

**MAHARAJA GANGA SINGH UNIVERSITY, BIKANER**

**SCHEME OF EXAMINATION AND  
COURSES OF STUDY**

# **SYLLABUS**

**FACULTY OF SCIENCE**

**M.SC.**

**MICROBIOLOGY (ANNUAL SCHEME)**



**M.Sc. Previous Examination - 2021**

**M.Sc. Final Examination – 2022**

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## M.Sc. MICROBIOLOGY (Annual Scheme)

### SCHEME OF EXAMINATION

#### Syllabus for M.Sc. Microbiology (Session 2020-21 & 2021-22)

#### 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/Veterinary/Life Sciences with 50% marks.

#### PASS CRITERIA

For passing in the examination, a candidate is required to obtain at least 25 % in each theory paper (Internal +External) and 36 % marks in the total aggregate in theory and 36 % in practical separately (in each semester examination)

#### CLASSIFICATION OF SUCCESSFUL STUDENTS

##### Division

First Division

Second Division

Pass

Fail

##### Total Marks

60% and above

Above 48 % and below 60 %

Above 36 % and below 48 %

Below 36 %

#### BACKLOG

As per University Norms

#### Teaching and Examination Scheme for

#### M.Sc. (Previous) Microbiology

#### Examination 2021

Paper code	Paper Name	Lecture Per week	Exam Hours	Max Marks	Min. Pass Marks (36%)
Theory Papers					
Paper-1	General Microbiology, Bacteriology and Virology	3	3	75	19(25 %)
Paper-2	Microbial Genetics, Molecular Biology and Techniques of Genetic Engineering	3	3	75	19(25 %)

Paper-3	Microbial Physiology, Biochemistry and Bioinstrumentation	3	3	75	19(25 %)
Paper-4	Biostatistics & Computer Applications & Bioinformatics	3	3	75	19(25 %)
<b>Aggregate</b>					<b>108 (36 % aggregate)</b>
Practical					
	Practical Based on Theory papers		6Hrs per day (Total two days)	100	
	Experimental work			20	
	Seminar			10	
	Record			20	
	Viva-voce				
	Aggregate			150	54
<b>Grand Total</b>				<b>450</b>	<b>162</b>

**M.Sc. (Final) Microbiology  
Examination 2022**

Paper code	Paper Name	Lecture Per week	Exam Hours	Max Marks	Min. Pass Marks
Theory Papers					
Paper-5	Industrial and Food Microbiology	3	3	75	19 (25 %)
Paper-6	Microbial Ecology and Environmental Biotechnology	3	3	75	19(25 %)
Paper-7	Geomicrobiology, Soil & Agricultural Microbiology	3	3	75	19(25 %)

Paper-8	Medical Microbiology & Immunology	3	3	75	19(25 %)
Paper-RP/CS	*Research Project/Case Study	-	10 min presentation/ viva voce per student	50	13 (25%)
<b>Aggregate</b>					<b>126 (36 % aggregate)</b>
Practical					
	<b>Practical Based on Theory papers</b>		6Hrs per day (Total two days)		
	Experimental work			50	
	Seminar			20	
	Record			10	
	Viva-voce			20	
	<b>Aggregate</b>			<b>100</b>	<b>36</b>
<b>Grand Total</b>				<b>450</b>	<b>162</b>

\*The student shall 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.

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

### M.Sc. Previous Examination 2021

#### Paper- 1: General Microbiology, Bacteriology and Virology

##### Scheme of Examination

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 compulsory questions. Section B will consist of 10 questions (2 questions from each unit of the syllabus). Section C will consist of 5 questions (1 question from each unit of the syllabus).

**Maximum Marks: 75**

**Duration: 3 Hrs**

**Minimum Passing Marks: 19**

#### UNIT-I

History and Scope of Microbiology, Culturable and unculturable bacteria. Microbial Taxonomy: Taxonomic ranks. Polyphasic classification; Phenetic classification, Numerical taxonomy, Phylogenetic classification. Major characteristics used in taxonomy (Classical and Molecular characteristics); Microbial phylogeny; Bergey's manual of systematic bacteriology. Ultra structure, chemistry and function of prokaryotic and eukaryotic cells with special reference to bacteria, protozoa, algae and fungi.

#### UNIT –II

Autotrophs, Heterotrophs, lithotrophs, chemotrophs and phototrophs. Cultivation, isolation and identification of bacteria based on phenotypic and bio-chemical characteristics. Microbial Growth: Growth factors, Growth curve, kinetics, asynchronous and synchronous growth of bacteria. Control of Microorganisms: Sterilization; Dry, Wet, Chemical, Filtration, Radiation. Media preparations, types of media. Differential, Selective and enrichment media. Aerobic and Anaerobic cultivation. Evaluation of effectiveness of antimicrobial agents.

