SCHEME OF EXAMINATION
RULES & REGULATIONS
AND
SYLLABUS

(Applicable for Academic Session 2023-2024)

Master of Science (M.Sc.)
Microbiology

Faculty of Science

UNIVERSITY OF KOTA

MBS Marg, KOTA (Rajasthan)-324 005
INDIA

CONTENTS

University of Kota, Kota

M.Sc. Microbiology

Semester wise Consolidated Common Scheme of Examinations for the Academic Sessions 2022-2023

Year / Semester	Number, Code or ID and Nomenclature of Paper			Duration of Exam. (in Hrs.)	Teaching Hrs / Week			Distribution of Assessment Marks					
	Number of Paper	Code / ID of Paper	Nomenclature of Paper					Continuous or Internal Assessment (30%)		Semester or External Assessment (70%)		Total	
					Teaching		Credit Point	Max. Marks	Min. Pass Marks	Max. Marks	Min. Pass Marks	Max. Marks	Min. Pass Marks
					Th.	Pr.							
1st Year I Semester	Paper-1.1	MB-511	General Microbiology	3	4	-	4	30	12	70	28	100	40
	Paper-1.2	MB-512	Cell Biology and Enzymology	3	4	-	4	30	12	70	28	100	40
	Paper-1.3	MB-513	Microbial Genetics	3	4	-	4	30	12	70	28	100	40
	Paper-1.4	MB-514	Biochemistry and Microbial Physiology	3	4	-	4	30	12	70	28	100	40
	Paper-1.5	MB-515	Lab Course-I	6	-	8	4	--	--	100	50	100	50
	Paper 1.6	MB-516	Lab Course-II	6		8	4	--	--	100	50	100	50
	Total (I Semester)			**24**	**32**		24	**120**	**48**	**480**	**212**	**600**	**260**
1st Year II Semester	Paper-2.1	MB-521	Microbial Diversity	3	4	-	4	30	12	70	28	100	40
	Paper-2.2	MB-522	Molecular Biology	3	4	-	4	30	12	70	28	100	40
	Paper-2.3	MB-523	Immunology and Immunotechnology	3	4	-	4	30	12	70	28	100	40
	Paper-2.4	MB-524	Tools and Techniques in Microbiology	3	4	-	4	30	12	70	28	100	40
	Paper-2.5	MB-525	Lab Course-III	6		8	4			100	50	100	50
	Paper 2.6	MB-526	Lab Course-IV	6		8	4			100	50	100	50
	Total (II Semester)			**24**	**32**		**24**	**120**	**48**	**480**	**212**	**600**	**260**
2nd Year III Semester	Paper-3.1	MB-631	Microbial Ecology and Environmental Microbiology	3	4	-	4	30	12	70	28	100	40
	Paper-3.2	MB-632	Fermentation Technology & Bioinformatics	3	4	-	4	30	12	70	28	100	40
	Paper-3.3	MB-633	ELECTIVE I 1. Biofuel and Bioenergy 2. Pharmaceutical microbiology	3	4	-	4	30	12	70	28	100	40
	Paper-3.4	MB-634	ELECTIVE II 1. Antimicrobial Resistance 2. Microbial nanotechnology	3	4	-	4	30	12	70	28	100	40
	Paper-3.5	MB-635	Lab Course-V	6	-	8	4	--	--	100	50	100	50
	Paper-3.6	MB-636	Lab Course-VI (Based on electives I & II)	6		8	4			100	50	100	50
	Total (III Semester)			**24**	**32**		**24**	**120**	**48**	**480**	**212**	**600**	**260**
2nd Year IV Semester	Paper-4.1	MB-641	Industrial Microbiology/Medical Microbiology	3	4	-	4	30	12	70	28	100	40
	Paper-4.2	MB-642	Research Methodology, IPR & Bioethics	3	4	-	4	30	12	70	28	100	40
	Paper-4.3	MB-643	Lab Course-VII	6	-	8	4	--	--	100	50	100	50
	Paper-4.4	MB-644	Comprehensive viva voice	3	-		4	--	--	100	50	100	50
	Paper-4.5	MB-645	Dissertation	3	-		8	--	-	200	100	200	100
	Total (IV Semester)			**16**	**16**		**24**	**60**	**24**	**540**	**256**	**600**	**280**
Grand Total (I + II + III + IV Semester)				**88**	**112**		**96**	**420**	**168**	**1980**	**892**	**2400**	**1060**

M.Sc. Microbiology

Third Semester Examination

Paper 3.1 MB-631– Microbial Ecology and Environment Microbiology

Contact Hours / Week : 4 Hours	Maximum Marks	: 100 Marks
Duration of Examination: 3 Hours	Continuous/Internal/Assessment	: 30 Marks
	Semester Assessment	: 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into three sections.*

- **Section-A** will carry 10 marks with 01 compulsory question comprising 10 short answer type questions (maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.
- **Section-B** will carry 25 marks with equally divided into five long answer type questions (answer about in 250 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.
- **Section-C** will carry 35 marks with five long answer type questions comprising one compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 500 words) and any two more questions (answer about in 400 words) out of remaining four questions. Paper setter shall be advised to design question paper covering from all five units.

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

UNIT I 15-18L

Soil: Soil Profile, Microorganism, Fertility, Rhizosphere & Phyllosphere. Biogeochemical cycles, Biological nitrogen fixation.
Microbial ecology: Concept of habitat and niche. Concept of population and community.
Development of microbial communities & diversity analysis. Microbial growth curve representing r and k reproductive strategies. Planktonic growth and Biofilm formation. Concept of plant probiotics.

UNIT II 15-18L

Microbial interactions. Microbiology of extremophiles (Stress microbiology): Stress sequestration in halophiles, osmophiles, thermophiles, xerophiles, barophiles. Heavy metal detoxificants.
Quantitative microbial ecology: Modern and conventional methods used to study microorganism, (sampling procedure, microbial enumeration, biomass determination).

UNIT III 15-18L

Biofertilizers: Definition, types- Nitrogen fixing, Phosphate solubilizing and cellulolytic microbes, mass production of bacterial inoculants (*Rhizobium, Azotobacter, Azospirillum, cyanobacteria*) mode of action, advantages and limitations.
Biopesticides: Bacterial, viral, fungal and protozoan, mode of action, factors influencing, genes involved in production technology. Mycorrhiza: Types and their application. Lichen.

