assessments 	
Unit- V:	Biomarkers and Bioreporters	10
	<ul style="list-style-type: none"> • Concept and approaches for metagenomics analysis and ecological inference • Concept w.r.t. probing microbes from environment • Biomarker gene (antibiotic and heavy metal resistance genes, ice-nucleation, bioluminescence genes, green fluorescent genes) • Bioreporter genes 	

References:

- Singh, A. and Ward, O. P. (2004) Biodegradation and Bioremediation, Springer-Verlag,, Berlin (ISBN: 3-540-21101-2)
- Hurst, C.J. (2002) Manual of Environmental Microbiology, ASM Press, Washington D.C. (ISBN: 1-55581-199-x)
- Demain, A. L. and Davies, J. E. (1999) Manual of Industrial Microbiology and Biotechnology, ASM Press, Washington D.C. (ISBN: 1-55581-128-0)
- Martin, A. M. (1998) Bioconversion of waste materials to Industrial Products, Blackie Academic and Professional, London (ISBN: 0-7514-0423-3)
- Harrigan, W. F. and McCance, M.E. (1994) Laboratory Methods in Food and Dairy Microbiology. Academic Press, London
- Mossel, D.A.A., Correy, J.E.L., Struijk, C.B. and Baird, R. M. (1995) Essentials of the Microbiology of Foods, John-Wiley and Sons Inc., New York.
- Satyanaraya, U. (2005) Biotechnology, Books and Allied (P) Ltd., Kolkata
- Hobbs, B & Roberts, D. (1993) Food Poisoning & Food Hygiene, Edward Arnold, London
- Baker, K.H. and Herson, D. S. (1994) Bioremediation, Mc-Graw Hill Inc., New York.
- Pandey, A. (2004) Concise Encyclopedia of Bioresource Technology, Food Products Press, The Haworth Reference Press, New York (ISBN: 1-56022-980-2)
- Rehm, R. G. and Reed, G. (1984) Biotechnology, Vol.1-8, Verlag-Chemie, Weinheim.
- Forster, C. F. (1985) Biotechnology and waste water treatment, Cambridge University Press, Cambridge.
- Maier, R. Pepper, I. L. and Gerba, C. P. (2000) Environmental Microbiology, Academic Press, London

MB-302 Molecular Biology and Bioinformatics		Lectures
Unit I:	<p>Basics molecular biology</p> <ul style="list-style-type: none"> • DNA: topological properties (linking, writhing, twisting number), Structure of superhelix, Base flipping, Palindrome, Inverted repeats and stem and loop. • Overview of DNA replication • RNA: Structure, types and functions • Denaturation and renaturation kinetics of nucleic acids • Proteins: Domain and motifs Histone proteins, • DNA –Protein interactions - helix-loop-helix, helix-turn-helix, leucine zipper, Zinc finger motifs, 	10
Unit II	<p>Transcription</p> <ul style="list-style-type: none"> • Types of RNA polymerase (prokaryotic & eukaryotic), Process of transcription • mRNA processing, editing: capping, adenylation, splicing, RNA transport • transcriptional regulation: transcriptional bursting/pulsing, specificity factors, enhancers, repressors, activators and general transcription factors • post-transcriptional modifications:, RNA degradation, nuclear transport, mRNA localization, anti-sigma factors, RNAi (siRNA, miRNA and CRISPR mechanism) 	10
Unit III:	<p>Translation</p> <ul style="list-style-type: none"> • Ribosome (structure and composition), Activation of tRNA, tRNA synthetase • Steps: Initiation: factors and their regulation, Elongation, Termination • Inhibitors • Post translational modification of proteins and protein degradation • Translational regulation: Cytoplasmic polyadenylation, UTR sequence elements, RNA binding proteins, ribosomal regulation, non-sense mediated RNA decay, 5' decapping 	10
Unit IV	<p>Protein targeting & degradation</p> <ul style="list-style-type: none"> • Signal hypothesis • Signal sequences in bacteria • Membrane and Lysosomal protein targeting • HSP and Chaperons • Protein degradation 	10
Unit V	<p>Basic Bioinformatics</p> <ul style="list-style-type: none"> • Biological databases :Nucleic acid databases (GenBank, EMBL, DDBJ) • Protein sequence data base (UniProt, PDB, PIR) • Scoring matrices, local. global and multiple sequence alignment • Database search for homologous sequences, BLAST • Phylogenetic analysis: Overview and tree construction methods 	10

