M.Sc. MICROBIOLOGY (Semester System)

SCHEME OF EXAMINATION

ELIGIBILITY

In the light and looking at the interdisciplinary nature of Microbiology, eligibility with respect to subject at graduation level is as below:

B.Sc. with one of the subject of life sciences or bachelor degree in Microbiology/Biotechnology/Biochemistry/Genetics/Medicine/Agriculture/Horticulture/Forestry/Wild life/Pharmacy/Life Sciences with 50% marks.

PASS CRITERIA

Each theory paper shall be of 50 marks (40 Paper+10 Internal). For passing in the each theory examination, a candidate is required to obtain 25% marks in individual paper and 36% marks in aggregate of all theory papers and 36% marks separately in the practical examination.

CLASSIFICATION OF SUCCESSFUL STUDENTS

Division	**Total Marks**
First Division	60% and above
Second Division	Above 48 % and below 60 %
Pass	Above 36 % and below 48 %
Fail	Below 36 %

BACKLOG

As per University Norms

Teaching and Examination Scheme for

M.Sc. Microbiology (Semester Scheme)

Examination 2023

Session 2022-23

Paper Code	**Paper Name**	**Lecture / week**	**Exam Hours**	**Maximum Marks**		**Minimum Passing Marks**
				Internal Marks	**External Marks**	
Semester-I						
Theory Papers						
MB-101	General Microbiology and Bacteriology	**3**	**3**	10	40	13 (25 %)
MB-102	Microbial Physiology and	**3**	**3**	10	40	13 (25 %)

	Biochemistry					
MB-103	Molecular Biology	**3**	**3**	10	40	13 (25 %)
MB-104	Microbial Genetics and Genetic Engineering	**3**	**3**	10	40	13 (25 %)
				40	**160**	
Total Theory Marks					**200**	**72** **(36% aggregate)**
Practical						
Practical (Based on theory papers)		**3**	**6**	**25**	**75**	**36** **(36% aggregate)**
Grand Total					**300**	
Semester-II						
Theory Papers						
MB-201	Virology	**3**	**3**	10	40	13 (25 %)
MB-202	Bioinstrumentation	**3**	**3**	10	40	13 (25 %)
MB-203	Eukaryotic Microbiology	**3**	**3**	10	40	13 (25 %)
MB-204	Industrial and food Microbiology	**3**	**3**	10	40	13 (25 %)
				40	**160**	
Total Theory Marks					**200**	**72** **(36% aggregate)**
Practical						
Practical (Based on theory papers)			**6**	**25**	**75**	**36** **(36% aggregate)**

Grand Total					**300**	
Semester-III						
Theory Papers						
MB-301	Microbial Ecology and Environmental Biotechnology	**3**	**3**	10	40	13 (25 %)
MB-302	Soil and Agricultural Microbiology	**3**	**3**	10	40	13 (25 %)
MB-303	Medical Microbiology	**3**	**3**	10	40	13 (25 %)
MB-304	Immunology	**3**	**3**	10	40	13 (25 %)
				40	**160**	
Total Theory Marks					**200**	**72** **(36% aggregate)**
Practical						
Practical (Based on theory papers)			**6**	**25**	**75**	**36** **(36% aggregate)**
Grand Total					**300**	
Semester-IV						
MB-401	Biostatistics	**3**	**3**	10	40	13 (25 %)
MB-402	Bioinformatics and Computer Applications	**3**	**3**	10	40	13 (25 %)
MB-D	Research Project/ case study	-	10 min presentation/ viva voce per student	20	80	36 (25 %)
				40	**160**	

Total Theory Marks				**200**	**72** **(36% aggregate)**
Practical					
Practical (Based on theory papers)		**6**	**25**	**75**	**36** **(36% aggregate)**
Grand Total				**300**	

MASTER OF SCIENCE IN MICROBIOLOGY

Semester 1

Marking Scheme for External

Theory Papers	**Duration**	**Max. Marks**
Paper MB-101	**3 Hrs.**	**40**
Paper MB-102	**3 Hrs.**	**40**
Paper MB-103	**3 Hrs.**	**40**
Paper MB-104	**3Hrs.**	**40**
Combined Practical	**1 Day (6Hrs)**	**75**

MB-101: General Microbiology and Bacteriology

Scheme of Examination

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 questions (at least 3 questions from each unit of syllabus). Section B will consist of 9 questions (3 questions from each unit of syllabus). Section C will consist of 6 questions (2 questions from each unit of the syllabus).

Maximum Marks: 50 (40 Paper + 10 Internal) **Duration: 3 Hrs**

Minimum Passing Marks: 13

UNIT-I

History and Scope of Microbiology, Culturable and unculturable bacteria. Microbial Taxonomy: Taxonomic ranks, Phenetic and Phylogenetic classification approaches, Numerical taxonomy and Polyphasic classification approaches, Major groups of bacteria according to Bergey's manual of systematic bacteriology. Ultra structure, chemistry and function of prokaryotic cells.

UNIT-II

Autotrophs, heterotrophs, lithotrophs, chemotrophs and phototrophs. Microbial Growth: Growth factors, Growth curve, kinetics, synchronous growth of bacteria. Control of Micro-organisms: Sterilization; Dry, Wet, Chemical, Filtration, Radiation. Evaluation of effectiveness of physical and chemical antimicrobial

agents.Media preparations, types of media.Differential, Selective and enrichment media.Aerobic and Anaerobic cultivation.

UNIT-III

General Characters of Important Bacteria- *Escherichia, Salmonella, Vibrio, Proteus, Bacillus, Lactobacillus, Streptococcus, Staphylococcus, Corynebacterium, Treponema, Mycobacterium, Pseudomonas, Klebsiella, Thiobacillus, Rhizobium, Azotobacter, Acetobacter, Streptomyces, Clostridium.* Characters of Special group of organism as- Archaebacteria, Photosynthetic bacteria, Nitrogen fixing bacteria, Spirochaetes, Mycoplasma, Rickettsia, Bdelovibrio.