UNIT IV **15-18L**

Introduction of environmental microbiology. Applications of microbes in solving environmental pollution problems.
Bioaccumulation of metals and detoxification, biosorption, scavenging.
Bioaugmentation: Pollution, wastes, their types and characterization. Methods of treatment-Physical, chemical, biological (Oxidation ponds, HRABP, ASP, Trickling Filter, Fluidized Bed Reactor, Biogas, Rotating contactor).
Nanotechnology: Concept, scope and their role in pollution abatement. Biosensors for environment monitoring

UNIT V **15-18L**

Bioremediation techniques: *In situ* and *ex-situ.* Use of GEMs in bioremediation.
Biodeterioration: Role of microbes in wood, pulp and paper.
Biodegradation: Xenobiotics, hydrocarbons, pesticides and plastics.
Biomonitoring: Microorganisms as bioindicators and applications of bioindicators. Role of *Dianococcus radiodurans* in disposal of radioactive waste material and its future in environmental biotechnology.

Recommended Books:

1. Soil Microbiology by Prof. N.S. Subba Rao, Fourth edition, Oxford and IBH Publishing CO. PVT., LTD., New Delhi
2. P.D. Sharma. 2006. Plant pathology. Alpha Science International.19.
3. Modern Soil Microbiology, Dirk J, Elas V, Trevors JT, Wellington, EMH (1997) Marcel Dekker INC, New York.
4. Robert, S. Burlage Ronald Maltus, 1998. Techniques in Microbial Ecology. ASM Press.
5. Larry Barton, Diana E. Northup, 2011. Microbial Ecology. John Publisher, Academic Press.
6. Environmental microbiology: principles and applications by Patrick K. Jemba. Science publisher, 2004.
7. Environmental microbiology by P. D. Sharma, Alpha Sciences international, 2005.
8. Environmental microbiology, second edition, by Ralph, Ji Doug Gu, Wiley.
9. Atlas R M and Bartha, 1993. Microbial Ecology, Bejaminn Cummings Publishing Co. Redwood City CA
10. Environmental microbiology by Ian Papper and Charles Gerba, Elsevier Press.
11. Environmental microbiology by Rose Vol III-IV, 1999
12. Practical microbiology, third edition, by Dubey, D K. Maheswari, S. Chand publishers, 2012
13. Advances in applied Bioremediation, Springer.
14. Alexander M 1971. Microbial Ecology. John Wiley & Sons Inc., New York.
15. Eldowney Ec S., Hardman DJ. and Waite S 1993. Pollution: Ecology and biotreatment. Longman Scientific Technical.
16. Baker KH and Herson DS 1994. Bioremediation. Mc Graw Hill Inc., New York.

M.Sc. Microbiology

Third Semester Examination

Paper 3.2 MB-632–Fermentation Technology & Bioinformatics

Contact Hours / Week	: 4 Hours	Maximum Marks	: 100 Marks
Duration of Examination	: 3 Hours	Continuous/Internal/Assessment	: 30 Marks
		Semester Assessment	: 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into three sections.*

- **Section-A** will carry 10 marks with 01 compulsory question comprising 10 short answer type questions (maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.
- **Section-B** will carry 25 marks with equally divided into five long answer type questions (answer about in 250 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.
- **Section-C** will carry 35 marks with five long answer type questions comprising one compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 500 words) and any two more questions (answer about in 400 words) out of remaining four questions. Paper setter shall be advised to design question paper covering from all five units.

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

UNIT- I **15-18L**

Introduction to fermentation technology: History, Scope and Development of Fermentation technology. Microbial culture selection for fermentation processes. Strain improvement: Mutant selection and Recombinant DNA technology.

Preservation and maintenance of industrially important microbes.

UNIT –II

15-18L

Inoculum development for industrial fermentation & Microbial Kinetics: Introduction, Criteria for transfer of inoculum, development of inoculum for bacterial processes, yeast processes and mycelial processes. Inoculum development for plant fermenter, aseptic method of inoculation, achievement, and maintenance of aseptic conditions. Fermentation Material and Energy balance, Microbial growth kinetics: Microbial growth cycle, measurement of growth, Batch culture, continuous culture, fed-batch culture, applications, and examples. Design of fermenter/ bioreactors- Design aspects of flask, Stirred tank reactor, Air-lift fermenter, Tower fermenter, Kinetics of operation of bioreactors, Batch, Fed-batch, Continuous processes, Design and operation of immobilized cell reactors.

UNIT III **15-18L**

Fermentation media Natural and Synthetic media; Basic components of a media (Carbon sources; Nitrogen sources; Vitamins; Minerals; Anti-foaming agents); Role of buffers in media. Media formulation and process optimization.Process of aeration, and agitation. Aeration-Theory of oxygen transfer in bubble aeration, Oxygen transfer kinetics, determination of KLa, Agitation-Design of impellers and their hydrodynamics, Fermentation

broth rheology and power requirements for agitation-Concept of Newtonian and non-Newtonian fluids, effect of broth rheology on heat, nutrient and oxygen transfer, Reynolds number, power number, aeration number.

UNIT-IV **15-18L**

Bioinformatics: An overview, introduction and scope of bioinformatics. Databases: Characteristics, categories and types (Genome database, Literature database, Disease database, Sequence database, Structure database, PDB). Information retrival system (Entrez, SRS). Data mining tools: Modelling tools (Rasmol, SPDV, HyperChem), Data submission tools (Bankit, Sequin, Webin, Sukura, Spin, AutoDep).

UNIT-V **15-18L**

Algorithms: Classification of algorithms. Sequence Comparison algorithms. Submission metrics algorithms, Tools for sequence alignment. Gene Prediction: Methods, Gene mapping: DNA sequencing, Sequence alignment optimal algorithms. Tools for Genome analysis. Phylogenetic analysis: Phylogenetic trees. Methods of phylogenetic evaluation. Prediction tools Proteomics: Proteome analysis, Tools for Protein sequence analysis and proteomics, structure analysis. Molecular descriptors in QSAR studies, Small molecule force field parameters (charges), potentials, Active site identification, ligand docking, Drug stability, synthesizability and drug delivery. Steps and software of drug designing.