References:

- Lewin B. (2013) Gene XI, Pearson Prentice Hall, Pearson Education, Inc., NT, USA (ISBN: 0-13-123826-4)
- Malacinski GM (2003) Essentials of Molecular Biology, 4th edn., Jones & Batielt, London. (ISBN: 0-7637-2133-6)
- Watson JD, Baker JA, Bell SP, Gann A, Lewin M, Losick R (2004) Molecular Biology of the Gene, Benjamin Cummings- CSHL Press, USA
- Stryer, Lubert () Biochemistry 5th edn. W. H. Freeman & Co. New York
- Wink M. (2006) An Introduction to Molecular Biotechnology, Wiley-VCH Verlag GmbH & Co., Weinheim, Germany (ISBN: 978-3-527-31412-6/3-527-31412-1)
- Weaver, RF (1999) Molecular Biology, WCB McGraw-Hill Co. Inc., NY (ISBN: 0-697-14750-9)
- Brown, TA (1995) Essential Molecular Biology, Vol. I, A Practical Approach, IRL Press, Oxford, UK
- Nelson DL & Cox MM (2005) Lehninger's Principles of Biochemistry, 4th edn., McMillan Worth Publ. Inc. NY
- Russell, PJ (1998) Genetics, 5th edn, Benjamin-Cummings Publ. Co. Inc., NY (ISBN: 0-321-0038-2)
- Oliver, RP and Schweizer, M. (1999) Molecular Fungal Biology, Cambridge University Press, Cambridge, UK (ISBN: 0-521-56784-X)
- Klug, WS and Cummings, MR (2003) Concepts of Genetics, 7th edn., Pearson Education Inc., (ISBN: 81-7808-884-3)
- Bates, AD and Maxwell, A (2006) DNA Topology, Indian Edn., Oxford University Press, New Delhi (ISBN: 0-19-56831-X)
- Turner, PC, McLennan, AG, Bates AD and White, MRH (2002) Instant Notes: Molecular Biology, 2nd edn., Viva Books Pvt. Ltd., New Delhi (ISBN: 81-7649-215-9)
- Lesk, AM (2002) Introduction to Bioinformatics, Oxford University Press, UK (ISBN: 0-19-925196-7)
- Korf, I, Yandell, M and Bedell, J () An essential guide to the Basic Local Alignment Search Tool-BLAST O'Reilly Network Publishers, (ISBN:)
- Baxevanis, A. D. and Ouellette, B. F. F. (2001) Bioinformatics: A practical guide to the analysis of genes and proteins. Second Edition. John Wiley & Sons, New York.
- Mount, D. W. (2001) Bioinformatics: sequence and genome analysis. Cold Spring Harbor Laboratory Press, New York.
- Zoe L. and Terence C. (2004) Bioinformatics: Managing Scientific Data, Morgan Kaufmann Publishers, New Delhi.