SUGGESTED READINGS:

1. General Microbiology (5th edition) by Stanier Ingraham Wheelis, Macmillan; 2007.
2. Prescott/Harley/Klein's Microbiology by Willey J., Sherwood L. and Woolverton C. McGraw Hill;2007.
3. Microbiology A laboratory manual by Cappuccino, G. .James, Sherman Natalie, Pearson Education; 2011.
4. Microbiology by Pelczar J. Michael, Chan E.C.S, Krieg R. Noel, Tata McGraw-Hill Publishing Company Limited, 1998.
5. The Prokaryotes. A handbook on the biology of bacteria: ecophysiology, isolation, identification, applications. Volumes I-IV by Balows, A., Truper, H. G., Dworkin, M., Harder, W., Schleifer, K. H. Springer-Verlag, New York; 1992.
6. Bacterial Systematics, by Logan, A., Niall A. Logan, Wiley-Blackwell; 1994.
7. Bergey's Manual of Determinative Bacteriology (8th edition) by Breed and Buchanan; 1974.
8. Bergey's Manual of Determinative Bacteriology (9th edition) by Breed and Buchanan; 1982.
9. Bergey's Manual of Systematic Bacteriology (2nd edition) by Breed and Buchanan. (Volumes. 1 – 5); 2001- 2003.
10. Principles of Microbiology by R.M. Atlas, Mosby publishers, St. Louis; 1995.
11. Brock Biology of Microorganisms (12th edition) by Madigan and John M. Martinko, Paul V. Dunlap, David P. Clark Benjamin Cummings; 2008.
12. Microbiology: An Introduction by Gerard J., Tortora, Berdell R. Funke, Christine L Case Benjamin-Cummings Publishing Company; 2008.

MB-102: Microbial Physiology and Biochemistry

Scheme of examination

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 questions (at least 3 questions from each unit of syllabus). Section B will consist of 9 questions (3 questions from each unit of syllabus). Section C will consist of 6 questions (2 questions from each unit of the syllabus).

Maximum Marks: 50 (40 Paper + 10 Internal) **Duration: 3 Hrs**

Minimum Passing Marks: 13

UNIT-I

Structure of atom, molecules and chemical bonds. Biochemistry of enzymes: classification, nomenclature, specificity, isolation and purification. Enzyme kinetics and inhibition. Co-enzymes. Allosteric and other regulations of enzyme activity, Mechanism of action of enzymes.

UNIT-II

Cell metabolism: anabolic principles and synthesis of fatty acids, lipids, amino acids and proteins in microbes. Studies of biosynthesis of hormones. Synthesis of vitamins and their role as coenzymes. Basic aspects of bioenergetics, entropy and enthalpy. Electron carriers, artificial electron donors, inhibitors, uncouplers, energy bonds and phosphorylation. Brief account of photosynthetic and accessory pigments. Autotrophic generation of ATP and Fixation of CO_2 in Microorganism, Calvin cycle. Oxygenic and anoxygenic photosynthesis.

UNIT-III

Microbial Oxidation of Inorganic Molecules: sulphur, iron, hydrogen and nitrogen. Bioluminescence.

Catabolism of carbohydrates proteins and lipids; Respiratory pathways: Embden Mayer Hoff Parnas pathway, EntnerDoudroff pathway, Glyoxalate pathway, Krebs cycle, oxidative and substrate level phosphorylation, Reverse TCA cycle, Gluconeogenesis, Pasture effect; Fermentation of carbohydrates: homo and heterolactic fermentations.

SUGGESTED READINGS:

1. Biochemistry by Geoffrey L. Zubay. Fourth Edition, Addison-Wesley educational publishers Inc.,2008.

2. Lehninger: Principles of Biochemistry by David L. Nelson and Michael M. Cox.Fifth Edition, W.H.Freeman and Company; 2008.

3. Biochemistry, (2nd edition) byVoet Donald &Voet Judith G.,John Wiley & sons New York; 1995.

4. Physiology and Biochemistry of Prokaryotes(2nd edition) byWhiteDavid,Oxford University Press, NY;2000.

3. Microbial lipids edited by C. Ratledge and SG Wilkinson, second edition, Academic Press; 1988.

4. Microbial Physiology by Albert G. Moat and John W. Foster. (3rd edition), John Wiley and Sons;2002

5. The Physiology and Biochemistry of Prokaryotes by David White. (2nd edition), Oxford UniversityPress; 2000.
6. Biochemistry by Berg Jeremy, Tymoczko John, StryerLubert 6th Edition, W. H. Freeman, New York.(2001)

MB-103: Molecular Biology

Scheme of examination

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 questions (at least 3 questions from each unit of syllabus). Section B will consist of 9 questions (3 questions from each unit of syllabus). Section C will consist of 6 questions (2 questions from each unit of the syllabus).

Maximum Marks: 50 (40 Paper + 10 Internal) **Duration: 3 Hrs**

Minimum Passing Marks: 13

UNIT-I

Genetic Material : Chemical composition and organization, 3-D structure of DNA, linking number, topological properties, super coiling of DNA, packaging of DNA in pro & eukaryotes. DNA denaturation and renaturation, Coding and non-coding DNA, repetitive DNA sequences, DNA replication and repair mechanism: comparison between prokaryotes and eukaryotes, inhibitors of DNA replication, DNA damage, DNA recombination. Transposons and mechanism of transposition.

UNIT-II

Transcription in pro and eukaryotes, Reverse transcription, inhibitors of transcription, post transcriptional processing. Translation in pro- and eukaryotes, Genetic code. Inhibitors of translation, post translational modifications.

UNIT-III

Mechanism of gene regulation, catabolite repression, Lac and tryptophan operon, ara operon, cis-acting elements, transacting factors, positive and negative regulation, inducers and co-repressors. Negative regulation; regulation by attenuation. Antitermination - Proteins pN, pQ and nut sites,DNA binding sites, Global regulatory responses: heat shock response, stringent response and regulation by small molecules such as ppGpp(p) and cAMP.

