Proposed Syllabus and Structure
For
M.Sc. Microbiology

Choice Based Credit System
(2020-21)

Date of BoS: 05 January 2021

Department of Microbiology
Dr. Harisingh Gour Vishwavidyalaya (A Central University)
Sagar (M.P.) 470003

About the Department

The pioneering work done in the Microbiology and Mycology laboratory of the Botany department triggered a vision of initiating a full-fledged curriculum in Applied Microbiology and Biotechnology at Dr. Harisingh Gour Vishwavidyalaya, Sagar. The idea conceived by the founder head, Prof. S. C. Agrawal (Head:1996-2004) resulted in the start of this much awaited PG course in Life Science faculty in 1990-91.

Under the able directios and untiring efforts of Late Prof. P.C. Jain (Head: 2004-2012) the department could acquire the present status. Since then department has stood among the front runners in teaching and research in Microbiology and occupies a place of prominence in the field. In last ten years the department has witnessed a great deal of expansion with regards to infrastructure and facilities as a seat of higher learning in Microbiology. With the establishment of Central University in 2009, the department was renamed as Department of Microbiology and became a part of School of Biological Sciences (SBS).
The department offers following courses:

S.No.	Course	Intake
1.	M.Sc. Microbiology	19
2.	Ph.D. Microbiology	12* (*subject to availability of seats)

The department has published significant number of publications in the leading national and international peer reviewed scientific journals. In past, the department has also organized several hand's on workshops, national and international conferences. At the department of Microbiology, research is being pursued in both basic and applied areas of Microbiology. With an inclination towards inter disciplinary research, faculty members in the department have forged active collaboration within and outside the university. Recently, laboratories of bioimaging, infection and immunity and host-pathogen interaction have been established. The major research fields encompass microbial hemicellulases, inulinases, L-asparaginase, thermophilic fungi, immobilized biocatalysts, bioimaging, fructosyltransferase, nanobiotechnology etc.

1. Name of the Program: **M.Sc. Microbiology**

2. Duration of the program:

(a) Minimum duration: Two years
(b) Maximum duration: Four Years

3. Structure of the program:

(a) Number of Core Courses: 0**8**
(b) Minimum number of Elective Courses to be opted by the student : 0**4**
(c) Minimum number of open Elective Courses to be opted by the student: **01**

4. Scheme of examination
(a) Mid Semester Examination : 20 Marks
(b) Internal Assessment : 20 Marks
(c) End Semester Examination : 60 Marks

5. Assessment:

1) Internal Assessment:
a) Theory
Each theory course must clearly mention the methodology of assessment i.e. assignment, presentation, group discussion etc. depending on the number of students in the class and feasibility of adopting a particular methodology. The distribution of marks of internal assessments shall be as follows:

(i) Evaluation of the assignment
Presentation, group discussion etc. : 15 marks
(ii) Attendance : 05 marks

The marks for attendance shall be awarded as follows:

(i)	75% and below	: 00 Mark
(ii)	>75% and upto 80%	: 01 Mark
(iii)	>80% and upto 85%	: 02 Marks
(iv)	>85% and upto 90%	: 03 Marks
(v)	>90% and upto 95%	: 04 Marks
(vi)	>95%	: 05 Marks

Note: To be eligible to appear in End Semester Examination a student must appear in Mid Semester Examination and Internal Assessment.

b) Practical/Lab Courses:

1. Evaluation of Practical/Lab Courses shall be as follows:

(i) Performing and getting the experiment checked regularly and Incorporating the suggestions in the practical note book : 15 Marks
(ii) Attendance : 05 Marks

The marks for attendance shall be as follows:

(i)	75% and below	: 00 Mark
(ii)	>75% and upto 80%	: 01 Mark
(iii)	>80% and upto 85%	: 02 Marks
(iv)	>85% and upto 90%	: 03 Marks
(v)	>90% and upto 95%	: 04 Marks
(vi)	>95%	:05 Marks

c) End Semester Examination for practical/Lab Courses:

It will consist of 60 marks as follows:
(a) Assessment of performance in the Experiment : 50 Marks
(b) Viva-Voce of Experiment : 10 Marks

d) Evaluation of Projects:

It will be based on periodic assessment of the progress of the project and End Semester Examination as follows:

(i)	First periodic assessment of the progress after 08 weeks	: 20 Marks
(ii)	Second periodic assessment after 04 weeks	: 20 Marks
(iii)	End Semester Examination will consist of :	
	(a) Evaluation of the project report	: 50 Marks
	(b) Viva-Voce of the project report	: 10 Marks

Department of Microbiology
Dr. Harisingh Gour Vishwavidyalaya, Sagar
Scheme of M.Sc. Program in Microbiology under CBCS System

I Semester

Core Courses			
S.No.	**Course Code**	**Name of the Course**	**Credit**
1.	MIC CC 121	General Microbiology and Microbial Diversity (Theory)	**4**
2.	MIC CC 122	General Microbiology and Microbial Diversity (Practical)	**2**
3.	MIC CC 123	Principles of Biochemistry(Theory)	**4**
4.	MIC CC 124	Principles of Biochemistry(Practical)	**2**
5.	MIC CC 125	Bioinstrumentation, Bioinformatics and Biostatistics (Theory)	**4**
6.	MIC CC 126	Bioinstrumentation, Bioinformatics and Biostatistics (Practical)	**2**
7.	MIC CC 127	Enzyme Technology (Theory)	**4**
8.	MIC CC 128	Enzyme Technology (Practical)	**2**

II Semester

Core Courses			
S. No.	**Course Code**	**Name of Course**	**Credit**
1.	MIC CC 221	Microbial Physiology and Metabolism (Theory)	**4**
2.	MIC CC 222	Microbial Physiology and Metabolism (Practical)	**2**
3.	MIC CC 223	Industrial Microbiology (Theory)	**4**
4.	MIC CC 224	Industrial Microbiology (Practical)	**2**
Elective Courses			
5.	MIC EC 221	Environmental Microbiology (Theory)	**3**
6.	MIC EC 222	Environmental Microbiology (Practical)	**1**
7	MIC EC 223	Methods in Molecular Biology (Theory)	**3**
8.	MIC EC 224	Methods in Molecular Biology (Practical)	**1**
Open Elective			
9.	MIC OE 221	World of Microbes (Theory)	**2**

III Semester

Core Courses			
S. No.	**Course Code**	**Name of Course**	**Credit**
1.	MIC CC 321	Medical Microbiology and Immunology (Theory)	**4**
2.	MIC CC 322	Medical Microbiology and Immunology (Practical)	**2**
3.	MIC CC 323	Microbial Genetics and Molecular Biology (Theory)	**4**
4.	MIC CC 324	Microbial Genetics and Molecular Biology (Practical)	**2**
Elective Courses			
5.	MIC EC 321	Food and Dairy Microbiology (Theory)	**3**
6.	MIC EC 322	Food and Dairy Microbiology (Practical)	**1**
7.	MIC EC 323	Principles of Bioimaging (Theory)	**3**
8.	MIC EC 324	Principles of Bioimaging (Practical)	**1**

IV Semester

Core Course			
S. No.	**Course Code**	**Name of Course**	**Credit**
1.	MIC CC 421	Project Work / Dissertation on any Microbiology related aspect	**16**

Scheme

Core Course	**Dept. Elective**	**Open Elective**	**Project Work**	**Total**
8 *6 = 48	**4*4=16**	**2**	**16**	**82**

CC- Core Course, EC- Department Specific Elective, OE- Open Elective

00

Department of Microbiology						
Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	**Microbiology**	**I**	**MIC CC 121**	**General Microbiology and Microbial Diversity (Theory)**	**Mid Sem 40** **End Sem 60**	**04**

Unit 1 12 hours

Milestones in development of Microbiology: Contributions of Leeuwenhoek, Pasteur, Jenner, Koch, Metchnikoff, Waksman etc.

Bergey's Manual of and Systematic Bacteriology. Microbial taxonomy: Numerical taxonomy and basis of Three domain classification (Carl Woese).

Structural components of Eubacteria: Ultra structure of bacterial cell A) Cell wall; B) Surface adherents: capsule and slime layer; C) Surface appendages: Flagella and Pili; D) Endospores. Staining: Gram's staining, Endospore, Capsule, Acid fast staining.