MB-303 Pharmaceutical Microbiology		Lectures
Unit I	Antibiotics and Synthetic antimicrobial agents	10
	Mechanism of action, microbial resistance, therapeutic, prophylactic usage and adverse reactions <ul style="list-style-type: none"> • Antibiotic and Synthetic antimicrobial agents: β-lactam, aminoglycosides, tetracyclines, ansamycins, macrolides • Antifungal antibiotics: Griseofulvin • Antiviral drugs: Amantidines, Nucleoside analogues, Interferons • Peptide antibiotics • Synthetic antibiotics: Sulphonamides, Chloramphenicol, Quinolone 	
Unit II	Microbial aspects of pharmaceutical products	10
	<ul style="list-style-type: none"> • Microbial contamination (atmosphere, water, operator, raw material, packaging, buildings, equipments) • Microbial spoilage (Types & factors affecting) & preservation • Sterilization of pharmaceuticals (survivor curve, D, Z, F value) <ul style="list-style-type: none"> ○ Methods: Heat, Gaseous, Radiation, Filtration ○ Disinfectants 	
Unit III	Regulatory aspects and quality assurance in pharmaceuticals	10
	<ul style="list-style-type: none"> • GMP in pharmaceuticals • FDA regulation and pharmacopeia • Reimbursement of drugs and biologicals • Quality control through WHO, ICH process • Design of sterile product manufacturing unit • Quality control in pharmaceuticals: In-process & final product control • Sterilization control: physical, chemical & biological indicators sterility testing (sampling & methods) 	
Unit V	Production of Biopharmaceuticals	10
	<ul style="list-style-type: none"> • SK and SD, Asperaginase, Clinical dextran • Vaccines (DNA/ multivalent subunit/ bacterial) • Viral vaccines: Live attenuated, Inactivated, , Live recombinant Virion subunit vaccines, production of viruses for vaccines, Virus-like particles, Synthetic peptide vaccines, DNA vaccines • Immunosera • Novel therapeutics / biopharmaceuticals 	
Unit VI	Drug design	10
	<ul style="list-style-type: none"> • Rational drug design <ul style="list-style-type: none"> ○ Concept of lead drug ○ Pro-drug: concept and its applications ○ Structure based and combinatorial approach ○ Peptidomimetic and strategies for drug discovery • Biopolymers for drug delivery 	

References:

- Hugo, WB and Russell, AD (2003/1998) *Pharmaceutical Microbiology*, 6th edn, Blackwell Science, Oxford, UK (ISBN: 0-632-04196-X) Reprinted
- Krogsgaard-Larsen, P., Lilijefors, T. and Madsen, U. (2004) *Textbook of Drug Design and Discovery*, 3rd edn., Taylor and Francis, London (ISBN: 0-415-28288 PB)
- Haider, SI (2006) *Validation Standard Operating Procedures*, 2nd edn., CRC Press Taylor and Francis Group, NY (ISBN: 0-8493-9529-1)
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- Seth SD (2004) *Textbook of Pharmacology*, 2nd edn., Elsevier, New Delhi (ISBN: 81-8147-553-4)
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- Chakraborty C and Bhattacharya A (2004) *Pharmacogenomics: An approach to New Drug Development*. Biotech Books, New Delhi (ISBN: 81-7622-105-8)

MB 304 Methods in biostatistics and Bioinformatics	
1	Basic concepts: Population, Sampling, Accuracy, Precision, sampling errors, experimental design, Process optimization. Significance of statistics in microbiology and description to choose an appropriate statistical test.
2	Calculate mean, median, mode, range, variance, standard deviation, standard error, confidence interval using MS-Excel/suitable software
3	Plot straight Line (Linear Least squares) using LINEST Function of MS-excel/ suitable software
4	Plot - line, scatter graphs, bar graphs, error bars using MS-Excel/suitable software
5	Determine: linear regression, Correlation and their coefficients using MS-Excel/suitable software
6	Compute paired and unpaired, F-test, t-test, ANOVA, χ^2 -test using MS-Excel/suitable software
7	Introduction to Sigma Stat/SPSS/R/Minitab/any commercially available biostatistics software
8	Using biological databases - Protein Data Bank and GenBank
9	Different types of sequence analysis using BLAST
10	Multiple sequence alignments and Phylogenetic analysis.
11	Protein structure prediction software.
12	Primer designing using biological software
13	Genomes and Proteomes available on the web and their use.

References:

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- Irfan Ali Khan and Atiya Khanum (2004) *Fundamentals of biostatistics*, Ukaaz Publication, Hyderabad.
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- Ewens Warren J. and Gregory R. Grant. (2004) *Statistical Methods in Bioinformatics, An Introduction*, Springer, New York.
- Lacroix, Z. and Critchlow, T. (Eds.) 2003. *Bioinformatics. Managing Scientific Data*. Morgan Kaufmann Publishers.
- Misener, S. and Krawetz, S. A. (Eds.). 2000. *Methods in Molecular Biology*, Volume 132. *Bioinformatics: Methods and Protocols*. Humana Press, New Jersey.
- Mount, D. W. (2001) *Bioinformatics: sequence and genome analysis*. Cold Spring Harbor Laboratory Press, New York.