SUGGESTED READINGS:

1. Gene IX by Benjamin Lewin, Jones and Bartlett Publishers, Sudbury, Massachusetts, 2007.
2. Molecular Biology by R.F. Weaver , 4th edition, McGraw Hill. New York. USA, 2007.
3. Molecular Biology of the Gene by J.D. Watson, T.A. Baker, S.P. Bell, A. Gann, M. Levin, R. Losick, 6thedition, Benjamin Cummings, San Francisco, USA, 2007.
4. Molecular Biology of the Cell by B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts, P. Walter, 5thedition, Garland Science, New York and London, 2007.

5. Biochemistry (5th edition) by J.M. Berg, J.L. Tymoczko, L. Stryer, W.H. Freeman and Company, New York, USA, 2008.
6. Current Protocols in Molecular Biology Edited by: Fred M. Ausubel; Roger Brent; Robert E. Kingston; David D. Moore; John A. Smith; Kevin Struhl, John Wiley and Sons, Inc. 2007

MB-104: Microbial Genetics and Genetic Engineering

Scheme of examination

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 questions (at least 3 questions from each unit of syllabus). Section B will consist of 9 questions (3 questions from each unit of syllabus). Section C will consist of 6 questions (2 questions from each unit of the syllabus).

Maximum Marks: 50 (40 Paper + 10 Internal) **Duration: 3 Hrs**

Minimum Passing Marks: 13

UNIT-I

Bacterial genome, Plasmids: Structure, classification, copy control, incompatibility, F-factor, col and R plasmids. Gene transfer in bacteria: Transformation, transduction, conjugation (F+, F- and Hfr cells), Genetic map, Genetic mapping of *E. coli.* Mutation*versus* adaptation, Luria Delbruck experiment and significance, Mutagenesis: Spontaneous and induced mutations, deletions, insertion and point mutations, physico-chemical agents of mutation, mutant selection.

UNIT-II

Nucleic Acid Hybridization: Southern, Northern, Western Blotting, DNA finger printing, Foot printing, Gel retardation assay, Restriction endonucleases, Restriction mapping, Polymerase chain reaction, Gel electrophoresis (DNA, RNA and Protein).

DNA and RNA sequencing, (16S-23S rRNA), DNA Probes and their applications, RFLP, RAPD, AFLP, Use of micro arrays to study gene expression.

UNIT-III

Genetic Engineering: Plasmids pBR322, PUC18, phagemids, cosmids, BAC, YAC, Expression vectors, Enzymes (Ligases, topoisomerases, Gyrase, Nuclease), Cloning vehicles, Gene transfer techniques: chemical, electroporation, microinjection, particle bombardment, *Agro- bacterium* mediated gene transfer. Screening of recombinants, Reporter genes. Construction of cDNA and genomic library, Site directed mutagenesis. Applications of genetic engineering in agriculture, industry and medical, Biosafety regulations, Intellectual property rights, Patenting laws in India.

SUGGESTED READINGS:

1. Principles of Gene Manipulation: An introduction to Genetic Engineering by R. W. Old, S. B. Primrose, University of California Press, 1980.

2. Molecular Genetics: An Introductory Narrative by Stent, G.S., Calendar, R. 2nd ed. San Francisco: W.H. Freeman, 1978.
3. Molecular Genetics of Bacteria by Larry Snyder and Wendy Champness, 3rd edition; ASM press; 2007.
4. Fundamental Bacterial Genetics by Nancy Trun and Janine Trempy, 1st edition; Blackwell Science Publishers; 2004.
5. Modern Microbial Genetics by U.N. Streips and R.E. Yasbin, 2nd edition; Wiley Publishers; 2002.
6. Microbial Genetics by Stanly R. Maloy, John E. Cronan, Jr. & David Freifelder, 2nd edition; Narosa Publishing House; 1987.
7. Molecular Biology by David P. Clarke, 1st edition; Elsevier Academic Press; 2005.
8. Molecular Cloning: A laboratory manual by Joseph Sambrook& David Russell, 3rd edition; CSHL press; 2001.
9. DNA Technology: The Awesome Skill by I. Edward Alcamo, 2nd edition; Hardcourt Academic Press; 2001.
10. Molecular Biology of the Gene by James Watson, Tania Baker, Stephen Bell, Alexander Gann, Michael Levine & Richard Losick , 6th Edition; CSHL Press; 2007.

PRACTICALS

Isolation and identification of bacteria by phenotypic and biochemical tests.

Enrichment and isolation of members of Rhodospirillaceae: analysis of photopigments.

Induction of *β*-galactosidase gene in *E. coli.*

Staining techniques.

Growth curve analysis.

Media preparation, sterilization, inoculation and incubation methods.

Microbiological studies of air, water and soil.

Evaluation of antimicrobial chemical agents by log reduction method

Effect of following on the growth of microbes-

(a) Temperature, (b) Aeration, (c) pH, (d) Salts, (e) Nutrients.

Quantitative tests for Carbohydrates, fats, proteins, chlorophyll, Nucleic acids

Isolation of carbohydrates, proteins and fats.

Chromatographic separation methods for pigments and amino acids.

Study of Enzyme kinetics

Preparation of biologically important buffers

Protein purification using various column chromatography, SDS-PAGE and NATIVE PAGE analysis.

Identification and screening of autotrophic mutants of *E. coli* by replica plating

PCR amplification of DNA

Electrophoresis of DNA/RNA/Protein.

Isolation of DNA/RNA from plant, animal cell, bacteria.

Transformation and Conjugation in Bacteria

Restriction digestion, ligation of DNA and cloning in bacteria

Randomly Amplified Polymorphic DNA (RAPD) analysis in bacteria

16SrDNA gene amplification analysis for sequencing

Semester 2

Theory Papers	**Duration**	**Max. Marks**
Paper MB-201	**3 Hrs.**	**40**
Paper MB-202	**3 Hrs.**	**40**
Paper MB-203	**3 Hrs.**	**40**
Paper MB-204 Project/case studies/training		**40**
Combined Practical	**1 Day (6Hrs)**	**75**

MB-201: Virology

Scheme of examination

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 questions (at least 3 questions from each unit of syllabus). Section B will consist of 9 questions (3 questions from each unit of syllabus). Section C will consist of 6 questions (2 questions from each unit of the syllabus).