Books/ References

1. Whitaker; Stanbury, Peter F; Hall, S.; Whitaker, A. Principles of Fermentation Technology, Second Edition (9780750645010) by Robert W. Hutkins. Microbiology and Technology of Fermented Foods.
2. D. W. Mount; Bioinformatics-Sequence and genome analysis; Cold Spring Harbour Lab press. 2001.
3. B.N. Mishra; Bioinformatics: Concept and application, Pearson Education (in press) 2020.
4. O' Reilly; Developing Bioinformatics computer skills-1stIndian edition, SPD publication. 2001.
5. Anthony J.F. Griffiths et al; An introduction to genetic analysis, 1stEd 1976.
6. Michael Starkey and Ramnath Elaswarapu; Genomics protocols, Humana press.
7. Peter F Stanbury, Allan Whitaker, Stephen J Hall. Principles of Fermentation Technology. (2016) Butterworth-Heinemann Press. UK.
8. H. J. Peppler, D. Perlman. Microbial Technology: Fermentation Technology. (2014). Academic Press.
9. T. El-Mansi, C. Bryce, Arnold L. Demain, A.R. Allman. Fermentation Microbiology and Biotechnology. Second Edition. (2006). CRC Press, USA.
10. Hongzhang Chen. Modern Solid-State Fermentation: Theory and Practice. (2013). Springer Press, Germany.
11. John E. Smith. Biotechnology. (2009). Cambridge University Press.UK.
12. Celeste M. Todaro, Henry C. Vogel. Fermentation and Biochemical Engineering Handbook. (2014). William Andrew Press. Norwich, NY.
13. G. Lancini, R. Lorenzetti. Biotechnology of Antibiotics and other Bio.

M.Sc. Microbiology

Third Semester Examination

Paper3.3 MB-633(1)– **Biofuel and Bioenergy**

Contact Hours / Week	: 4 Hours	Maximum Marks	: 100 Marks
Duration of Examination	: 3 Hours	Continuous/Internal/Assessment	: 30 Marks
		Semester Assessment	: 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into three sections.*

- **Section-A** will carry 10 marks with 01 compulsory question comprising 10 short answer type questions (maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.
- **Section-B** will carry 25 marks with equally divided into five long answer type questions (answer about in 250 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.
- **Section-C** will carry 35 marks with five long answer type questions comprising one compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 500 words) and any two more questions (answer about in 400 words) out of remaining four questions. Paper setter shall be advised to design question paper covering from all five units.

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

UNIT I **15-18L**

Current energy consumption, overview of biofuel/bioenergy and biorefinery concepts. Fundamental concepts in understanding biofuel/bioenergy production. Biomass preprocessing: drying, size reduction, and densification. Microbes as a source of bioenergy.

Biomass for energy. Calorific value and its estimation. Co-generation of energy. Various biofuels/bioenergy from biomass. Biomass conversion to heat and power: thermal gasification of biomass, anaerobic digestion.

UNIT II **15-18L**

Biomass conversion to biofuel: thermochemical conversion, syngas fermentation. Environmental impacts of biofuel production. Alternatives as biofuels: Alkanes, Biobutanol, bioethanol, biomethanol, biodiesel, biogas, hydrogen, syngas/synfuels and other energy dense molecules and their comparisons.

Biochemical conversion to ethanol: biomass pretreatment,Starch to sucrose conversion and Sucrose to ethanol fermentation. Different enzymes, enzyme hydrolysis, and their applications in ethanol production. Distillation and Quantification of ethanol.

UNIT III **15-18L**

Lignocellulosic hydrolysis, Fermentation of pentoses and other issues in bioethanol production from lignocelluloses. Biobutanol production, Estimation of biobutanol.

Microbes and biogas production: Biogas and methane estimation. Bio gas Bottling Plant Technology, Application of Bio gas slurry in agriculture. Design of Biogas for cold climates.

UNIT IV **15-18L**

Global biodiesel scenario. Oil crops. Microbes and Biodiesel: Production and feed stock. Techniques of lipid extraction and conversion to biodiesel (lipid transesterification), Biodiesel quality and its assessment.
Strategies of genetic engineering of organisms for biofuel production.

Wastewater remediation and biomass generation for biofuel purposes. Microbial Fuel Cells.

UNIT V **15-18L**

Food vs Fuel debate. Carbon sequestration and its necessity. Carbon credits. Biorefinery, Thermochemical Conversion Processes (Gasification: Biofuels from Synthesis Gas and Pyrolysis) Biochemical Conversion Processes, Photobiological conversion: Biohydrogen production. Commercialized microalgae (*Spirulina, Dunaliella, Hematococcus, Chlorella* and others) and their production. Economics of microalgae production. Cultivation of seaweeds.

Reference Books:

1. Balachandran P. (2010); Engineering Fluid Mechanics, Prentice Hall India
2. Dessler A. (2011); Introduction to Modern Climate Change, Cambridge University Press.
3. Bioenergy (Biomass to Biofuel) 1st Edition 2014 Academic Press Editor: Anju Dahiya.
4. Biorenewable Resources: Engineering New Products from Agriculture. Robert C. Brown. Wiley-Blackwell Publishing (2003).
5. Anaerobic Biotechnology for Bioenergy Production: Principles and Applications. Samir K. Khanal. Wiley-Blackwell Publishing (2008).
6. Kothari D. P. and Nagrath I. (2009); Basic Electrical Engineering, Third Edition, McGraw Hill, India
7. Zemansky M. and Dittman R. (2011); Heat and Thermodynamics, McGraw Hill, India
8. Wadhwa C. L. (2012); Generation, Distribution and Utilization of Electrical Energy, Third Edition, New Age International .

M.Sc. Microbiology

Third Semester Examination

Paper3.3 MB-633(2)– **Pharmaceutical Microbiology**

UNIT I **15-18L**

Antibiotics and synthetic antimicrobial agents: Antibiotics and synthetic antimicrobial agents:(Aminoglycosides, β lactams, tetracyclines, ansamycins, macrolid antibiotics), Antifungal antibiotics, antitumor substances. Peptide antibiotics, Chloramphenicol, Sulphonamides and Quinolinone antimicrobial agents. Chemical disinfectants, antiseptics and preservatives. Antimicrobial Testing Systems: Introduction, Antimicrobial agents, broad types, therapeutic ratio, MIC and MBC. Antimicrobial Susceptibility Testing.

UNIT II **15-18L**

Mechanism of action of antibiotics: Mechanism of action of antibiotics (inhibitors of cell wall synthesis, nucleic acid and protein synthesis). Molecular principles of drug targeting. Drug delivery system in gene therapy. Bacterial resistance to antibiotics. Mode of action of bacterial killing by quinolinones. Bacterial resistance to quionolinones. Mode of action of non – antibiotic antimicrobial agents. Penetrating defenses- How the antimicrobial agents reach the targets (cellular permeability barrier, cellular transport system and drug diffusion).