MB 305 Methods in Applied Microbiology	
1	Validation of autoclave
2	Phenol coefficient (RW Test/Chick Martin Test),
3	Sterility Test (Direct inoculation/ Membrane filtration)
4	Microbial Assay (Antibiotic /Vitamins),
5	Microbial Limit Test (analysis of water, raw material, finished product, packaging material, Excipients)
6	Demonstrations: SOP, documentation, Pharmaceutical audits, GMP, FDA, WHO guidelines Market surveillance and monitoring
7	Demonstrations : Ames test, Pyrogen test
8	Environmental monitoring samples from production areas and personnel.
9	Test for endotoxin/pyrogen using LAL (e.g., water, in-process, final product)
10	Test for bioburden (e.g. water, in-process, final product)
11	Test sterilization cycles with biological indicators.
12	Test for quality of media/reagents using growth promotion tests.
13	Sterility testing of in-process materials and finished products

References:

- White, D (2000) The Physiology and Biochemistry of Prokaryotes, Oxford University Press, Oxford
- Mu dili, J (2007) Introductory Practical Microbiology, Narosa Publ. House Pvt. Ltd., New Delhi (ISBN: 978-81-7319-744-4)
- Primrose, SB and Wardlow, AC (1982) Source Book for Experiments for the Teaching of Microbiology, Academic Press, London (ISBN: 0-12-565680-7)
- Sawhney, SK and Singh, R. (2001) Introductory Practical Biochemistry, Narosa Publ. House, Chennai

SEMESTER – IV

MB-401 Fermentation Technology		Lectures
Unit I	Underlying principles, Upstream processing <ul style="list-style-type: none"> • Metabolic pathways and control mechanisms • Fermentation- kinetics of batch and continuous culture • Designing of medium and strain improvement • Microbial growth kinetics and measurement of cell growth • Stoichiometry of microbial growth and product formation 	10
Unit II	Bioreactors (Design and Application) bioreactor operation <ul style="list-style-type: none"> • Design and construction materials of bioreactor • Parameters involved in fermentation process monitoring • Aeration and agitation for mass transfer • Strategy for medium sterilization, maintenance of aseptic/axenic condition • Control of process parameters and overview of process automation • Scale up 	10
Unit III	Downstream processing and product recovery <ul style="list-style-type: none"> • Biomass harvesting: centrifugation, filtration • Cell disruption: ultrasonication, thawing, enzymatic way. • Product extraction: Liquid –liquid, supercritical fluid extraction, ultrafiltration, Three phase partitioning • Product purification: Chromatography- adsorption, size exclusion, affinity, ion exchange, reverse phase, HPLC • Characterization and analysis of recovered product: purity, contaminants Quality practices and audit <ul style="list-style-type: none"> • Quality practices- concept of SOP, GLP and role of FDA • Biosafety aspects of handling infectious organisms • IPR: Patents, copyrights, trademarks, geographical indications • Patenting biological materials, transgenic materials • Patent regulatory bodies at National and International level 	10
Unit IV	Microbial Products I <ul style="list-style-type: none"> • Types of products: primary and secondary, extra- and intra-cellular • Fermentations: <ul style="list-style-type: none"> ○ Enzymes: Protease, asparaginase ○ Organic acids: citric acid, lactic acid ○ Amino acids: Lysine, aspartic acid ○ Polysaccharides: Alginate, Hyaluronic acid 	10
Unit V	Microbial Products II Fermentations: <ul style="list-style-type: none"> • Antibiotics: Penicillin, streptomycin / phenazines • Ethanol: 1st and 2nd generation • Vaccines production: DPT, MMR 	10

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| | <ul style="list-style-type: none"> • Recombinant proteins: Insulin, Monoclonal antibodies • Nucleotides: IMP, GMP | |
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References:

- Mukhopadhyay, S.N. (2004) Process Biotechnology Fundamentals, 2nd edn., Viva Books, Mumbai, (ISBN: 81-7649-496-8)
- Shuler M.L. and Kargi F (2008) "Bioprocess Engineering--basic Concepts", 2nd Edn. Prentice-Hall
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- Food Safety and Standards act (Government of India), 2006
- El-Mansi, EMT, Bryce, CFA, Demain, AL and Allman, AR (2007) Fermentation Microbiology and Biotechnology, 2nd edn., CRC Taylor & Francis Group, Boca Raton, Florida (ISBN: 0-8493-5334-3)
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- Stanbury, Peter F.; Whitaker, Allan; Hall, Stephen J. (1994) Principles Of Fermentation Technology . II Edn, Butterworth-Heinemann Publishers
- Okafor Nduka (2007) Modern Industrial Microbiology and Biotechnology, Science Publishers, USA