Maximum Marks: 50 (40 Paper + 10 Internal) **Duration: 3 Hrs**

Minimum Passing Marks: 13

UNIT-I

Virology: Brief outline on discovery of viruses, Classification and nomenclature of viruses: distinctive properties and ultra structure of viruses; DNA and RNA viruses, Replication of different group of viruses; Cultivation of viruses in embryonated eggs, experimental animals and cell cultures.

UNIT-II

Assay of viruses: physical and chemical methods (Protein, nucleic acid, radioactivity, electron microscopy), Infectivity assay (plaque method, end point method). Bacteriophage structural organization; Lytic and lysogenic cycles (molecular mechanisms), bacteriophage typing and its application in bacterial genetics; brief details on M13, Mu, T, Lamda and P1 phage.

UNIT-III

Classifications and nomenclature of plant viruses; brief details of plant viruses like TMV, Cauliflower Mosaic Virus and Potato virus X; transmission of plant viruses.

Classification and nomenclature of animal and human viruses.Brief details of RNA viruses Picorna, Ortho Myxo, Paramyxo, Toga viruses, Rhabdo, Rota, HIV and Oncogenic Viruses; DNA viruses; Pox, Herpes, Adeno SV40; Hepatitis viruses, viral vaccines.

SUGGESTED READINGS:

1. Principles of Virology: Molecular Biology, Pathogenesis and Control of Animal Viruses by S.J. Flint, L.W. Enquist, V.R. Racaniello, and A.M. Skalka 2nd edition, ASM Press, Washington, DC, 2004.
2. Introduction to Modern Virology EPZ by Nigel Dimmock, Andrew Easton and Keith Leppard, 5thedition, Blackwell Publishing, 2005.
3. Human virology by Collier, L H (Leslie Harold), Kellam, Paul; Oxford, J S (John Sidney). 4th ed., Oxford : Oxford University Press, 2011.
4. Basic Virology by Edward K. Wanger, Martinez Hewiett, David Bloom and David Camerini, 3rd edition, Blackwell Publishing, 2007.
5. Principles of Molecular Virology by Alan J. Cann, 3rd edition, Elsevier Academic Press, 2001.
6. Plant Virology by Roger Hull, 4th edition, Academic press, 2002.

MB-202: Bioinstrumentation

Scheme of examination

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 questions (at least 3 questions from each unit of syllabus). Section B will consist of 9 questions (3 questions from each unit of syllabus). Section C will consist of 6 questions (2 questions from each unit of the syllabus).

Maximum Marks: 50 (40 Paper + 10 Internal) **Duration: 3 Hrs**

Minimum Passing Marks: 13

UNIT-I

Microscopy: Principles and use of light microscope, bright-field, dark-field, phase-contrast, fluorescent, electron microscopy (SEM, TEM), confocal microscopy and scanning probe microscopy. Specimen preparation for light microscopy and electron microscopy, staining of specific structures, fixatives and dyes, principle and uses of simple staining and differential staining. Principle and working of instruments used for sterilization.

UNIT-II

Electrophoresis: zonal techniques, supporting medium, vertical, submarine, gradient and two dimensional electrophoresis. Isoelectric focusing. Spectroscopy: Beer-Lambert relationship, components of a spectrophotometer, type of detectors; UV-Vis spectrophotometry, atomic absorption spectroscopy. Applications of spectroscopy.

UNIT-III

Chromatography: Adsorption Chromatography, liquid Chromatography, Gas- liquid Chromatography, Ion exchange Chromatography, Affinity Chromatography, GC-MS, HPLC.

pH meter, Centrifugation: Basic principle, working and application of analytical and preparative centrifuges, Differential, density gradient, zonal and isopycnic.

SUGGESTED READING:

1. Principles and Techniques of Biochemistry and Molecular Biology. (6thEdition) by Wilson K. & Walker J. Cambridge University Press. 2008.
2. Biochemistry (6th edition) by Berg J. M., Tymoczko J. L. &Stryer, L. W.H. Freeman and Company, New York; 2007.
3. Foundations in Microbiology (6th edition) by Talaro K. P. &Talaro A. McGraw-Hill College, Dimensi;2006.
4. Analysis of Biological Molecules: An Introduction to Principles, Instrumentation and Techniques, by Potter G. W. H. & Potter G. W. Kluwer Academic Publishers; 1995.
5. Prescott/Harley/Klein's Microbiology by Willey J., Sherwood L. and Woolverton C. McGraw Hill; 2007.

MB-203: Eukaryotic Microbiology

Scheme of examination

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 questions (at least 3 questions from each unit of syllabus). Section B will consist of 9 questions (3 questions from each unit of syllabus). Section C will consist of 6 questions (2 questions from each unit of the syllabus).

Maximum Marks: 50 (40 Paper + 10 Internal) **Duration: 3 Hrs**

Minimum Passing Marks: 13

UNIT-I

General Characteristics and Life Cycle of important Fungi- *Dictyostelium, Rhizopus, Saccharomyces, Candida, Trichoderma, Penicillium, Gliocladium, Fusarium, Helminthosporium, Alternaria, Albugo.* Fungal endophytes of tropical plants and their applications: Endophytic fungi, colonization and adaptation of endophytes. Agriculturally important toxigenic fungi: Biodiversity, toxigenic fungi in sustainable agriculture with special emphasis on biopesticides.

UNIT-II

Mycorrhizal fungi: Diversity of endo- and ectomycorrhizal fungi. Biology of arbuscular mycorrhizal fungi: signaling, penetration and colonization inside roots, culturing and benefits, recent advances in the field of mycorrhiza. Biotechnological applications of yeasts: Yeasts as producers of bioactive molecules such as pigments, lipids, organic acids and EPS, yeasts as probiotics, yeasts in bioremediation, yeasts in alcoholic fermentations.