#### UNIT-III

General Characters of:-

Important Bacteria- *Escherichia*, *Salmonella*, *Vibrio*, *Proteus*, *Bacillus*, *Lactobacillus*, *Streptococcus*, *Staphylococcus*, *Corynebacterium*, *Treponema*, *Mycobacterium*, *Pseudomonas*, *Klebsiella*, *Thiobacillus*, *Spirochaete*, *Azotobacter*, *Rhizobium*, *Beijerenkia*, *Acetobacter*, *Streptomyces*, *Clostridium*.

Characters of Special group of organism as:- Archaeobacteria, Photosynthetic bacteria, Nitrogen fixing bacteria, Spirochaetes, Mycoplasma, Rickettsia, Bdelovibrio.

Important Fungi- *Dictyostelium*, *Rhizopus*, *Saccharomyces*, *Candida*, *Trichoderma*, *Penicillium*, *Gliocladium*, *Fusarium*, *Helminthosporium*, *Alternaria*, *Albugo*.

Important Protozoa- *Entamoeba*, *Trypanosoma*, *Plasmodium*, *Coccidia*, *Giardia*.

Important Cyanobacteria/Algae:- *Nostoc*, *Oscillatoria*, *Scenedesmus*.

#### UNIT –IV

Virology: Brief outline on discovery of viruses, nomenclature and classification of viruses : distinctive properties of viruses; Electron microscopic morphology and ultra structure; Classification of viruses. DNA and RNA viruses, Replication of different group of viruses.

Cultivation of viruses in embryonated eggs, experimental animals, Primary & secondary cell cultures; suspension cell cultures and monolayer cell cultures; assay of viruses physical and chemical methods (Protein, nucleic acid, radioactivity, trackers, electron microscopy)-Infectivity assay (plaque method, end point method).

#### UNIT-V

Bacteriophage structural organization; life cycle; one step growth curve; transcription; DNA replication; eclipse phase; phage production; burst size; lytic- lysogenic cycle; bacteriophage typing; application in bacterial genetics; brief details on M13, Mu, T4, 2, R17, *Salmonella* phages, Lambda, P1 *Coli* phage.

Common viruses of cyanobacteria, algae, fungi; life cycle; type species of plant viruses like TMV, Cauliflower Mosaic Virus and Potato virus X; transmission of plant viruses with vectors and without vectors.

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

### **Suggested Readings**

Schlegel Hans G. (1995) *General Microbiology*, Edition 7, CUP, Cambridge.

Stanier R. Y., Adelberg E. A., Ingraham J. L., (1976) *General Microbiology*, 4th edition, Mac Millan Press, London.

Stephen W. Paddock, *Confocal Microscopy*, from *Methods and Protocols* Vol. 122, *Methods in Molecular Biology*, Humana Press, Press Inc., Totowa, NJ

Barnett, H. L. and Hunter, B. B. 1960. *Illustrated Genera of Imperfect Fungi*. Burgess Publishing Co., Minnesota.

Breed and Buchanan. *Bergey's Manual of Determinative Bacteriology*. 8th Edition, 1974.

Breed and Buchanan. *Bergey's Manual of Determinative Bacteriology*. 9th Edition, 1982.

Breed and Buchanan. *Bergey's Manual of Systematic Bacteriology*. 2nd Edition, (Volumes. 1 – 5) (2001 – 2003).

Lodder J. (1974). *The Yeasts: A Taxonomic Study*, North Holland Publishing Co. Amsterdam.

Sykes, G. and F. A. Skinner (Eds). *Actinomycetales: Characteristics and Practical Importance*. Society for Applied Bacteriology Symposium Series No. 2, Academic Press. 1973.

Amann R. Ludwig W. and Schleifer K. (1995). *Phylogenetic Identification and In situ detection of Individual Microbial Cells Without Cultivation*, *Microbiological Reviews* 59, 143-169.

Cook T. (2002) *Microbial Biodiversity: Saving Bacteriata save ourselves*, *Harvard Science Review*, 26-28.

Hugenholtz P. (2002) *Exploring Prokaryotic Diversity in the Genomic Era*, *Genome Biology*, 3(2), 0003.1-0003.8.

Keller M. and Zengler K. (2004) *Tapping in to Microbial Diversity*. *Nature Reviews* 2, 141-150.

Pace N. (1997) *A Molecular View of Microbial Diversity and the Biosphere*, *Science*, 276, 734-740.

Woese C. (1987), *Bacterial Evolution*. *Microbiological Reviews*, 221-271.

Straus J. H. and Straus E.S. (1998) *Evolution of RNA Viruses* *Ann. Rev. Microbiol.* 42: 657 – 83

Luria S. E. et.al. (1978) *General virology*, 3rd Ed, New York. John Wiley and Sons.