MB-402 Applied Molecular Biology		Lectures
Unit I	Tools of molecular biology (or rDNA technology) <ul style="list-style-type: none"> • Enzymes: Restriction endonucleases and its types, DNA methylases, DNA polymerase, DNA ligases, Kinases, Phosphatases, topoisomerase • Cloning vectors: Choice and its properties, Bacterial vectors: plasmid, Bacteriophage, Cosmids, Phagmids. Eukaryotic vectors: YACs, Ti, SV40 • Cloning hosts: Prokaryotic and eukaryotic hosts: properties 	10
Unit II	Methods in rDNA technology <ul style="list-style-type: none"> • Vector mediated and chromosomal integration • Cloning from mRNA and genomic DNA • Screening, analysis and confirmation of rDNA <ul style="list-style-type: none"> ○ Genetic methods ○ Hybridization techniques – Dot Blot, Colony, Dip stick, Plaque ○ Immunochemical methods ○ Plus and minus screening, HRT and HART ○ Analysis – Restriction mapping, Blotting techniques, DNA sequencing ○ Confirmation by genetic marker and reporter genes • Applications of genetic engineering 	10
Unit III	Microbial Genomics <ul style="list-style-type: none"> • Concept of - Genome density, GC content, CPG Islands, Isochores, codon usage bias, cDNAs and ESTs, Contigs • Structural, Functional, Application and Comparative Genomics: <ul style="list-style-type: none"> ○ Methods for whole genome sequencing, gene annotation ○ Gene and SNP identification ○ Genome mapping (Conjugation, Recombination and complementation) and map integration • Microarray technology and its applications in diagnostics 	10
Unit IV	Protein Engineering and Proteomics <ul style="list-style-type: none"> • Protein identification and Expression Mapping: 2D-gel electrophoresis, Mass Spectrophotometry and isotope labelling • Protein-ligand docking • Experimental approach to Protein-Protein interaction mapping: <ul style="list-style-type: none"> ○ Yeast and Bacterial 2-hybrid systems ○ Protein-ligand interactions ○ Protein fragment complement assays • Protein arrays and chips: Antibody and peptide arrays 	10
Unit V	Techniques in Molecular biology <ul style="list-style-type: none"> • Gene transfer techniques: Electroporation, Microinjection, biolistic • DNA Sequencing : Sanger, Maxum Gilbert and high throughput 	10

	<ul style="list-style-type: none"> • PCR: basics, Reverse transcriptase PCR, Real time PCR, RCAT (Rolling circle amplification technology), Applications of PCR • Analysis of gene expression : basics, SAGE (Serial analysis of gene expression) • Ribotyping in microbiology • SSCP (Single stranded conformation Polymorphism), Denaturing Gradient Gel Electrophoresis (DGGE) 	
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References:

- Channarayappa (2006) Molecular Biotechnology: Principles & Practice, Universities Press (India) Pvt. Ltd, Hyderabad (ISBN: 81-7371-501:7)
- Nicholl, D.S.T. (2002) An Introduction to Genetic Engineering, 2nd edn., Cambridge University Press, Cambridge, UK (ISBN: 81-7596-101-5 paperback)
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- Weaver, RF (1999) Molecular Biology, WCB McGraw Hill Co., Inc., NY (ISBN: 0-321-0038-2)