UNIT-III

General Characteristics and Life Cycle of important Algae- *Volvox* and *Chlamydomonas, Sargassum* and *Fucus, Gracileria* and *Gelidium*. Algal diversity from morphology to molecules:

Importance of algae in production of algal pigments, biofuels, hydrogen production, important bioactive molecules, role of algae in sustainable environment. Important Protozoa- *Entamoeba, Trypanosoma, Plasmodium, Coccidia.*

SUGGESTED READINGS:

1. Fundamentals of the fungi by Elizabeth Moore, Fourth edition, Benjamin Cummings; Landecker;1996.
2. Mycotechnology: Present status and future prospects. Edited by MahendraRai.I.K., International Publishing House Pvt. Ltd.; 2007.
3. The Yeast Handbook: Biodiversity and Ecophysiology of yeasts by Carlos A. Rosa and Gabor Peter. Springer- Verlag Berlin Heidelberg; 2006.
4. Algae: Anatomy, Biochemistry and Biotechnology by Laura Barsanti and Paolo Gualtieri. Taylor and Francis Group, LLC; 2006.

MB-204: Industrial and Food Microbiology

Scheme of examination

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 questions (at least 3 questions from each unit of syllabus). Section B will consist of 9 questions (3 questions from each unit of syllabus). Section C will consist of 6 questions (2 questions from each unit of the syllabus).

Maximum Marks: 50 (40 Paper + 10 Internal) **Duration: 3 Hrs**

Minimum Passing Marks: 13

UNIT-I

Introduction to fermentation processes, history of fermentation process.

Bioreactors: Design and components- vessel materials, baffles, impellers, inoculation and sampling devices, biosensors etc., biohazard and containment. Types of bioreactors: airlift, fluidized bed, micro carrier, photo bioreactor, stirred bioreactor. Immobilization of cells and its industrial application (Pharmaceutical, food and chemical industries).

UNIT-II

Isolation, selection, screening, preservation and maintenance of industrially important microorganisms.

Formulation of fermentation media: energy source, water, nitrogen source, minerals, chelators, growth factors, buffers, precursors, inhibitors and antifoam agents, Optimization of media. Media and air sterilization. Types of fermentation processes with kinetics: Batch, continuous and fed batch. Downstream processing: foam separation, cell disruption, industrial scale centrifugation, liquid-liquid extraction, solvent recovery, chromatography, two phase aqueous extraction, drying and crystallization.

UNIT-III

Production process for Yeast (Bakers, food and fodder), Single cell protein (SCP), Single cell and Single cell oil (SCO), lactic acid, Beer, Wine, Whisky, Sauerkraut, Bread, amylases and proteases, penicillin, streptomycin, Riboflavin, Production of non-microbial product through GEMs: insulin, cell growth factors, tissue plasminogen activator. Bioplastic (PHB, PHA), Steroid transformation. Production of bioinsecticides. Vaccine types: live, attenuated and recombinant and their production.

SUGGESTED READINGS:

1. Biotechnology: A Text Book of Industrial Microbiology by W. Crueger & A. Crueger, Panima Publishing Corporation, New Delhi/Bangalore, 2000.
2. Principles of Fermentation Technology by P.F. Stanbury, W. Whitaker &S.J. Hall, Aditya Books (P) Ltd., New Delhi, 1997.
3. Modern Industrial Microbiology & Biotechnology by N. Okafer, Scientific Publishers, Enfield, USA.,2007.
4. Fermentation Microbiology and Biotechnology by El Mansi & Bryce, Taylor & Francis, London, Philadelphia, 1999.
5. Fermentation Biotechnology by O.P. Ward, Open University Press, Milton Keynes, U.K., 1989
6. Industrial Microbiology: An Introduction by Waites, Morgan, Rockey& Highton, Blackwell Science, 2001.
7. Biochemical Engineering and Biotechnology by B. Atkinson & F. Mavituna , The Nature Press, 1982
8. Microbial Biotechnology: Fundamentals of Applied Microbiology by Glazer & Nikaido , W.H. Freeman and Co., New York, 1995.
9. Modern Food Microbiology, 4th edition by J.M. Jay, Springer, 2006.
10. Fundamental Food Microbiology, 3rd edition by B. Ray., CRC press, 2006.
11. Food Microbiology: Fundamentals and Frontiers, 2nd edition by Michael P. Doyle, Larry R. Beuchat, Thomas J. Montville, ASM press, 2001.
12. Food Microbiology by M.R. Adams & M.O. Moss., Royal Society of Chemistry, 2000.
13. Food Microbiology by M.R. Adams, Royal Society of Chemistry, 2008.

PRACTICALS

Chick embryo inoculation for viruses.
Estimation of infectivity titre of a virus sample using Plaque assay.
Production of purified virus stock and its quantification.
Study of virus infected plant material.
Isolation of Probiotic bacteria from milk and curd
Isolation and identification of important Algae and Fungi.
Morphology of important Protozoa and Viruses.
Study of dimorphism in yeast
Testing of milk by MBRT.
Isolation and cultivation of fungi and protozoa.

Microbial examination of food and milk

Sample collection and biomass determination for small scale fermentation

To determine the specific growth rate and generation time of a bacterium during submerged fermentations.

To determine R: S ratio of bacteria by CFU counts.

To determine phenol coefficient

To determine Thermal death time and thermal death point.

To check the calibration of spectrophotometer

To check and verify Lambert- Beer Law

To find out the λ-max (absorption spectra) of $K_2Cr_2O_7$, $CuSO_4$, proteins and nucleic acids.

To grow yeast and fungus in artificial medium and to calculate the yield and productivity of biomass produced.

To make wine from different juices by fermentation.

To demonstrate production of sauerkraut and cheese.

To investigate heavy metals/pesticides etc. in the given food and water sample.