Unit 2 12 hours

Principles of microbial growth: Liebig's Law and Shelfords law. Microbial classification based on energy and nutrient requirements. Introduction to biochemical characteristics based on carbohydrate metabolism (oxidative and fermentative metabolism; gas production; MR-VP test) and nitrogen metabolism (Indole production).

Unit 3 12 hours

Bacteriology: Microbial diversity of Archaebacteria: Classification, Characteristic features and importance. Characteristics of methanobacteria, halophiles, thermoacidophiles.

Microbial diversity of Eubacteria: Structure-function, properties and economic importance of Gram Positive (Actinomycetes) and Gram negative bacteria Spirochetes, Chlamydia, Rickettsia and Mycoplasma.

Unit 4 12 hours

Mycology: General characteristics of Division Eumycota with emphasis on Morphology, Reproduction and Nutrition in Fungi. General characteristics and life-cycle of Oomycetes (Phytophthora) *Rhizhopus / Mucor* (Zygomycetes). *Saccharomyces* (Ascomycetes). *Agaricus* (Basidiomycetes), characteristics and importance of Deuteromycetes.

Unit 5 12 hours

Virology: General characteristics structure of and classification of virus ultra structure TMV-Lytic and Lysogenic cycle in bacteriophoges. Life cycle of HIV and Herpes simplex virus.

Department of Microbiology						
Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	**Microbiology**	**I**	**MIC CC 122**	**General Microbiology and Microbial Diversity (Practical)**	**Mid Sem 40 End Sem 60**	**02**

60 Hours

List of Practicals

1. Preparation of A) Nutrient agar (NA) for bacterial isolation and B) Potato/Sabouraud Dextrose Agar (PDA/SDA) for fungal/yeast growth.
2. A) Isolation and growth of rhizosphere bacteria on NA plate using serial dilution and spread plate method. B) Isolation and growth of fungal colony on PDA/SDA plate.
3. Preparation of single bacterial colony using streak plate method.
4. A) Bacterial identification: Morphological staining and biochemical tests on isolated bacteria. B) Fungal identification: Spore and hyphal staining and their characteristics.
5. General characteristics and microscopic identification of Bacteria & Fungi.
6. Isolation of plaques from sewage water.

Essential Readings:

1. The Microbial World by Stainier R.V., Ingraham, J.L., Wheelis, M.L. and Painter P.R. , Prentice-Hall of India (Pvt.) Ltd., New Delhi.
2. Microbiology By Pelczar M., Chan E.C.S. and Krieg, N.R. Tata Mc Grew Hill Pub. Co. Ltd., N. Delhi.
3. Brock-Biology of Microorganisms Madigan M.T., Martinko J.M. and Parker J., Prentice Hall Int. Inc.
4. An Introduction to Mycology by Mehrotra, R.S. and K.R.Aneja, New Age International Press, New Delhi.
5. Webster, J. 1985. Introduction to fungi . Cambridge University Press. Cambridge, U.K.
6. Kango, N. (2009). Textbook of Microbiology. IK international Publishers, New Delhi.

Suggested Readings:

1. Bergey's Manual of Determinative Bacteriology (8 Edition) Buchanan, R.E. and Giboson, N.E.,Williams and Wilkinson company, Baltimore
2. Morphology and Taxonomy of fungi By E.A. Bessey, Vikas Publishing House Pvt. Ltd., New Delhi.

Department of Microbiology						
Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	**Microbiology**	**I**	**MIC CC 123**	**Principles of Biochemistry (Theory)**	**Mid Sem 40** **End Sem 60**	**04**

Unit 1 12 hours

Concept of pH and buffers, pKa, Amino Acids: Classification, structure and properties, unusual amino acids, peptides, Isoelectric point, Zwitter ion, Proteins: Classification, structure and functions.

Unit 2 12 hours

Carbohydrates: Classification, structure, properties and functions. Aldoses, ketoses, monosaccharide, disaccharides, polysaccharides, homo and Heteropolysaccharides, Starch, Glycogen, Chitin, Cellulose, Peptidoglycan, Metabolism of monosaccharides.

Unit 3 12 hours

Nucleic Acids: Structure of nucleotides. Structure and properties of RNA and DNA, Variation from Watson and Crick model, Special structures of DNA, Hybridization, Hypo and hyperchromic shift, Tm, Concept of Central Dogma, Concept of genes and their regulation.