UNIT III **15-18L**

Microbial production and Spoilage of pharmaceutical Products: Microbial contamination and spoilage of pharmaceutical products (sterile injectables, non-injectables, ophthalmic preparations and implants) and their sterilization. Manufacturing procedures and in process control of pharmaceuticals. Other pharmaceuticals produced by microbial fermentations (streptokinase, streptodornase).

UNIT IV **15-18L**

Regulatory practices, biosensors and applications in Pharmaceuticals: Financing R&D capital and market outlook. IP, BP, USP. Government regulatory practices and policies, FDA perspective. Reimbursement of drugs and biologicals, legislative perspective. Rational drug design. Immobilization procedures for pharmaceutical applications (liposomes).Macromolecular, cellular and synthetic drug carriers. Biosensors in pharmaceuticals. Application of microbial enzymes in pharmaceuticals.

UNIT V **15-18L**

Quality Assurance and Validation: Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry. Regulatory aspects of quality control. Quality assurance and quality management in pharmaceuticals ISO, WHO and US certification. Sterilization control and sterility testing (heat sterilization, D value, z value, survival curve, Radiation, gaseous and filter sterilization) Chemical and biological indicators. Design and layout of sterile product manufacturing unit, Designing of Microbiology laboratory.

References

1. K. Park (2009), 20th Edition Park's Textbook of Preventive and Social Medicine
2. Konrad J. Karczewski, Roxana Daneshjou, Russ B. Altman, 2012 Chapter 7. Pharmacogenomics PLOS
3. Franklin T.J. and Snow G.A., 1975, Biochemistry of Antimicrobial Action, Chapman and Hall, London
4. Gale E.F., Cundliffe E., Reynolds P.E., Richmond M.H. and Waring M.J., 1972, The molecular basis of antibiotic action, John Wiley and Sons, London

5. Goldstein A., Aronow L. and Kalman S.M. 1969, Principles of Drug Action, The Basis of Pharmacology, Harper International Edition, New York
6. Mannfred A. Holliger, 2008, Introduction to Pharmacology, 3rd Edition, CRC Press
7. Kokate C. K., Purohit A.P., Gokhale A.B.2000, Pharmacology, 4th Edition, Nirali Prakashan

M.Sc. Microbiology

Third Semester Examination

Paper3.4 MB-634(1)– **Antimicrobial Resistance**

UNIT I **15-18L**

Definition, phenomenon of antibiotics, concept of secondary metabolites. Discovery and History of antibiotics, importance of antibiotics, Different classes of antimicrobials (bacterial, Viral & fungal) and their mode of action. Role of antibiotics in the producer organism. Importance of optimizing antimicrobial usage for maintaining cost-effective therapies.

UNIT II **15-18L**

Biochemical modes of action of antibiotics acting as inhibitors of ribosomal function (as for example aminoglycosides, tetracyclines, puromycin, chloramphenicol, microlides etc.), inhibitors of nucleic acid metabolism (actinomycin D, mitomycin C etc.), inhibitors of cell wall biosynthesis (penicillin, bacitracin etc.) and inhibitors of membrane function (polyenes, tunicamycin, ionophores etc.) and other mode of actions.

UNIT III **15-18L**

Phenomenon of antibiotic resistance. Emergence and spread of resistance; Microbial resistance – a global issue. Reservoirs of antibiotic resistance, Molecular mechanisms of Resistance; Different biochemical mechanisms of resistance development, multiple-drug resistance and XDR, their genetics and chemical significance. Bacterial Biofilms.

UNIT IV **15-18L**

Assay of antibiotics: chemical versus microbiological assay system, different methods of antibiotic assays (serial dilution, photometric and agar-diffusion methods) - theory and practice; Chemical and biochemical modification of antibiotic structures: development of antibiotics (Different generations of antibiotics) taking penicillin and chloramphenicol's as parent compounds.

UNIT V **15-18L**

Antimicrobial susceptibility tests; methods for detecting antimicrobial resistance; Obtaining good results; interpretation of antimicrobial susceptibility results; genomic analysis tools to detect resistance genes. Alternative therapies to antibiotics – phage therapy, probiotics, vaccines, etc. Roles and responsibilities of different stakeholders in antimicrobial stewardship (including physician, pharmacist, microbiologist, hospital administrators); Case studies - Antimicrobial stewardship strategies by WHO, ICMR etc.

Books/References:

1. Kateryna Kon and Mahendra Rai "Antibiotic Resistance: Mechanisms and New Antimicrobial Approaches" Academic press 2016
2. CARD - Comprehensive Antibiotic Resistance Database (https://card.mcmaster.ca/) site for information on publicly available resistance genes and related information.
3. Research papers and Reports provided as per the course content.

M.Sc. Microbiology

Third Semester Examination

Paper3.4 MB-634(2)– **Microbial Nanotechnology**

UNIT I **15-18L**

Introduction to Nanotechnology: Characteristic scale for quantum phenomena, nanoparticles, nano-clusters, nanocomposite, nanotubes, nanowires and emergence of bio-nanotechnology.
Characterization of nanoparticles – UV-Vis spectroscopy, FTIR, Electron Microscopy – HRTEM, SEM, AFM, EDS, XRD.

UNIT II **15-18L**

Microbial nanotechnology-Microbial synthesis of Nanoparticles. Synthesis of nanodrugs-metal nanoparticles and drug delivery vechicles- Nanoshells- Tectodentrimers Nanoparticle drug systems – Diagnostic applications of nanotechnology.

UNIT III **15-18L**

Preparation of nano-biomaterials – Polymeric scaffolds collagen, Elastins: Mucopolysaccharides, proteoglycans, cellulose and derivates; Dextrans, Alginates, Pectins, Chitin. Nanoparticles-types, functions- Silver, Gold and Titanium. Physical and chemical properties of nanoparticles.

UNIT IV **15-18L**

Nanoscale applications in biology and medicine: Nanotechnologies for biology and medicine - Micro- and nano-fluidics - Scanning probe microscopy in biology and medicine- Self-assembly of biological molecules. Nano-biotics, Application of Nanoparticles in theragnostic, Drug delivery- protein mediated and nanoparticle mediated. Hybrid conjugates of gold nanoparticles- DNA oligomers - use of DNA molecules in nano-mechanics and Computing. Nanoparticles as carrier for genetic material. Genetically Modified Organisms (GMO) and applications.

UNIT V **15-18L**

Implications of nanotechnology: Health and safety implications from nanoparticles: Health issues- Environmental issues- Need for regulation- Societal implications: Possible military applications - Potential benefits and risks for developing countries - Intellectual property issues - Criticism of Nanotechnology - Studies on the implications of Nanotechnology.