Fields B.N.; Knipe D. M. Chanock R.M. Hirsch M. J. (Eds) *Fields Virology*, 2nd Ed. New York, Raven Press. (1996)

Stephens B. and Compton R. W. (1998) *Assembly of animal viruses at the cellular membrane* *Ann. Rev. Microbiol.* 42:489-519

Reisner D. & Gross H.J. (1985) *Viroids* *Ann. Rev. Biochem.* 54:531-64

Prusiner S. B. (1995) *The Prion Diseases*, *Scientific American* (1):48-57

Sherkar A. H. & Marion P.L. (1991) *Hepo DNA viruses and Hepatocellular Carcinomas*. Ann. Rev. Microbiol.45:475-508

## **Paper- 2: Microbial Genetics, Molecular Biology and Techniques of Genetic Engineering**

### **Scheme of Examination**

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 compulsory questions. Section B will consist of 10 questions (2 questions from each unit of the syllabus). Section C will consist of 5 questions (1 question from each unit of the syllabus).

**Maximum Marks: 75**

**Duration: 3 Hrs**

**Minimum Passing Marks: 19**

### **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*. Bacteriophage:, 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**

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 –mechanism, enzymology and repair mechanism, inhibitors of DNA replication, DNA damage, DNA recombination. Transposons and mechanism of transposition.

### **UNIT-III**

Transcription in pro and eukaryotes, Reverse transcription, inhibitors of transcription, post transcriptional processing.

Translation in pro and eukaryotes, Genetic code properties. Inhibitors of translation, post translational modifications, Protein transport.

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 - N protein and nut sites, binding sites on DNA, Global regulatory responses : heat shock response, stringent response and regulation by small molecules such as ppGpp(p) and cAMP.

#### UNIT-IV

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

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

#### UNIT-V

Genetic Engineering: detailed account of Enzymes (Ligases, topoisomerases, Gyrase, Nuclease), Cloning vehicles, plasmids pBR322, PUC18, ss & ds Phage vector, phagemids, cosmids, BAC, YAC, MAC, Expression vectors.

Gene transfer techniques: chemical, electroporation, microinjection, particle bombardment, *Agrobacterium* mediated gene transfer.

Screening of recombinants, Reporter gene, general account of onco 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

De Robertis E. D. P. and De Robertis E. M. F. (1987), Cellular and Molecular Biology Lea and Febiger, Philadelphia

Gene IX by Benjamin Lewin, Jones and Bartlett Publishers, Sudbury, Massachusetts, 2007.

Molecular Biology by R.F. Weaver, 4th edition, McGraw Hill. New York. USA, 2007.

Molecular Biology of the Gene by J.D. Watson, T.A. Baker, S.P. Bell, A. Gann, M. Levin, R. Losick, 6<sup>th</sup> edition, Benjamin Cummings, San Francisco, USA, 2007.

Molecular Biology of the Cell by B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts, P. Walter, 5<sup>th</sup> edition, Garland Science, New York and London, 2007.

Biochemistry (5th edition) by J.M. Berg, J.L. Tymoczko, L. Stryer, W.H. Freeman and Company, New York, USA, 2008.

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

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

Molecular Genetics: An Introductory Narrative by Stent, G.S., Calendar, R. 2nd ed. San Francisco: W.H. Freeman, 1978.

Molecular Genetics of Bacteria by Larry Snyder and Wendy Champness, 3rd edition; ASM press; 2007.



Fundamental Bacterial Genetics by Nancy Trun and Janine Trempy, 1st edition; Blackwell Science Publishers; 2004.

Modern Microbial Genetics by U.N. Streips and R.E. Yasbin, 2nd edition; Wiley Publishers; 2002.

Microbial Genetics by Stanly R. Maloy, John E. Cronan, Jr. & David Freifelder, 2nd edition; Narosa Publishing House; 1987.

Molecular Biology by David P. Clarke, 1st edition; Elsevier Academic Press; 2005.

Molecular Cloning: A laboratory manual by Joseph Sambrook& David Russell, 3rd edition; CSHL press; 2001.

DNA Technology: The Awesome Skill by I. Edward Alcamo, 2nd edition; Hardcourt Academic Press; 2001.

Molecular Biology of the Gene by James Watson, Tania Baker, Stephen Bell, Alexander Gann, Michael Levine & Richard Losick , 6th Edition; CSHL Press; 2007.

### **Paper- 3: Microbial Physiology, Biochemistry and Bioinstrumentation**

#### **Scheme of Examination**

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 compulsory questions. Section B will consist of 10 questions (2 questions from each unit of the syllabus). Section C will consist of 5 questions (1 question from each unit of the syllabus).

**Maximum Marks: 75**

**Duration: 3 Hrs**

**Minimum Passing Marks: 19**

#### **UNIT-I**

Microbial growth: definition of growth, growth curve; The mathematics of growth-generation time, specific growth rate, batch and continuous culture. Temperature -temperature ranges for microbial growth. pH- pH ranges for microbial growth. Microbial transport : diffusion – Passive and facilitated, Primary active and secondary active transport, Group translocation (phosphotransferase system), symport, antiport and uniport.