Unit 4 12 hours

Lipids: Classification, structure, types and biological functions- Oils, fats, waxes, fatty acids, phospholipids, Sphingolipids, galactolipds, Sulpholipids, Steroids, Lipids in signal transduction.

Unit 5 12 hours

Transport of molecules -Active and passive, diffusion, Group translocation, Ionophores; Membrane proteins, Cell Junctions, Molecular mechanism of signal transduction pathways.

Class	Subject	Semester	Course Code	Course Title	Marks	Credit
M.Sc.	**Microbiology**	**I**	**MIC CC 124**	**Principles of Biochemistry (Practical)**	**Mid Sem 40 End Sem 60**	**02**

List of Practicals

1. Fehling's test and Molisch's test for detection of carbohydrates.
2. Demonstration of light absorption by Nucleic acid.
3. Detection of proteins using spectrophotometry
4. Quantification of proteins.
5. Quantification of Nucleic Acids
6. Agarose gel electrophoresis for nucleic acid visualization.
7. Analysis of quality of DNA/RNA by spectrophotometer.
9. Demonstration of phenomena of hypochromic shift and hyperchromic shift.

Essential Readings:

1. Biochemistry by G. Zubey.
2. Biochemistry, D. Freifilder, W.H. Freeman & Company.
3. Harper's Biochemistry, Murray et al., Mc Graw Hill.
4. Principles of Biochemistry, Lehininger, Nelson and Cox.

Suggested Readings:

1. Biochemistry, Stryer 5th edition W.H. Freeman 2001
2. Clinical Biochemistry by MN Chaterji and Rana Shinde

Department of Microbiology						
Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	**Microbiology**	**I**	**MIC CC 125**	**Bioinstrumentation, Bioinformatics and Biostatistics (Theory)**	**Mid Sem 40 End Sem**	**04**

Unit 1 12 hours

Principles and applications of sterilization: Physical and chemical control of microorganisms: Heat, filtration and radiation. Use of halogens, and phenolic compounds, heavy metals, alcohols, ethylene oxide, aldehydes and hydrogen peroxide for sterilization.

Unit 2 12 hours

Microscopy and microscopic techniques: A general knowledge of principles involved in various types of microscopy and their applications including light microscopy, dark field, phase contrast microscopy, fluorescence microscopy and electron microscopy (SEM,TEM), Principle and practice of micrometry.

Unit 3 12 hours

Principle and applications of spectrophotometry, microplate reader, flow-cytometer, DNA sequencer and thermocycler (PCR). Principle, applications and types of centrifuge. Cellular fractionation

Unit 4 12 hours

Chromatographic techniques: Types and uses of paper chromatography, thin layer chromatography, column chromatography, high performance liquid chromatography (HPLC). Electrophoresis: principle and applications in characterization of proteins and enzymes.

Unit 5 12 hours

Biological databases for nucleic acid and proteins. Data mining, Database searching, Sequence alignment - BLAST, CLUSTAL W. Application of bioinformatic tools in microbiology. Mean, median and mode. Standard error, standard deviation. Respone surface methodology for optimization of bioprocess.

Department of Microbiology						
Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	**Microbiology**	**I**	**MIC CC 126**	**Bioinstrumentation, Bioinformatics and Biostatistics (Practical)**	**Mid Sem 40 End Sem 60**	**02**

List of Practicals:

1. Application of various methods/apparatus for sterilization of liquids/solids
2. Visualization of various microorganisms by using different microscopic techniques
3. To decipher the principle of Beer-Lambert`s law using spectrophotometer.
4. To amplify a single gene of interest by PCR.
5. To perform Paper/TLC chromatography of compounds
6. Separation of DNA fragments by Electrophoresis
7. Bioinformatics data mining/primer designing/BLAST

Essential Readings:

1. Biochemistry Laboratory Techniques by Chaykin, S.
2. Statistical Analysis in Biology by Mathur, K.
3. Introductory Practical Biostatistics by Mishra and Mishra.
4. Instrumental Methods of Chemical Analysis by Sharma, B.K.
5. Statistical Methods in Biology by Bailey, N.T.J. (3rd Ed.).
6. Fundamentals of Information Technology by Leon, A. and Leon, M. Vikas Publishing House and LeonPress Chennai.
7. Advances in Bio-Imaging: From Physics to Signal Understanding Issues: State edited by Nicolas Loménie, Daniel Racoceanu, Alexandre Gouaillard, 2012
8. Kango, N. (2009). Textbook of Microbiology. IK international Publishers, New Delhi.