MASTER OF SCIENCE IN MICROBIOLOGY

Semester 3

Marking Scheme for External

Theory Papers	Duration	Max. Marks
Paper MB-301	**3 Hrs.**	**40**
Paper MB-302	**3 Hrs.**	**40**
Paper MB-303	**3 Hrs.**	**40**
Paper MB-304	**3Hrs.**	**40**
Combined Practical	**1 Day (6Hrs)**	**75**

MB-301: Microbial Ecology and Environmental Biotechnology

Scheme of examination

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 questions (at least 3 questions from each unit of syllabus). Section B will consist of 9 questions (3 questions from each unit of syllabus). Section C will consist of 6 questions (2 questions from each unit of the syllabus).

Maximum Marks: 50 (40 Paper + 10 Internal) **Duration: 3 Hrs**

Minimum Passing Marks: 13

UNIT-I

Aero Microbiology : Droplet nuclei, aerosol, assessment of air quality, solid - liquid impingement methods, **Aquatic microbiology:** Water ecosystems - types, fresh water (ponds, lake, streams) - marine

habitats (estuaries, mangroves, deep sea, hydrothermal vents, saltpans, coral-reefs). Potability of water- microbial assessment of water quality- water purification. Brief account of major water borne diseases.

UNIT-II

Inter species interactions: Antagonism, competition, commensalisms, synergism, parasitism and predation. Gause and Hardin's principles of competition. Rumen microbiology, digestion, fermentation and detoxification by microbes, factors influencing rumen microbes. Microbial ecology: Concepts, microbial behavior in ecosystems, microbial biodiversity, interaction among the microbial populations, development of microbial communities. Oxidative transformation of metals: sulfur oxidation, iron oxidation, ammonia oxidation and hydrogen oxidation.

UNIT-III

Waste water treatment : Wastes - types- solid and liquid wastes characterization- solid - liquid; treatments- physical, chemical, biological- aerobic- anaerobic -primary - secondary- tertiary(trickling- activated sludge- oxidation pond- oxidation ditch). Subterranean microbes and bioremediation. Biodeterioration and biodegradation of paints, plastics, rubber, paper, leather, wood, wool, degradation of xenobiotics, pesticides and polymers.

SUGGESTED READINGS:

1. Microbial Ecology By Atlas R.M., Bartha R., Benjamin Cummings Publishing Co, Redwood City, CA.,1993.
2. Environmental Microbiology by A.H. Varnam& M.G. Evans, Manson Publishing Ltd., 2000.
3. Manual of Environmental Microbiology by Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, DavidA. Lipson, Aaron L. Mills, ASM Press, 2007.
4. Environmental Microbiology by W.D. Grant & P.E. Long, Kluwer Academic Publishers, 1981.

302: Soil and Agricultural Microbiology

Scheme of examination

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 questions (at least 3 questions from each unit of syllabus). Section B will consist of 9 questions (3 questions from each unit of syllabus). Section C will consist of 6 questions (2 questions from each unit of the syllabus).

Maximum Marks: 50 (40 Paper + 10 Internal) **Duration: 3 Hrs**

Minimum Passing Marks: 13

UNIT-I

Soils: Origin and evolution, soil profiles. Major physiochemical and biological characteristics. Soil microflora: distribution and contribution to ecosystem.

Biogeochemical cycles: Carbon cycle, Nitrogen Cycle, Phosphorus cycle, Sulphur cycle, Iron and Manganese cycle. Bioleaching and biomining. Agricultural and urban waste compost, vermicompost,

mushroom compost, silage, methane production, biogas plants. Microbiology of Rhizospheres, phyllosphere and spermosphere,

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UNIT-II

Plant Diseases: Physiology of parasitism, mechanism of disease resistance, host parasite relationship. Symptomatology and control measure of various diseases.

Viral diseases: TMV, Yellow vein mosaic of Bhindi, and Papaya leaf curl.

Bacterial diseases: Citrus canker, Crown gall

Fungal diseases: Green ear of bajra, Wheat rusts and Loose and Covered smuts.

Mycoplasmal diseases: Witches broom of potato, Stripe disease of sugarcane

UNIT-III

Biofertilizers: Production technology, standards, storage and application methods for *Rhizobium, Azotobacter, Azospirillium*, Cyanobacteria, *Azolla.* Biological nitrogen fixation - nitrogenase enzyme - nif genes; symbiotic nitrogen fixation - (*Rhizobium, Frankia*)- non-symbiotic microbes- *Azotobacter-Azospirillium* PSM, Cellulolytes, VAM and PGPR. Microbial pesticides: biology and chemistry of the biocidal component, mode of action, effect on target organisms, production technology. Microbial insecticides; advantages of microbial insecticides, limitations-Mass production techniques; fermentation, formulation of insecticides, carrier materials quality control etc.

SUGGESTED READINGS:

1. Plant Pathology by Agrios G. N. Academic Press, San Diego;1997.
2. The Nature and practice of Biological Control of Plant Pathogens by Cook R. J. & Baker K. F.; 1983.
3. Amereca Phytopathological Society Press, St. Paul, MN.
4. Environmental Biotechnology by Forster C. F. & John D.A. Ellis Horwood Ltd. Publication;2000.
5. A Manual of Environmental Microbiology by Christon J. H. ASM Publications;2001.
6. Soil Microbiology by Rao, N.S.S. Oxford & IBH Publishing Co., New Delhi;1999.

MB-303: Medical Microbiology

Scheme of examination

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 questions (at least 3 questions from each unit of syllabus). Section B will consist of 9 questions (3 questions from each unit of syllabus). Section C will consist of 6 questions (2 questions from each unit of the syllabus).

Maximum Marks: 50 (40 Paper + 10 Internal) **Duration: 3 Hrs**

Minimum Passing Marks: 13

UNIT-I

Early discovery of pathogenic microorganisms. Pathogenicity and virulence; Quantitative measures of virulence: minimal lethal dose (MLD), LD 50 , ID 50, TCID 50. Normal microbial flora of human body; role

of the resident flora. Nosocomial infection, common types of hospital infections and their diagnosis and control. Establishment, spreading, tissue damage and anti- phagocytic factors; mechanism of bacterial adhesion, colonization and invasion of mucous membranes of respiratory, enteric and urogenital tracts.