MB-403 Agricultural Microbiology		Lectures
Unit I	Microbial ecology <ul style="list-style-type: none"> • Basic concept • Microbial interactions • Microbial communities and plant protection • Methods to quantitative microbial ecology 	10
Unit II	Microbial interactions with plant roots <ul style="list-style-type: none"> • Rhizosphere and its anatomy • Mycorrhizae (VAM, OM, EM, Ectomycorrhizae) • Plant Growth Promoting Rhizobacteria (PGPR) • Strategies for rhizosphere and mycorrhizae community study Microbial interaction with aerial plant structure <ul style="list-style-type: none"> • Phylloplane • Stems/ flowers, leaf buds • Approaches for studies Leguminous root nodules <ul style="list-style-type: none"> • Nodulation process • Strategies for study of infection process, root nodulation and nitrogen fixation 	10
Unit III	Pathogenic interactions with plants <ul style="list-style-type: none"> • Plant defense mechanisms (structural, biochemical, hypersensitive response) • Microbial pathogenicity mechanisms in virus, bacteria, fungal pathogens • Genetic basis of plant-pathogen interactions • Region-specific plant diseases (etiology, symptoms and control): Red rot of sugarcane, Sigatoka disease of banana, Banana bunchy top, Tikka disease of groundnut 	10
Unit IV	Microbial Biocontrol Agents <ul style="list-style-type: none"> • Strategies for plant disease management • Types of biocontrol agents • Biological control of post harvest diseases • Control of plant pathogens by genetic engineering 	10
Unit V	Microbial production and formulation <ul style="list-style-type: none"> • BT, Pseudomonas, Trichoderma • Integrated Plant Nutrition through biofertilizers: PSM, S-solublisers, N₂fixers Recent approaches in Agriculture microbiology <ul style="list-style-type: none"> • Microbial Siderophores for fungal phytopathogen suppression • Phytoremediation – Rhizodegradation • Rhizosphere engineering 	10

References:

- Stanier, RY, Ingraham, JL, Wheelis, ML and Painter, PR (1993) General Microbiology, 5th edn., The McMillan Press Ltd., London (ISBN: 0-333-41768-2)
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- Lynch and Poole (1984) Microbial Ecology- A Conceptual Approach, Blackwell Scientific Publ.
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- Ciancio, A and Mukerji, KG (2007) General Concepts in Integrated Pest and Disease Management, Springer, The Netherlands (ISBN: 978-1-4020-6060-1)
- Buchanan, BB, Gruissem, W and Jones, RL (2000) Biochemistry and Molecular Biology of Plants, IK International Pvt. Ltd., New Delhi (ISBN:81-88237-11-6)
- Boland, GJ and Kuykendall, LD (1998) Plant-Microbe Interactions and Biological Control, Marcel Dekker Inc., NY, USA (ISBN: 0-8247-0043-0)
- Chincholkar, SB and Mukerji, KG (2007) Biological Control of Plant Diseases, Haworth Press Inc., London (ISBN: 1-56022-328-6)

MB-404 Methods in Biotechnology	
1	Isolation and estimation of DNA from bacteria/ yeast / fungi / bacteriophage
2	Isolation and estimation of RNA / mRNA from bacteria/ yeast/ fungi
3	Determination of Tm and % (G+C) of DNA
4	DNA fingerprinting through southern blotting
5	Demonstration of DNA amplification by PCR/ RT-PCR
6	Demonstration of GFP marker cloning and expression
7	Fermentative production / biotransformation of antibiotic/ steroid
8	Estimation of penicillin/ streptomycin by microbiological/ chemical assay
9	Analysis of biogas digested slurry for organic C, COD, pectin, lignin, Fatty acids and N
10	Nodulation of legume by Rhizobium using Leonard Jar/ Pot assay
11	Production and detection of siderophore produced by bacteria / fungi
12	Isolation of VAM spores from soil
13	Isolation of microbes from Rhizosphere / Phylloplane

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The project allotted during the Forth semester and it is expected that the students will design experiments and collect experimental data to deduce conclusions. At the end, they will submit a detailed thesis for evaluation. The students should be introduced to research methodology in the beginning through few lectures.

The approach towards the execution of project should be as follows:

1. Selection of topic relevant to priority areas of biotechnology.
2. Collection of literature from libraries, internet, on-line journals, etc.
3. Planning of research experiments
4. Performing the experiments with scientific and statistical acceptability.
5. Presentation of observations and results.
6. Interpretation of results and drawing important conclusions.
7. Discussion of obtained results with respect to literature reports.
8. Preparation of report (thesis) containing introduction, materials and methods, results and discussion, conclusions, bibliography.
9. Presentation of research data in a bound form.