Structure of atom, molecules and chemical bonds. Biochemistry of enzyme: classification, nomenclature, specificity, isolation and purification. Enzyme kinetics and inhibition. Co-enzymes. Allosteric and other regulations of enzyme activity, Mechanism of action of enzymes, Enzymes used in Industries: cellulase, amylase, glucosidase, invertase, protease, rennin, pectinase, lactase, lipase.

#### **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, Synthesis of cell membrane and cell wall of microbes, Synthesis of RNA and DNA in microbes.

### UNIT-III

Basic aspects of bioenergetics. Brief account of photosynthetic and accessory pigments, chlorophyll, bacteriochlorophyll, rhodopsin, carotenoids, phycobilliproteins. Microbial Oxidation of Inorganic Molecules: sulphur, iron, hydrogen and nitrogen. Methanogenesis and Bioluminescence.

### UNIT-IV

Carbohydrate: anabolism, autotrophy, aerobic and anaerobic photosynthesis, autotrophic generation of ATP, Fixation of CO<sub>2</sub> in Microorganism, Calvin cycle.

Catabolic break down of carbohydrates proteins and lipids

Respiratory pathways: Embden Mayer Hoff Parnas pathway, Entner Doudroff pathway, Glyoxalate pathway, Krebs cycle, ETC: electron carrier, artificial electron donors, inhibitors of ETC, and uncouplers.

Oxidative and substrate level phosphorylation, Reverse TCA cycle,

Gluconeogenesis, Pasture effect; Fermentation of carbohydrates: homo and heterolactic fermentations.

### UNIT -V

Microscopy and specimen preparation: light microscope, bright-field, dark-field, phase-contrast, fluorescent, electron microscopy (SEM, TEM), confocal microscopy and scanning probe microscopy. preparation and staining of specimens: fixatives and dyes, simple staining, differential staining, staining specific structures, Specimen preparation for electron microscopy.

Electrophoresis: zonal techniques, supporting medium, vertical, submarine and gradient electrophoresis. Isoelectric focusing.

Centrifugation general principal and types, Spectroscopy: Beer-Lambert relationship components of a spectrophotometer, type of detectors; UV-Vis spectrophotometry, atomic absorption spectroscopy. Application of spectroscopy. Separation methods: principles, general methods of separation; methods based on polarity (absorption chromatography, liquid chromatography, gas-liquid chromatography), methods based on ionic nature (ion-exchange chromatography), methods based on shape (affinity chromatography), HPLC.

#### **Suggested Readings**

Nelson D. L. and Cox M. M. (2005) *Lehninger's Principles of Biochemistry*, Fourth edition, W. H. Freeman & Co. New York.

Voet Donald and Voet Judith G. (1995) *Biochemistry*, 2nd Ed.. John Wiley and sons New York.

White Abraham, Handler Philip, Smith Emil, Hill Rober, Lehman J. (1983) Principles of Biochemistry, Edition 6, Tata Mc-Graw Hill Companies, Inc.

White David (2000) *Physiology and Biochemistry of Prokaryotes*. 2nd Ed. Oxford University Press, New York.

Zubay Geoffrey (1998) *Biochemistry*, 4th Ed., W. C. Brown, New York.

Moat Albert G. and Foster John W. (1988) *Microbial Physiology* 2nd Ed. John Wiley and Sons New York.

Berg Jeremy, Tymoczko John, Stryer Lubert (2001) *Biochemistry*. 6th Edition, W. H. Freeman, New York.

Conn Eric, Stumpf Paul K., Bruening George, Doi Roy H., (1987) *Outlines of Biochemistry*. 5th Edition, John Wiley and Sons, New Delhi.

Dawes Edwin A. (1972). *Quantitative Problems in Biochemistry*, Churchill Livingstone, Edinburgh.

Laskin A. I. and Lechevalier H. A. (1977), *CRC Handbook of Microbiology*, Vol. 1, Bacteria, CRC Press Ohio.

Metzler David E. (2001) *Biochemistry: The Chemical Reactions of Living Cells*, Volume 1 & 2, Academic Press California.

Clayden, Greeves, Warren and Wothers, *Organic Chemistry*, Oxford Press

Jerry March, *Advanced Organic Chemistry*, John Wiley

Alberts Bruce (1985) *Molecular Biology of Cell*. Garland Pub.

Garrett, R. H. and Grisham, C. M. (2004) *Biochemistry*. 3rd Ed. Brooks/Cole, Publishing Company, California.

Mandelstam Joel and McQuillen Kenneth (1976) *Biochemistry of Bacterial Growth*, Blackwell Scientific Publication London.