Suggested Readings:

1. Fundamentals of Computers by C. Xavier, New Age Publishers, New Delhi.
2. Introduction to Bioinformatics by Parrysmith and Attwood.

Department of Microbiology						
Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	**Microbiology**	**I**	**MIC CC 127**	**Enzyme Technology (Theory)**	**Mid Sem 40** **End Sem 60**	**04**

Unit 1 12 hours

Introduction to enzymes: classification and nomenclature, Characteristics of enzymes. Mode of action and kinetics of enzyme catalyzed reactions (K_m, V_{max}). Types and Mechanism of enzyme inhibition, Biotechnological importance of enzymes.

Unit 2: 12 hours

Microbial sources of enzymes. Primary and secondary screening of microorganisms for enzyme production. Qualitative and quantitative assay of enzyme activity; Enzymes units Amylases, Cellulases, Hemicellulases, Proteases. Natural and synthetic substrates for enzyme assay,.

Unit 3: 12 hours

Microbial enzyme production: submerged and solid state fermentation (SSF). Important parameters in enzyme production. Enzyme purification Techniques- Precipitation, chromatographic separation-gel filtration, anion and cation exchange, zymography.

Unit 4 12 hours

Techniques used in characterization of enzymes- determination of molecular weight (SDS PAGE, Gel filtration), Isoelectric point, pH & temperature optima and stability, Inhibition pattern, Product analysis of enzyme action using TLC, HPLC, and MALDI-TOF

Unit 5 12 hours

Molecular biology of enzymes- aminoacid sequencing, structure and function relationship. Protein engineering & directed evolution. Cloning and over expression of microbial enzymes in heterologous host.

Department of Microbiology						
Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	**Microbiology**	**I**	**MIC CC 128**	**Enzyme Technology (Practical)**	**Mid Sem 40 End Sem 60**	**02**

List of Practicals

1. Primary screening of α-amylase and protease on solid media.
2. Quantitative estimation of microbial enzymes.
3. Preparation of standard for glycosidase, proteases etc.
4. End product analysis of enzyme action using TLC, HPLC.
5. Major steps of enzyme purification- precipitation, ion exchange chromatography, gel filtration
6. Zymography- visualization of enzymes on gels.
7. Use of synthetic substrates in enzyme assay.

Essential Readings:

1. Atkinson D.E. 1966. Regulation of Enzyme Action. Ann Rev. Biochem. 35: 85–124.
2. Fersht A. 1985. Enzyme Structure and Mechanism. 2nd ed. W.H. Freeman and Co., New York.
3. Microbial Biotechnology: Fundamentals of Applied Microbiology By Alexander N. Glazer, Hiroshi Nikaido, 2007
4. Advances in Enzyme Biotechnology (Eds Shukla & Pletschke), Springer 2013
5. Gutfruend H. 1972. Enzyme: Physical Principles. Wiley-Intescience, New York.
6. Price N.C., Stevens L. 1982. Fundamentals of Enzymology. Oxford University Press, Oxford.
7. Bailey, J.E., and Ollis, D. F. 1977. Biochemical engineering fundamentals, McGraw-Hill Book Company, London.

Suggested Readings:

1. Sumner J.B., Somers G.F. 1953. Chemistry and Methods of Enzymes. Academic Press, Inc., New York
2. Allan Svendsen 2016 Understanding Enzymes- Function, Design, Engineering, and Analysis. Pan Stanford Publishing Pvt. Ltd.

Department of Microbiology						
Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	**Microbiology**	**II**	**MIC CC 221**	**Microbial Physiology and Metabolism (Theory)**	**Mid Sem 40 End Sem 60**	**04**

Unit 1 12 hours

Microbial Growth and Movement: Mathematical nature and expression of microbial growth. Generation time. Synchronous growth. Bacterial growth in batch and continuous cultures, chemostats and turbidostats. *E.coli* chemotaxis system, structural organization of bacterial sensors for chemotaxis, mechanism of chemotaxis regulation.