Recommended Text Books:

1. Pradeep T. (2012). Textbook of Nanoscience and Nanotechnology. McGraw Hill Education (India) Private Limited.

2. Murty B.S., Shankar P., Baldev Raj, Rath B. B., James Murday. (2013). Textbook of Nanoscience and Nanotechnology. Springer, Berlin, Heidelberg.
3. Risal Singh, Shipra Mital Gupta. (2016). Introduction to Nanotechnology: Understanding the Essentials, 1st edition. Oxford University Press.
4. Rakesh K. Tekade. (2019). Biomaterials and Bio-Nanotechnology, 1st edition. Academic Press.
5. David E. Reisner. (2011). Bio-nanotechnology II: Global Prospects. CRC Press.
6. Yubing Xie. (2017). The Nanobiotechnology Handbook, 1st edition. CRC Press.

M.Sc. Microbiology

Third Semester Examination
Paper 3.5 MB 635 Lab Course V

Practical Exercises

1. To study the micro-flora of air (indoor and outdoor).
2. Analysis of soil: Texture, pH, moisture content, water holding capacity, percolation, and capillary action.
3. Isolation and study of microbes (bacteria and fungi) from Rhizosphere and Rhizoplane.
4. Isolation of *Rhizobium* from root modules of legumes (*Trigonella / Cicer / Soybean*)
5. Isolation of free nitrogen fixers (*Azotobactor, Azospirillum*) from soil.
6. Isolation of Phosphate solubilizing bacteria from soil.
7. To study the bacterial ecology in freshwater environment.
8. To study the microbial ecology of the rhizosphere and determination of Rhizospheric effect.
9. To study the effect of various salt concentrations on bacterial fungal growth.
10. To study the effect of osmotic pressure on bacterial fungal growth.
11. To determine the microbial biomass from different natural habitats.
12. Demonstration of biological treatment.
13. Determination of alkalinity
14. Determination of chlorine in water.
15. Demonstration of VAM.
16. Production of Biofertilizers: *Rhizobium / Azotobacter sp.*
17. Production of Single cell protein
18. Demonstrate the Mushroom cultivation.
19. Bioremediation of polluted soils by plants/ microbes.
20. Laboratory demonstration of vermi-composting
21. Field visit to recycling industries.
22. To study the Fermenter, Its Design and Working mechanism.
23. Determine the growth patterns and specific growth rate of *E. coli*
24. Determine the effect of peptone concentration on *E. coli* growth
25. Isolation of antibiotic producing microorganisms from soil
26. Isolation of enzyme producing microorganisms from soil
27. Isolation of organic acid producing microorganisms from soil
28. Retrieving sequence data from Entrez
29. Locating the chromosome of a Gene
30. Retrieve gene expression data from GEO
31. Finding ORF of a Given Sequence
32. Retrieving structural data of a protein using PDB database
33. To access scientific data from Literature data bases (PUBMED, LITDB, Medline)
34. To access nucleic acid databases for retrieval of gene sequence.
35. To access protein databases for retrieval of amino acid sequence of target protein.
36. To perform multiple sequence alignment using BLAS and CLUSTAL-W
37. To prepare Phylogenetic tree and Cladogram using CLUSTAL-W

M.Sc. Microbiology

Third Semester Examination
Paper 3.6 MB 636 Lab Course VI (Based on elective papers)

Practical Exercises based on Biofuel and Bioenergy

1. Qualitative and Quantitative estimation of solid waste from different sites.
2. Liquid bio-fuel production and characterization.
3. Biogas production by anaerobic digestion and analysis.
4. Production of energy from microbes (microbial fuel cell)
5. Production of Biodiesel from nonedible oil.
6. Biogas production and application.
7. Bioethanol production.
8. Cultivation of seaweeds.

Practical Exercises based on Pharmaceutical Microbiology

1. Spectrophotometric / Microbiological methods for the determination of Griesofulvin.
2. Bioassay of chloramphenicol by plate assay method or turbidiometric Assay method.
3. Treatment of bacterial cells with cetrimide, phenol and detection of Leaky substances such as potassium ions, amino acids, purines, Pyrimidines and pentoses due to cytoplasmic membrane damage.
4. To determine MIC, LD 50 of Beta-lactum/aminoglycoside/ tetracycline/anamycins.
5. Sterility testing by *Bacillus stearothermophilus*
6. Sampling of pharmaceuticals for microbial contamination and load (syrups, suspensions, creams and ointments, ophthalmic preparations).
7. Determination of D value, Z value for heat sterilization in pharmaceuticals.
8. Determination of antimicrobial activity of a chemical compound (Phenol, resorcinol, thymol, formaldehyde) to that of phenol under Standardized experimental conditions.
9. Microbiological assay of antibiotics by cup plate method and other methods
10. Extraction of bioactive ingredients from plant and its activity fraction.
11. Estimation of antimicrobial activity using CLSI.
12. Determination of microbial load of non-sterile products – ointments, capsules.
13. Determination of drug sensitivity of *Streptococcus mutans.*

Practical Exercises based on Antimicrobial resistance

1. Antimicrobial Susceptibility Testing: Agar disk-diffusion method
2. Antimicrobial gradient method (E test)
3. Agar well diffusion method
4. Poisoned food method
5. Agar overlay bioassay
6. Broth dilution method
7. Agar dilution method
8. Time-Kill test (time- kill curve)

Practical Exercises based on Microbial Nanotechnology

1. Synthesis of Nanoparticles from plant materials
2. Synthesis of nanoparticles from microbiological sources
3. Affinity purification of immunoglobulins & quantification
4. Demonstration of Imaging techniques: SEM/TEM/Bio-AFM (Natural Sample sources)
5. Bioconjugation of nanoparticles with proteins/antibodies/DNA
6. Protein quantification by spectroscopy/ELISA
7. Mining of biological databases: DNA/Protein search
8. Synthesis of Metal Oxide Nanoparticle using different techniques.
9. Synthesis of TiO_2 and ZnO nano particles by sonochemical method
10. Synthesis of CdS and SrTiO3 nano particles by sonochemical method
11. Biogenesis of Iron nano-particles –for development of Microbial Emulsion.
12. To demonstrate Characterizations using UV visible spectrophotometer, FTIR, X-ray Analysis.
13. Synthesis of Polymeric Nanocomposite.