Segel Irvin H. (1997) *Biochemical Calculations* 2nd Ed.,

Voet Donald & Voet Judith G. (1995) *Biochemistry*, 2nd Ed. John Wiley & Sons New York.

Cotterill, R. M. J. (2002) *Biophysics: An Introduction*. John Wiley & Sons, England.

Drenth, J. (2007) *Principles of protein X-ray crystallography*. 3rd Ed. Springer, Germany.

Wilson Keith and Walker John (2005) *Principles and Techniques of Biochemistry and Molecular Biology*, 6th Ed. Cambridge University Press, New York.

Keeler, J. (2002) *Understanding NMR Spectroscopy*. John Wiley & Sons, England.

#### **Paper- 4: Biostatistics & Computer Applications & Bioinformatics**

##### **Scheme of Examination**

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 compulsory questions. Section B will consist of 10 questions (2 questions from each unit of the syllabus). Section C will consist of 5 questions (1 question from each unit of the syllabus).

**Maximum Marks: 75**

**Duration: 3 Hrs**

**Minimum Passing Marks: 19**

### **UNIT-I**

Definition of statistics, symbols, notations and terminology of statistics, Collection of data: primary and secondary data; parameter and 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. Construction of histograms and their interpretations.

### **UNIT-II**

Central tendency & partition values: Mean, mode, median; quartiles, quintiles, deciles and percentiles. Measure of dispersion: mean deviation, standard deviation and variance. Probability: the probability scale, measures of probability. Probability distributions: Normal distribution, Binomial distribution, Poisson distribution. Student Regression and Correlation: Scatter diagram, simple linear regression, correlation coefficient.

### **UNIT-III**

F-test and ANOVA. Test of significance of mean: standard error, student 't' test. The chi-square test. Statistical basis of biological assays, Response-Dose relationship.

Introduction to research methods: research question, literature review, theoretical framework or model, formulation of objectives and research hypothesis, population under study, statistical design, sample size, methods of data collection, data processing.

### **UNIT-IV**

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

### **UNIT-V**

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

#### **Suggested Readings**

Cochran W. G. – Sampling Techniques, Wiley esternLtd, New Delhi.

Feller W. Introduction to probability theory and its applications, Asia Publishing House, Mumbai.

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

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

Irfan Ali Khan and Atiya Khanum, Fundamentals of Biostatistics. 2nd Ed. Ukaaz Publications, Hyderabad.

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

Murthy M.N. Sampling methods, Indian Statistical Institute, Kolkata.

Wayne Daniel 2007. Biostatistics, a foundation for analysis in the health Sciences, Edn. 7, Wiley-Indian Edn.

Baldi, P. and Brunak, S. (2001) *Bioinformatics: The machine learning approach*. Bradford Book, MIT Press, Cambridge.

Baxevanis, A. D. and Ouellette, B. F. F. (2001) *Bioinformatics: A practical guide to the analysis of genes and proteins*. 2nd Edition. John Wiley & Sons, New York.

Ewens Warren J. and Gregory R. Grant. (2004) *Statistical Methods in Bioinformatics, An Introduction*, Springer, New York.

Lacroix, Z. and Critchlow, T. (Eds.) 2003. *Bioinformatics. Managing Scientific Data*. Morgan Kaufmann Publishers.

Misener, S. and Krawetz, S. A. (Eds.). 2000. *Methods in Molecular Biology*, Volume 132. Bioinformatics: Methods & Protocols. Humana Press, New Jersey.

Mount, D. W. (2001) *Bioinformatics: sequence and genome analysis*. Cold Spring Harbor Laboratory Press, NY.

Zoe L. & Terence C. (2004) *Bioinformatics: Managing Scientific Data*, Morgan Kaufmann Publishers, New Delhi.

### **PRACTICAL**

Isolation and identification of Bacteria.

Isolation and identification of important Fungi.

Morphology of important Protozoa, Algae and Viruses.

Oculometry, Microbial biochemical tests

Staining of Bacteria, Fungi and Spores.

Media preparation and incubation methods.

Microbial studies of air, water, food, sewage and soil.

Chick embryo inoculation for viruses.

Biochemical test for- Carbohydrate, fats, proteins

Practical's based on enzyme kinetics.

Isolation of carbohydrates, proteins and fats.

Chromatographic separation methods for pigments and Amino acids.

Isolation of plasmids.

Studies of bacteriophages.

Quantitative and qualitative analysis of DNA/RNA.

PCR amplification of DNA  
Electrophoresis of DNA/RNA/Protein.  
Isolation of DNA/RNA from plant, animal cell, bacteria.  
Restriction digestion, ligation of DNA and cloning

**M.Sc. Final Examination 2022**  
**Paper- 5: 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 compulsory questions. Section B will consist of 10 questions (2 questions from each unit of the syllabus). Section C will consist of 5 questions (1 question from each unit of the syllabus).