Unit 2 12 hours

Central pathways of carbohydrate metabolism: Metabolic pathways in aerobic heterotrophs: Pyruvate formation (Embden-Meyerhof pathway (EMP) /glycolytic pathways, Pentose phosphate pathway (PPP) /hexose monophosphate shunt, Entner-Doudoroff pathway). Metabolic pathways utilizing pyruvate (TCA cycle, glyoxylate cycle).

Unit 3 12 hours

Energy production: Substrate level and oxidative phosphorylation. Electron Transport Chain. Note on transport system: Iron transport and phosphotransferase system.

Unit 4 12 hours

Microbial synthesis of purine and pyrimidine bases of RNA and DNA.
Biosynthetic pathways of Serine family (Serine, Glycine and Cysteine); Aromatic family (Tryptophan, Phenylalanine and Tyrosine); Pyruvate family (Alanine, Valine and Leucine).

Unit 5 12 hours

Biosynthetic pathways of Glutamate family (Glutamine, Arginine and Proline); Aspartate family (Asparagine, Methionine, Threonine, Isoleucine and Lysine) and Histidine.
Microbial synthesis of phospholipid (Phosphatidylethanolamine, Phosphatidylgycerol and cardiolipin).

Department of Microbiology						
Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	**Microbiology**	**II**	**MIC CC 222**	**Microbial Physiology and Metabolism (Practical)**	**Mid Sem 40 End Sem 60**	**02**

60 Hours

List of Practicals

1. Demonstration of bacterial growth curve using spectrophotometer/plate-reader (increase in OD at 600nm).
2. Effect of antibiotics or radiation on bacterial growth rate as demonstrated by spread plate method.
3. Demonstration of Bacterial chemotaxis/motility in bacteria.
4. Demonstration of bacterial biofilms as a product of its metabolism.
5. Demonstration of metabolically active cells using colour dyes e.g. SYBRGreen or tetrazolium salt 5-cyano-2,3-ditolyltetrazolium chloride (CTC) or other chemicals.

Essential Readings:

1. "The Microbial world" by Stanier, Ingraham, Wheelis and Painter. Mc Millan Educational Ltd., London.
2. Microbial Physiology by Moat and Foster , Wiley.
3. Essentials of Bacterial Physiology by Umbreit.
4. Bacterial Physiology and Metabolism by Skokatch.
5. Microbial life in Extreme Environments by Kushner, D.J. Academic Press.
6. Cell Biology by Pawar, C.B.
7. The control of Antibiotic Resistance in Bacteria by Sturart. Harris and Harris.
8. Biochemistry of Antimicrobial Action by Franklin and Snow, Chapman and Hall, New York.

Suggested Readings:

1. Manual of Methods for General Bacteriology by Philipp. G.
2. An Introduction to Practical Biochemistry by David T. Plummer.
3. Soil Microorganisms and Plant Growth by Subba Rao, N.S.

Department of Microbiology						
Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	**Microbiology**	**II**	**MIC CC 223**	**Industrial Microbiology (Theory)**	**Mid Sem 40 End Sem 60**	**04**

Unit 1 12 hours

Development and scope of industrial microbiology. Screening for economically important cultures (Primary and Secondary screening). Detection and assay of fermentation products: chemical and biological assay methods. Stock cultures and their preservation methods

Unit 2: 12 hours

Fermentation equipments: Design and construction of fermenters, Shaking device, aeration device, Monitoring of fermentation process. Characteristics of fermentation media, Raw materials (substrates). Scale up of fermentation processes, Product recovery methods

Unit 3 12 hours

Application of biotechnology in pharmaceutical industries: Production of antibiotics, (Penicillin, Streptomycin) and vaccines. Production and application of Microbial Enzymes: Amylases, proteases and cellulases. Immobilized enzymes and their application

Unit 4 12 hours

Microbiological production of beverages: Production of beer, wine and whiskey. Fermentative production of ethanol (Pasteur effect), Solvents and organic acids: Acetic acid, citric acid, n-butanol.