UNIT-II

Important diseases of human beings (short description of causal agent, pathogenesis, diagnosis and treatment)

Bacterial diseases: Typhoid, Syphilis, Cholera, Gonorrhoeae, Tuberculosis, Diphtheria, Tetanus, Plague, Botulism, Meningitis, Pneumonia, Enteritis.

Viral diseases: Influenza, Herpes, AIDS, Rabies, SARS, Human Pox, Yellow fever, Mumps and Measles.

Fungal diseases: Ringworm, Toxoplasmosis.

Important bacterial (Anthrax, Black quarter, Tuberculosis, Brucellosis) **and viral (**Foot and mouth disease, Rinderpest, Cow pox, Rabies) **diseases of domestic animals**, their causal agents, epidemiology, pathogenesis, diagnosis, vaccine and treatment).

UNIT-III

Antimicrobial therapy; Antibiotics and their classification, mode of action, Antimicrobial resistance: Multidrug efflux pumps, X- MDR *M. tuberculosis*, Methicillin-resistant *S. aureus* (MRSA), various methods of drug susceptibility testing, antibiotic assay in body fluids. Brief account on available vaccines and schedules. Coordinated regulation of virulence genes, two component signal transudation systems, type 1-IV secretion systems, biofilms and quorum sensing.

SUGGESTED READINGS:

1. Jawetz, Melnick, & Adelberg's Medical Microbiology by Brooks GF, Butel JS, Morse SA, Melnick JL,Jawetz E, Adelberg EA . 23rd edition. Lange Publication. 2004.

2. Cellular Microbiology by Cossart P, Boquet P, Normark S, Rappuoli R eds. 2nd edition. American Societyfor Microbiology Press. 2005.

3. Bacterial Pathogenesis: A molecular approach by Salyers AA and Whitt DD eds. American Society forMicrobiology Press, Washington, DC USA. 2002.

4. Pathogenomics: Genome analysis of pathogenic microbes by Hacker J and Dorbindt U. ed. Wiley-VCH.2006.

5. Molecular Microbiology: Diagnostic Principles and Practice by Persing DH, Tenover FC, Versalovic J,Tang Y, Unger ER, Relman DA, White TJ eds. American Society for Microbiology Press, 2004.

6. Infectious Disease Epidemiology: Theory and Practice by Nelson KE, Williams CM,
Graham NMH eds. An Aspen Publication. 2001.

MB 304: Immunology

Scheme of examination

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 questions (at least 3 questions from each unit of syllabus). Section B will consist of 9 questions (3 questions from each unit of syllabus). Section C will consist of 6 questions (2 questions from each unit of the syllabus).

Maximum Marks: 50 (40 Paper + 10 Internal) **Duration: 3 Hrs**

Minimum Passing Marks: 13

UNIT-I

Historical background: Humoral and Cellular components of the immune system. Innate Immunity: Skin & mucosal surface, Physiological Barriers, Phagocytic barriers, Inflammation, Adaptic immunity. Cells and Organs of Immune System. Antigens: Structure, properties, types, epitopes, haptens. Immunogens, Adjuvants.

UNIT-II

Antibodies: Structure, function and diversity, antibody mediated functions, classes and biological activities. Monoclonal antibodies. Antigen-Antibody Interaction. Major Histocompatibility Complex-structure, functionsand genes. Cytokinesis (Properties, receptors, antagonism & secretion). The complement system (functions, components, activation, regulation and deficiencies). Cell mediated effecter responses: Cytotoxic T-cells, natural killer cells, antibody-dependent cell-mediated cytotoxicity.

UNIT-III

Hypersensitive reactions (Type I,II,III and delayed type (DTH). Immune response to infectious diseases: viral, bacterial and protozon. Vaccines.Immuno-deficiencies.

Transplantation; Graft rejection, mechanism and prevention, HLA and disease**.**

Autoimmunity; Organ specific and systemic,Autoantibodies, experimental models

SUGGESTED READINGS:

1. Kuby Immunology by Kindt TJ, Goldsby RA, Osborne BA, Kuby J: 6th edition. New York. WHFreeman; 2006.

2. Cellular and Molecular Immunology by Abbas AK, Lichtman AH, Pillai S: Saunders Elsevier; 2007.

3. Immunobiology: The immune system in health and disease by JanewayCA,TraversP,Walport M,Shlomchik MJ: 6th edition. New York. Garland Science Publishing; 2005.

4. Medical Microbiology and Immunology by Levinson W, Jawetz E: Lange publication; 2001.

5. Fundamental Immunology by Paul WE: 4th edition. New York. Raven Press; 2000.

6. Roitt's Essential Immunology by Delves PJ, Martin SJ, Burton DR, Roitt IM; 11th edition. Blackwell Publishing/Oxford Univ. Press; 2006.

PRACTICALS

Study of coliform bacteria in water samples from different sewage sources

Study of decolouration of distillery or textile industrial waste.

Study of microbial degradation of hydrocarbons(s) or pesticide(s).

Study of fungal degradation of wood.

Study of Bacterial interactions (antagonism etc)

Isolation and cultivation of *Azotobacter, Rhizobium, Azospirillum, Cyanobacteria, Actinomycetes, Mycorrhiza.*

Biofertilizer production using *Rhizobium*

Biofertilizer production using Mycorrhiza

Soil analysis for various parameters like moisture content, water holding capacity, Micro and macronutrients like carbon, nitrogen, carbonates etc

Determination of following enzyme activities in the soil sample: amylase, cellulose, xylanase, protease and phosphatase.

Laboratory methods for studying soilborne diseases

a. Isolation of soilborne pathogen

c. Chemical control of soilborne pathogens using acylanilide and alkyl phosphonates.

Bacterial diseases of food plants

a. Isolation of pathogenic bacteria from rotten vegetables and fruits

b. Biochemical and physiological tests for detection of pathogens in vegetables and fruits

To study normal micro-flora of Skin, Respiratory tract, Gastro-intestinal tract, uro-genital tract.