M.Sc. Microbiology

Fourth Semester Examination

The students have to select one of the following specializations that shall be taught in fourth semesters:

Paper 4.1 MB-641– Industrial Microbiology **or** Paper 4.2 MB-642– Medical Microbiology.

Paper 4.1 MB-641– **Industrial Microbiology**

Contact Hours / Week	: 4 Hours	Maximum Marks	: 100 Marks
Duration of Examination	: 3 Hours	Continuous/Internal/Assessment	: 30 Marks
		Semester Assessment	: 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into three sections.*

- **Section-A** will carry 10 marks with 01 compulsory question comprising 10 short answer type questions (maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.
- **Section-B** will carry 25 marks with equally divided into five long answer type questions (answer about in 250 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.
- **Section-C** will carry 35 marks with five long answer type questions comprising one compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 500 words) and any two more questions (answer about in 400 words) out of remaining four questions. Paper setter shall be advised to design question paper covering from all five units.

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

UNIT- I **15-18L**

Novel microbes for future industry. Historical account of microbes in industrial microbiology. Industrial microorganisms: Sources and characters of industrially potent microbes, Media for industrial fermentation.
Industrial sterilization process for media, air and equipment. Fermentations technology: Principles of fermentation, Types of fermentations: Solid substrate fermentation (SSF) - Principles and application, Submerged Fermentation. Aerobic and anaerobic fermentation, Components of fermentation process.

UNIT-II **15-18L**

Downstream processing: Biomass separation by centrifugation, filtration, flocculation and other recent developments. Cell disintegration methods**.**
Extraction: Solvent, two phase, liquid extraction, supercritical fluid extraction, whole broth, aqueous multiphase extraction. Product Purification: precipitation, Crystallization, chromatographic methods, ultra-filtration, reverse osmosis. Drying devices.

UNIT-III **15-18L**

Industrial production of antibiotics: Streptomycin, Penicillin. Industrial production of: Vitamin B12, Riboflavin, Citric acid, Lactic acid, Vinegar; Glutamic acid, L – lysine; Acetone, glycerol, alcohol. Steroid biotransformation. Production of alcoholic beverages. Microbial Enzymes**:** Tannases, Proteases, Amylases,
Production of biopharmaceuticals through GEMs: Insulin, Interferons, Tissue plasminogen activator, Streptokinase. Immobilization of enzymes and cells: Types & applications.

UNIT- IV **15-18L**

Microbiology of food: sources and types of microorganisms in food, food borne pathogens, microbiological examination of food, spoilage of food, food preservation. Starter cultures their biochemical activities, production and preservation of the following fermented foods: Soy sauce fermentation by Moulds, Fermented vegetables – Sauerkraut, Fermented Meat – Sausages. Production and application of Baker's Yeast. Role of microorganisms in beverages – tea and coffee fermentations. Genetically modified foods. Biosensors in food.

UNIT- V **15-18L**

Dairy microbiology: sources and types of microorganisms in milk, microbial examination of milk, pasteurization and phosphatase test, sterilization of milk, grades of milk,Microbiology of fermented milk products (acidophilus milk, yoghurt), butter &cheese. Applications of microbial enzymes in dairy industry (Protease, Lipases). Quality assurance: Microbiological quality standards of food. Government regulatory practices and policies. FDA, EPA, HACCP, ISI.

Reference Books:

1. Microbiology an Introduction by Gerard J Tortora, Berdell R Funke and Christine L Case. Pearson Publisher (11th Edition) 2016.
2. Basic and Industrial Microbiology by S. M. Reddy.
3. Microbes: Concepts & Applications- P.S. Bisen, Mousumi Debnath, Godavarthi B.K.S. Prasad, John Wiley & Sons Publication 2012.
4. Industrial Microbiology by David B. Wilson, Hermann Sahm, Klaus-Peter Stahmann, Mattheos Koffas. Wiley Publisher 2019.
5. Reed G (2004). Industrial Microbiology. CBS Publishers (AVI Publishing Co.)
6. Stanbury PF, Whitekar A. and Hall (2006). Principles of Fermentation Technology. Pergaman. McNeul and Harvey.
7. Creuger and Creuger (2004). Biotechnology- A textbook of Industrial Microbiology, Sinaeur Associates.
8. Casida LE (2001). Industrial Microbiology, Wiley Eastern.
9. Manual of Industrial Microbiology and Biotechnology, Demain & Davies, 2nd ed.
10. Microbial Biotechnology A. N. Glazer and H. Nikaido
11. Biotechnology An Introduction Susan R. Barnum
12. Topics in Enzyme & Fermentation Biotechnology by Wisemen
13. S.N. Jogdand. Medical Biotechnology
14. S.N. Jogdand. Biopharmaceuticals

M.Sc. Microbiology

Fourth Semester Examination

Paper 4.2 MB-642– **Medical Microbiology**

Contact Hours / Week	: 4 Hours	Maximum Marks	: 100 Marks
Duration of Examination	: 3 Hours	Continuous/Internal/Assessment	: 30 Marks
		Semester Assessment	: 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into three sections.*

- **Section-A** will carry 10 marks with 01 compulsory question comprising 10 short answer type questions (maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.
- **Section-B** will carry 25 marks with equally divided into five long answer type questions (answer about in 250 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.
- **Section-C** will carry 35 marks with five long answer type questions comprising one compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 500 words) and any two more questions (answer about in 400 words) out of remaining four questions. Paper setter shall be advised to design question paper covering from all five units.

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

UNIT-I **15-18L**

Human microbiome & its significance. Probiotics: Gut microbiota, Gut brain interaction. Infection: types, sources, reservoirs and vehicles of infection, predisposing factors. Host-parasite relationship governing the infection and establishment of disease, factors affecting virulence. Mode of spread of infection.

Emerging epidemics, Re-emerging epidemics. Epidemics fundamentals: Types of epidemics, investingation, management and control. Biosafety: components, laboratory safety management. Management of biomedical waste. Biosafety levels. Introduction of center for Disease Control (CDC) and National center for disease control (NCDC).

UNIT-II **15-18L**

Study of diseases caused by pathogenic bacteria: Pathogenicity, laboratory diagnosis, epidemiology and control measures– *Streptococcus, Staphylococcus, Neisseria, Salmonella, E. coli, Klebsiella, Proteus, Pseudomonas, Shigella, Corynebacterium, Vibrio, Corynebacterium, Bacillus, Clostridium, Vibrio, Mycobacterium, Spirochetes, Chlamydiae, Rickettsia, Mycoplasma.*

UNIT-III **15-18L**

Morphology, pathogenesis, immune response, diagnosis and prevention of Pox viruses, Herpes, Picorna viruses (Enteroviruses and Polioviruses). Paramyxo viruses, Orthomyxoviruses, Hepatitis viruses, Rhabdo viruses (Rabies virus), Oncogenic viruses, HIV virus, Prion infection. Introduction to emerging diseases- Swine flu, chikungunya, Ebola, SARA-CoV-2.