**Maximum Marks: 75**

**Duration: 3 Hrs**

**Minimum Passing Marks: 19**

**UNIT-I**

Introduction to fermentation processes, history of fermentation process.  
Bioreactors: Design and components- vessel materials, baffles, impellers, inoculation and sampling devices etc., biohazard and containment.  
Use of biosensors in fermentation process.  
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, preservation and maintenance of industrially important microorganisms.  
Selection and screening of microorganism for industrial processes.  
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.

**UNIT-III**

Types of fermentation processes with Growth 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, supercritical fluid extraction, drying and crystallization.

**UNIT-IV**

Production process for food supplements: Yeast (Bakers, food and fodder), Single cell protein (SCP), Single cell and Single cell oil (SCO).  
Production process for acids: Lysine, Glutamic acid, lactic acid and Citric acid.

Production process for alcohols and alcoholic beverages: Ethanol, Beer, Wine and Whisky.

Production process for food products: Sauerkraut, Bread, Cheese, Yoghurt.

Production process of enzymes for amylases and proteases.

Production process for antibiotics: penicillin, streptomycin and tetracycline.

Production of vitamins: Vitamin B, Riboflavin fermentation

#### **UNIT-V**

Production of non-microbial product through GEMs: insulin, interferon, cell growth factors, tissue plasminogen activator. Biogums, Bioplastic (PHB, PHA), Biochips and nanotechnology. Steroid transformation. Production of bioinsecticides.

Vaccine types: live, attenuated and recombinant and their production.

Parameters Affecting Microbial Growth in Foods: Intrinsic, Extrinsic. Food Preservation & Principles of Quality Control: Chemicals, antibiotics, Radiation, Low and high temperature, High-Pressure Processing. Aseptic Packaging, Microbiological quality standards of food, FDA, HACCP, ISI.

Microbial Food Spoilage and Food borne diseases: Staphylococcal, *E. coli*, Salmonellosis, shigellosis. Mycotoxins, Aflatoxins, and viruses.

#### **Suggested Readings**

Biotechnology: A Text Book of Industrial Microbiology by W. Crueger & A. Crueger, Panima Publishing Corporation, New Delhi/Bangalore, 2000.

Principles of Fermentation Technology by P.F. Stanbury, W. Whitaker & S.J. Hall, Aditya Books (P) Ltd., New Delhi, 1997.

Modern Industrial Microbiology & Biotechnology by N. Okafer, Scientific Publishers, Enfield, USA., 2007.

Fermentation Microbiology and Biotechnology by El Mansi & Bryce, Taylor & Francis, London, Philadelphia, 1999.

Fermentation Biotechnology by O.P. Ward, Open University Press, Milton Keynes, U.K., 1989

Industrial Microbiology: An Introduction by Waites, Morgan, Rocky & Highton, Blackwell Science, 2001.

Biochemical Engineering and Biotechnology by B. Atkinson & F. Mavituna, The Nature Press, 1982

Microbial Biotechnology: Fundamentals of Applied Microbiology by Glazer & Nikaido, W.H. Freeman and Co., New York, 1995.

Modern Food Microbiology, 4th edition by J.M. Jay, Springer, 2006.

Fundamental Food Microbiology, 3rd edition by B. Ray., CRC press, 2006.

Food Microbiology: Fundamentals and Frontiers, 2nd edition by Michael P. Doyle, Larry R. Beuchat, Thomas J. Montville, ASM press, 2001.

Food Microbiology by M.R. Adams & M.O. Moss., Royal Society of Chemistry, 2000.

Food Microbiology by M.R. Adams, Royal Society of Chemistry, 2008.

## **Paper- 6: 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 compulsory questions. Section B will consist of 10 questions (2 questions from each unit of the syllabus). Section C will consist of 5 questions (1 question from each unit of the syllabus).

**Maximum Marks: 75**

**Duration: 3 Hrs**

**Minimum Passing Marks: 19**

#### **UNIT-I**

**Aero Microbiology :** Droplet nuclei, aerosol, assessment of air quality,-solid - liquid - impingement methods,- Brief account of air borne transmission of microbes - viruses - bacteria and fungi, their diseases and preventive measures. Assessment of air quality for microbial loads.

**Aquatic microbiology:** Water ecosystems - types -fresh water (ponds, lake, streams) - marine habitats (estuaries, mangroves, deep sea, hydrothermal vents, salt pans, coral-reefs). Zonations of water ecosystems -upwelling -eutrophication - food chain. Potability of water- microbial assessment of water quality- water purification - brief account of major water borne diseases and their control measures.

#### **UNIT-II**

Inter species interactions: Antagonism, competition, commensalisms, synergism, parasitism and predation. Gansse's and Hardin's principles of competition. Defense mechanisms (specific and non specific) of microorganisms.