To study cultural characteristics of pathogenic bacteria on various selective and differential media.

To study pathogenicity of *Staphylococcus aureus* by coagulase test.

To study antimicrobial susceptibility using an octadisc.

To determine the minimal inhibitory concentration (MIC) of an antibiotic on bacteria and fungi

Determination of Blood group and Rh factor.Blood cell counts. Serological tests: Radio immuno-diffusion, Immuno-electrophoresis, DOT ELISA, Sandwich ELISA,

Ochterlony double diffusion, agglutination test, Fluorescent Antibody test.

Semester 4

Theory Papers	**Duration**	**Max. Marks**
Paper MB-401	**3 Hrs.**	**40**
Paper MB-402	**3 Hrs.**	**40**
Paper MB-403	**3 Hrs.**	**40**
Paper MB-404 Project/case studies/training		**40**
Combined Practical	**1 Day (6Hrs)**	**75**

Students are advised to complete Dissertations preferably in some outside research institute/industry or otherwise in the University in the first 45 days starting from the beginning of the session.

MB-401:Biostatistics

Scheme of examination

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 questions (at least 3 questions from each unit of syllabus). Section B will consist of 9 questions (3 questions from each unit of syllabus). Section C will consist of 6 questions (2 questions from each unit of the syllabus).

Maximum Marks: 50 (40 Paper + 10 Internal) **Duration: 3 Hrs**

Minimum Passing Marks: 13

UNIT-I

Definition of statistics, symbols, notations and terminology of statistics: Sampling and estimation of population parameters, Random sampling, Sampling size in random sampling, stratified two stage cluster and sequential sampling, Bias in sampling. Presentation of research results, Graphic presentation.

UNIT-II

Interval Data: Construction of a histogram, interpretations of histogram, the normal distribution, the mean, mode, median and standard deviation, representing the normal curve, Chi square test, goodness of fit. Count data: examples of count data (bacterial cell count, radioactivity, colony and plaque counts), statistical treatment to count data. Poisson distribution, Standard error, confidence limits of counts.

UNIT-III

Simple Probability: Regression and Correlation, simple linear regression, Coefficient of determination. Brief introduction to the need and application on curvilinear and multiple regression. Use of partial correlation and partial covariance. Detecting association between a pair of species. Cole's measure of association and point correlation coefficient.

Statistical basis of biological assays: Response-Dose relationship, direct and indirect assay, statistical analysis of LD50.

SUGGESTED READINGS:

1. Sampling Techniques by Cochran W. G., Wiley estern Ltd, New Delhi.

2. Fundamentals of Biostatistics, by Irfan Ali Khan and Atiya Khanum, (2nd edition). Ukaaz Publications, Hyderabad.

3. Introduction to probability theory and its applications, by Fellller W., Asia Publishing House, Mumbai.

4. An introduction to Biostatistics by Glover T. and Mitchell K., McGraw-Hill , N.Y; 2002.

5. Fundamentals of statistics. Goon, Gupta and Dasgupta- World Press, Kolkota.

6. Design and analysis of experiments by Montgomery D. C., John Wiley and Sons.

7. Biostatistics, a foundation for analysis in the health Sciences, (7th edition),Wayne Daniel; 2007.

PRACTICALS:-

1. Exercises based on mean, median and mode.
2. Exercises based on standard deviation.
3. Exercises based on count data (bacterial cell count, colony and plaque count).
4. Determination of response-dose relationship.
5. Direct and indirect assay of enzymes, drugs etc.

MB-402: Bioinformatics and Computer Applications

Scheme of examination

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 questions (at least 3 questions from each unit of syllabus). Section B will consist of 9 questions (3 questions from each unit of syllabus). Section C will consist of 6 questions (2 questions from each unit of the syllabus).

Maximum Marks: 50 (40 Paper + 10 Internal) **Duration: 3 Hrs**

Minimum Passing Marks: 13

UNIT-I

Bioinformatics: Introduction, objectives. Bioinformatics and data analysis. Database concept, elementary knowledge of structure query language. Microbiological and Virology databases, cell gene banks related sites, biodiversity information databases.

UNIT-II

Metabolic pathway engineering. Genome analysis. DNA/Genome sequencing. Finding and retrieving sequences. Sequence data base. Submission of sequence to databases. Sequence formats. Protein and nucleic acid sequence database, Identifying protein sequence from DNA sequence.

UNIT-III

Computer applications: Computers and their organization, Hardware, software, operating system (Command line and WIMP) Application packages for microbiologists, Data processing and presentation (Spreadsheet and Statistical analysis) LIMS, computer graphics, Computer : CAL in microbiology, Use of computer as audio visual aid.

SUGGESTED READINGS:

1. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins by Baxevanis A.D. and Ouellette, Third Edition. John Wiley and Son Inc., 2005.
2. Bioinformatics Sequence and Genome Analysis by Mount D.W., CSHL Press, 2004.
3. Introduction to Bioinformatics by Tramontano A., Chapman & Hall/CRC, 2007.
4. Understanding Bioinformatics by Zvelebil, M. and Baum, Chapman & Hall/CRC, 2008.
5. Bioinformatics: Methods Express By: Paul H Dear, Scion Publishing Ltd, 2007
6. Bioinformatics: Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor Laboratory, 2004.

PRACTICALS:-

1. Usage of NCBI, PUBMED resources
2. Retrieval of DNA and Protein sequence from online databases
3. Construction of phylogenetic tree
4. Visualization of protein secondary structures
5. Exercise based on BLAST
6. Multiple sequence alignment using Clustal X Software
7. Softwares for Gene identification

MB-D: Research Project/Case Study

Scheme of examination

The student shall prepare a report of his/her work carried out as mentioned below and shall present it to the external examiner. The examiner will evaluate the work carried out and shall award the marks accordingly.

Maximum Marks: 80 **Duration: 10 min per student**

Minimum Passing Marks: 20

The student will select a topic of research in consultation with his/her supervisor/guide to do a research work or carry out a case study on any topic related to microbiology or allied sciences.