UNIT-IV **15-18L**

Fungal diseases: Aetiology, clinical symptoms, laboratory diagnosis and treatment of Human mycotic infections caused by Dermatophytes, Histoplasma, Cryptococcus, Candida, opportunistic mycoses. Mycotoxins.
Important protozoal diseases: Route of entry, Life Cycles, Immunity, diagnosis & prophylaxis of *Plasmodium, Entamoeba, Leishmania, Giardia, Taenia.*

UNIT-V **15-18L**

Antimicrobial resistance: Drug resistance organisms, mechanisms and development of multidrug resistance.
Mechanism of drug action: Antibacterial, Antifungal and Antivirals. Methods of testing drug sensitivity. Preclinical development: Safety profile of drugs, Toxicological evaluation of drug, Mutagenecity and Carcinogenicity. Clinical studies.
Recent advances in medical microbiology-antiretroviral therapy, Plasma therapy. Probiotics as therapeutic agents, Aptamers, nanotechnology in medicines, Interferons.

Reference Books:

1. Emerging epidemics: Management and control P.S. Bisen and E. Raghuvanshi 2013. Wilay & Sons publication New Jeisey
2. Molecular Diagnostics: Promises & Possibilities 2010. Mousuni Dabnath , G.B.K.S. Prasad P.S. Bisen.Principles of Therapeutics, Burn J. H., Blackwell Scientific Pub. O. Ltd. Oxford.
3. Medical Microbiology, McGraw Hill Publication 2019, by Stefan Riedel, Stephen A. Morse, Timothy A. Mietzner, Steve Miller
4. Role of Novel Drug Delivery Vehicles in Nanomedicine Edited by R.K. Tyagi, N. Garg, R. Shukla & P.S. Bisen 2020.
5. Ananthanarayan and Jayaram Paniker. Textbook of Microbiology, 4th ed. Orient Longman, 2000.
6. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication.
7. Tille P (2013) Bailey's and Scott's Diagnostic Microbiology, 13th edition, Mosby.
8. Medical Microbiology-David Green wood
9. Text book of Microbiology,Ananthanarayan& Jayaram Panicker
10. Jawetz-Medical Microbiology-Geo F.Brooks,Janet S Butel.
11. Microbiology: An introduction, G.J. Tortora, B.R. Funke and C.L. Funke.
12. Virology; Renato Dulbecco and Harold S. Ginsberg, Fourth edition, J.B. Lippincott Company, USA
13. An Introduction to viruses, S. B. Biswas and Amita Biswas. Forth edition, Vikas Publishing House PVT LTD New Delhi.
14. Medical Bacteriology, Medical Mycology and AIDS; N.C.Dey, T.K. Dey and D. Sinha, New Central Book Ajency (P) Ltd.

M.Sc. Microbiology

Fourth Semester Examination

Paper 4.2 MB-642**– Research Methodology, IPR & Bioethics**

Contact Hours / Week	: 4 Hours	Maximum Marks	: 100 Marks
Duration of Examination	: 3 Hours	Continuous/Internal/Assessment	: 30 Marks
		Semester Assessment	: 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into three sections.*

- **Section-A** will carry 10 marks with 01 compulsory question comprising 10 short answer type questions (maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark.
- **Section-B** will carry 25 marks with equally divided into five long answer type questions (answer about in 250 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.
- **Section-C** will carry 35 marks with five long answer type questions comprising one compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 500 words) and any two more questions (answer about in 400 words) out of remaining four questions. Paper setter shall be advised to design question paper covering from all five units.

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

Unit-I **15-18L**

Introduction to statistics: Aim and Scope of statistics, Sample size & Sampling. Tabulation and graphics representation. Measure of central tendency, Measure of dispersion, Range, Standard deviation, Lorenz curve.
Skewness and kurtosis: Definition, Types and measures of skewness. Kurtosis.
Correlation analysis: Definition, Types of Methods of correlation- scatter diagram, Karl Pearson's coefficient, Rank correlation.
Regression analysis: Regression Line, regression equations. Multiple regression.

Unit-II **15-18L**

Probability theory: Types and Theorems. Theoretical distributions: Binomial, Poisson and Normal distribution.
Hypothesis Testing: population and sample, sampling and non-sampling error. Steps in tests of hypothesis. Sampling and non-sampling error. Test of significance for attributes. Test for number of success and proportion of success. Test of significance for variables (Large samples)- tests of differences between means of two samples and between two standard deviations. Tests of significance for variables (Small samples)- Students t-distribution, F-Test. Chi-square, ANOVA

UNIT-III **15-18L**

Research Methodology: Introduction-Basic research, applied research, need based research. Identification of the problem, defining the problem. Research Project planning. Literature search-information sources, library resources-books, abstracts hand books, procedure manuals, encyclopedias, annual report, data banks, CDROMS, online literature search- internet access, websites, directories of information resources.

Progress of research- evaluation of results, statistical approach, comparison with existing methodologies, validation of findings, research communication, impact factor of journals, plagiarism. Software packages for statistical analysis.

UNIT IV **15-18L**

Intellectual Property Rights (IPR): Introduction to Intellectual Property & IPR, patent, copyrights, trademarks, trade secret, geographical indications, Industrial designs. Patent laws, Legislations covering IPR‟s in India, Patenting of living organisms, procedure involved in patenting, patent infringement, patent filing and international patent law, PCT, provisional and complete specification, patentable and non-patentable materials, product planning and development, Trade related aspects (TRIPS), WTO, WIPO, international & regional

UNIT-V **15-18L**

Introduction to Ethics, Bioethics and Biosafety. Personal ethics: Profession and professionalism, Moral Reasoning, Ethical theories, ethics in biotechnology, benefits and risks of genetic engineering, ethical aspects of genetic testing, ethical aspects relating to use of genetic information, genetic engineering and biowarfare. Ethical implications of cloning. Ethical, legal and socio-economic aspects of gene therapy, Human genome project and ELSI of human genome project. Ethical issues in genetically modified food and crops.