Beneficial interactions of microbes with animals: Symbiosis of roaches and bacteriodes, bacteria and protozoa, algae and invertebrates. Symptiotic cellulose digestion in insects and vertebrates. Rumen microbiology, digestion, fermentation and detoxification by microbes, factors influencing rumen microbes.

#### **UNIT-III**

Microbial ecology: Concepts, microbial behavior in ecosystems, microbial biodiversity, interaction among the microbial populations, development of microbial communities. Oxygenic photosynthetic microbes and anoxygenic photosynthetic microbes. Oxidative transformation of metals: sulfur oxidation, iron oxidation, ammonia oxidation and hydrogen oxidation. Environmental stresses

#### **UNIT-IV**

**Waste water treatment :** Wastes - types- solid and liquid wastes characterization- solid - liquid; treatments- physical, chemical, biological- aerobic- anaerobic -primary - secondary- tertiary; solid waste treatment - saccharification- gasification- composting, utilization for solid wastes - (SCP, mushroom, yeast): fuel (ethanol, methane) fertilizer(composting), liquid waste treatment- trickling- activated sludge-oxidation pond- oxidation ditch. Subterranean microbes and bioremediation



## UNIT-V

**Biodeterioration and biodegradation:** microbial degradation of paints, plastics, rubber, pharmaceuticals, paper, leather, wood, wool, petroleum and petroleum products, degradation of xenobiotics, pesticides and polymers. Microorganisms involved -its disadvantages- mode of prevention. GMO and their impact, Bioremediation.

### Suggested Readings

Microbial Ecology By Atlas R.M., Bartha R., Benjamin Cummings Publishing Co, Redwood City, CA., 1993.

Environmental Microbiology by A.H. Varnam & M.G. Evans, Manson Publishing Ltd., 2000.

Manual of Environmental Microbiology by Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.

Environmental Microbiology by W.D. Grant & P.E. Long, Kluwer Academic Publishers, 1981.

## Paper- 7: Geomicrobiology, Soil & Agricultural Microbiology

### Scheme of Examination

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 compulsory questions. Section B will consist of 10 questions (2 questions from each unit of the syllabus). Section C will consist of 5 questions (1 question from each unit of the syllabus).

**Maximum Marks: 75**

**Duration: 3 Hrs**

**Minimum Passing Marks: 19**

## UNIT-I

Geomicrobiology: Origin of microbial life, Chemical and Biological evolution. Geomicrobiology of fossil fuels. Biobleaching and biomining.

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.

## UNIT-II

Decomposition of Plant Litter: Microbes involved, fermentation of plant litter, Agricultural and urban waste compost, vermicompost, mushroom compost, silage, methane production, biogas plants.

Microbiology of Rhizospheres, phyllosphere and spermosphere, Mycorrhizal associations, Rhizobial and actinorhizal root nodules and stem nodules and nitrogen fixation.

### UNIT-III

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, Papaya leaf curl, Cucumber mosaic and Tobacco necrosis.

Bacterial diseases: Citrus canker, Crown gall

Fungal diseases: Green ear of bajra, Cotton wilt, Tikka disease of groundnut, Wheat rusts and Loose and Covered smuts.

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

### UNIT-IV

Microbial pathogens of plant roots and shoots, their control by competition and antagonism; importance of *Trichoderma viride*; *T.harzianum*; *Streptomyces*, *Rhizobacteria*, *Mycorrhiza* and *Thiobacillus* on the control of plant root pathogens; control of aerial pathogens, prophylaxis, pre-inoculation, and immunization with avirulent pathogens; role of microorganisms in protecting the wounds of trees; techniques of application of microorganisms for control of microbial diseases; seed treatment, aerial spray and soil treatment

### UNIT-V

Biofertilizers: Production technology, standards, storage and application methods for *Rhizobium*, *Azotobacter*, *Azospirillum*, *Cyanobacteria*, *Azolla*. Biological nitrogen fixation - nitrogenase enzyme - nif genes; symbiotic nitrogen fixation - (*Rhizobium*, *Frankia*)- non-symbiotic microbes- *Azotobacter*-*Azospirillum* PSM, Cellulolytes, VAM and PGPR.

Microbial pesticides: biology and chemistry of the biocidal component, mode of action, effect on target organisms, production technology and commercial microbial pesticides.

Microbial insecticides; advantages of microbial insecticides, limitations-Mass production techniques; fermentation, formulation of insecticides, carrier materials quality control etc; compatibility of microbial and chemical insecticides; suitable insecticides for major pests; field application of microbial insecticides and its perpetuation.

#### **Suggested Readings**

Introduction to Geomicrobiology, Konhauser K. BlackWell Publishing, USA, 2007

Geomicrobiology and Biogeochemistry. Parmar N. & Singh A. Springer Heidelberg New York Dordrecht London, 2014

Plant Pathology by Agrios G. N. Academic Press, San Diego;1997.