Reference Book:

1. A.R. Leach, Molecular Modeling- Principles and Applications, Second Edition, Pearson.
2. B.L. Wadera, Patents, trademarks, copyright, Designs and Geographical Judications.
3. Bioethics and Biosafety, M.K. Sateesh, I.K. International 2008
4. C.R., Kothari, Research methodology.
5. D.P. Mittal (Taxman Publication), Indian Patents Law and Procedure
6. David W. Mount. 2003. Bioinformatics: Sequence & Genome Analysis. CBS Publishers and Distributors. New Delhi.
7. Fundamentals of Statistics, Goon, Gupta and Dasgupta –World Press, Kolkata
8. Guide to Research Methodology and Biostatistics. Edited by KMK Masthan 2017 CBS Publisher.
9. Hilarry Pearson and Clifford Miller, Commercial Exploitation of Intellectual Property.
10. N.S. Gopalakrishnan & T.G. Agitha, Principles of Intellectual Property (2009), Eastern Book Company, Lucknow
11. P. Narayanan (Eastern Law House), Intellectual Property Law
12. Principles of Technical Writing by Robert Hays. Addison-Wesley, 1965.
13. Rastogi. S. C, Mendiratta. N and Rastogi. P. Bioinformatics Methods and Applications: Genomics, Proteomics and Drug Discovery. Prentice-Hall of India Pvt. Ltd.3rd edition.
14. Statistical Methods, Gupta SP. Sultanchand & Sons.
15. Zhumur Ghosh & Bibekanand Mallick, Bioinformatics: Principles and Applications, Oxford University Press, Second Edition

M.Sc. Microbiology

Fourth Semester Examination
Paper 4.3 MB-643–Dissertation

A dissertation shall be initiated at the end of the Semester III and continued during Semester IV. A dissertation may be undertaken in any related research laboratories/industries/university department. Project work for the dissertation will involve experimental work and the student will have to complete this in stipulated time i.e., 3 months. The final evaluation of the project work will be through a Panel involving internal and external supervisors and examiners. The students shall compulsorily submit the certificate of completion and report to the Department during the practical examination.
This process includes: Conceptualization of the independent research, Collection, analysis, and interpretation of data, Thesis writing, Oral presentation of findings and Viva-Voce.
The marks will be awarded by the external examiner on the day of the practical examination on the basis of the experimental, presentation and viva-voce. The distribution of marks for project work will be:

Project work : 200 Marks

1. Experimental Work & Thesis :100
2. Research work presentation :50
3. viva-voce :50

M.Sc. Microbiology

Fourth Semester Examination
Paper 4.4 BM 644 Lab Course VII

Practical Exercises based on Paper 4.1 MB-641-Industrial Microbiology

1. Components and Operation of a Bioreactor
2. Batch fermentation in conical flask
3. Solid state fermentation
4. Screening of industrially important microbes: Antibiotics producers, enzymes producers and organic acid producers.
5. Optimization of conditions for optimal production of enzyme: - Media composition, Incubation temperature, Aeration, Incubation time.
6. Purification of antimicrobial metabolites from a microbe.
7. Production of amylase and cellulase by SmF and SSF.
8. Production of antibiotics by SmF technology
9. Immobilization of cells and enzymes.
10. Instrumentation of fermentor. Design of various types of fermentors & bioreactors
11. Production of ethanol & wine from grapes.
12. DSP for microbial enzymes/antibiotics/organic acids.
13. Determination of TDT of microbes.
14. Determination of TDP of microbes.
15. Production and estimation of lactic acid by *Lactobacillu*s Sp. or *Streptococcus* Sp.
16. Sauerkraut fermentation
17. Isolation of food poisoning bacteria from contaminated foods,
18. Production of Dairy products: yoghurt, cheese.
19. Extraction and detection of aflatoxin for infected foods.
20. Preservation of potato/onion by UV radiation
21. Production of fermented milk by *Lactobacillus acidophilus*.
22. Rapid analytical techniques in food quality control using microbial Biosensors.

Practical Exercises based on Paper 4.2 MB-642- Medical Microbiology

1. To prepare various basic, selective, enrichment and enriched media used for isolation of medically important bacteria from clinical samples.
2. To perform various biochemical tests (IMVC, oxidase, catalase, urea utilization test, sugar utilization and H2S production on TSI agar slant) used for identification.
3. To perform sugar fermentation tests used for identification of medically important bacteria.
4. Preparation of transport media for different clinical samples.

5. Demonstration normal microbial flora of skin, mouth and throat.
6. Isolation and identification of *Staphylococcal* species using suitable media, staining techniques and biochemical tests.
7. Identification of bacterial species belonging to *Enterobacteriaceae* family using suitable biochemical tests (*E. coli, Proteus, Pseudomonas, Klebsiella)*
8. Isolation and identification of enteric fever causing bacteria (*Salmonella typhi*) using suitable media and biochemical tests.
9. Isolation and identification of *Bacillus* species using suitable media, staining techniques and biochemical tests.
10. Microbiological analysis of urine specimens.
11. Microbiological analysis of sputum specimens
12. Isolation dermatophytes and their identification based on colony morphology and microscopic characteristics.
13. To determine antibiotic sensitivity for Gram negative and Gram-positive bacteria by disc diffusion method
14. To determine Minimal Inhibitory Concentration (MIC) and Minimal Bactericidal concentration of an antibiotic for test bacteria.
15. Identification of human blood groups.
16. Estimation of blood haemoglobin.
17. Perform Total Leukocyte Count of the given blood sample.
18. Perform Differential Leukocyte Count of the given blood sample
19. Separate serum from the blood sample.

Practical Exercises based on Paper 4.2 MB-642-Research Methodology, IPR & Bioethics

1. Representation of statistical data by
a. Histogram 2. O give curves 3. Pie diagrams
2. Collection of data using different sampling methods
3. Determination of Averages or Central tendencies (Mean, Mode, Median)
4. Determination of measures of dispersion (Mean deviation, Standard deviation and Coefficient of variation, Quartile deviation)
5. Application of Tests of significance (Chi-Square test, student t-test, Standard error)
6. Applications of computers in biology using MS-office (MS-Word, Excel, Power point)
7. Searching of India Patent databases
8. Drafting and filing of Indian Patent databases
9. Searching of International Patent application
10. Drafting and filing of International Patent application

M.Sc. Microbiology

Fourth Semester Examination

Paper 4.4 MB 644 Comprehensive Viva Voce

A grand viva-voce of all the papers of all the semesters will be conducted at the end of semester by a board of examiners.