The Nature and practice of Biological Control of Plant Pathogens by Cook R. J. & Baker K. F.; 1983.

AmercaPhytopathological Society Press, St. Paul, MN.

Environmental Biotechnology by Forster C. F. & John D.A. Ellis Horwood Ltd. Publication;2000.

A Manual of Environmental Microbiology by Christon J. H. ASM Publications;2001.

Soil Microbiology by Rao, N.S.S. Oxford & IBH Publishing Co., New Delhi;1999.

## Paper- 8: Medical Microbiology & Immunology

### Scheme of Examination

The question paper will consist of three Sections: A, B and C. Section A will consist of 10 compulsory questions. Section B will consist of 10 questions (2 questions from each unit of the syllabus). Section C will consist of 5 questions (1 question from each unit of the syllabus).

**Maximum Marks: 75**

**Duration: 3 Hrs**

**Minimum Passing Marks: 19**

### UNIT –I

Early discovery of pathogenic microorganisms. 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, Role of aggressins, depolymerizing enzymes, organotropisms, variation and virulence.

### UNIT-II

**Important diseases of human beings** (short description of causal agent, pathogenesis, diagnosis, vaccine 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, Encephalitis Mumps and Measles.

**Fungal diseases:** Ringworm, Histoplasmosis.

**Mycoplasmal diseases:** inflammation of genitals, upper respiratory tract infection

**Important bacterial (Anthrax, Black quarter, Tuberculosis, Brucellosis, Contagious pleuro pneumonia) and viral (Foot and mouth disease, Rinderpest, Cow pox, Sheep pox, Rabies, blue tongue) diseases of domestic animals** (causal agent epidemiology, pathogenesis, diagnosis, vaccine and treatment).

### UNIT-III

Laboratory control of antimicrobial therapy; various methods of drug susceptibility testing, antibiotic assay in body fluids. Brief account on available vaccines and Schedules; passive prophylactic measures; Prokaryotic signaling mechanisms: Quorum sensing and bacterial pheromones, intracellular signaling, signaling pathways.

#### UNIT-IV

Historical background: Humoral and Cellular components of the immune system. Innate Immunity: Skin & mucosal surface, Physiological Barriers, Phagocytic barriers, Inflammation, Adaptive immunity. Cells and Organs of Immune System.

Antigens: Structure, properties, types, epitopes, haptens. Antibodies: Structure and function, antibody mediated functions, classes and biological activities. Monoclonal antibodies. Antigen-Antibody Interaction. Major Histocompatibility Complex- structure, functions, function and genes.

#### UNIT-V

Cytokines (Properties, receptors, antagonism & secretion). The complement system (functions, components, activation, regulation and deficiencies). Cell mediated effector responses: Cytotoxic T-cells, natural killer cells, antibody-dependent cell-mediated cytotoxicity. Hypersensitive reactions (Type I,II,III and delayed type (DTH).

Immune response to infectious diseases: viral, bacterial and protozoan. Vaccines. Immuno-deficiencies.

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

**Autoimmunity;** Organ specific and systemic, Autoantibodies, experimental models

#### **Suggested Readings**

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

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

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

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

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.

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

#### PRACTICAL

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

Soil analysis and soil microbial count.

Studies of soil protozoa.

Studies of soil Mycology.

Studies of bacterial, fungal and viral diseases and their diagnosis.

Study of airborne pollen and fungal spores.  
Microbial examination of water, food and milk.  
Laboratory production of Penicillin, Curd, Mushroom, Fermented food  
Activity of amylase, cellulase and catalase.  
Effect on growth of microbes-  
Temperature, (b) Aeration, (c) pH, (d) Nutrients.  
Normal micro flora studies of skin, Respiratory tract, Gastro-intestinal tract, uro-genital tract and important organisms causing disease in the above mentioned tracts.  
Study of Leprosy, Tuberculosis, Brucellosis, Typhoid, Cholera, Syphilis, Meningitis, Herpes, AIDS disease of human beings by visiting near by hospital.  
Study of Mastitis, Metritis, Anthrax, Rinderpest and Ranikhet, disease in animals and birds by visiting near by animal hospital.  
Isolation of one pathogenic organism.  
Ochterlony double diffusion, agglutination test, Fluorescent Antibody test.  
Examination blood.  
Examination urine.  
Examination sputum.  
Blood group and Rh factor.  
ELISA test for AIDS.  
Cultivation of animal cells.  
Callus growth technique.  
Testing of milk by MBRT.  
Serological tests: Radio immuno-diffusion, Immuno-electrophoresis, DOT ELISA, Sandwich ELISA,

### **Paper-RP/CS**

#### **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: 50**

**Duration: 10 min per student**

**Minimum Passing Marks: 13**

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.