Unit 5 12 hours

Screening and microbial production of amino acids (L-lysine, L-Glutamic acid), Transformation of steroids. Importance of microorganisms of in leather, petroleum and mine industries, bioleaching of metals.

Department of Microbiology						
Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	**Microbiology**	**II**	**MIC CC 224**	**Industrial Microbiology (Practical)**	**Mid Sem 40 End Sem 60**	**02**

List of Practicals

1. Screening of microbial population for bioactive molecules- enzymes, antibiotics etc.
2. Production of bioactive molecules in shake flasks and lab scale fermenter.
3. Downstream processing of a bioprocess- separation (filtration, centrifugation, precipitation), chromatographic methods etc.
4. Quantification of biological activity (enzyme assay, bioassay)
5. Studies on effect of process parameters on growth and production of microorganism and product.
6. Production of alcoholic beverages using native yeasts and estimation of yield using distillation.
7. Application of industrial enzymes in production of platform sugars, oligosaccharides etc.
8. Application of alkalistable protease in detergents – destaining of clothes, dehairing of hides etc.

Essential Readings:

1. Industrial Microbiology by Casida, L.E.
2. Industrial Microbiology by Patel, A.H.
3. Industrial Microbiology by Miller and Litsky.
4. Industrial Microbiology by Prescot and Dunn.
5. Industrial Microbiology by Onions, Allsopp and Eggins.
6. Microbial Enzyme and Biotechnology by Fogarty and Kelly.
7. Biotechnology: A Text Book of Industrial Microbiology by Crueger and Anneliese Cruger. Panima Publishing Corporation, New Delhi.
8. Principles of Fermentation Technology By Stanbury , P.F., ABP, New Delhi.

Suggested Readings:

1. Comprehensive Biotechnology by Murrag (Ed.). Vol. I
2. Process development of Antibiotics fermentation by Calam, C.T.
3. Economic aspects of Biotechnology by Andrew J. Macking.

Department of Microbiology						
Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	**Microbiology**	**II**	**MIC EC 221**	**Environmental Microbiology (Theory)**	**Mid Sem 40 End Sem 60**	**03**

Unit 1 9 hours

Air Microbiology: Air borne microorganisms and their significance in human health and plant disease development. Microorganisms in indoor and outdoor environment. Techniques for analysis of air borne microorganisms – The settling plate technique, slit type sampler, liquid impinger, sieve sampler (Anderson's sampler and cascade sampler); Filtration methods

Unit 2: 9 hours

Water Microbiology: General distribution and factor affecting water microbes. Methods of purification of water (Small and Large scale purification), Bacterial contaminants in water: The coli form group and non-coliform groups.

Sewage: Composition and its disposal, major groups of microorganisms in sewage, BOD, treatment of domestic and municipal sewage.

Unit 3 9 hours

Soil as environment for microbial growth: Rhizosphere soil microorganisms. Rhizosphere effect. Role of microorganisms in mineral cycling (Nitrogen, Carbon, Phosphorus).

Solid waste & its management using microbes as tool.

Unit 4 9 hours

Microbial interactions: commensalisms, neutralism, synergism and antagonism, symbiosis. Soil as source of industrially important microorganisms. Screening of soil microorganisms for bioactive molecules: enzymes and antibiotics

Unit 5 9 hours

Concept and scope of Environmental biotechnology: Role of microorganisms in Bioremediation. Nature of industrial effluents of leather and pharmaceutical industries.

Department of Microbiology						
Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	**Microbiology**	**II**	**MIC EC 222**	**Environmental Microbiology (Practical)**	**Mid Sem 40 End Sem 60**	**01**

30 Hours

List of Practicals

1. Analysis of microorganisms present in different type of environment/air by settling plate/different Air sampler.
2. MPN analysis of sewage and tap water.
3. Screening of microbes from environment to show their economic potential e.g. enzyme secretion or antibiotic producers.
4. Demonstrating rhizosphere effect.
5. Isolation & identification of microorganism from different biomass.

Essential Readings:

1. Brock-Biology of Microorganisms Madigan M.T., Martinko J.M. and Parker J., Prentice Hall Int. Inc.
2. Sewage treatment in hot climates by Mara, D.
3. Biotechnology and waste water treatment by fields, M.L.
4. Tilak, S.T. (1989). Environmental ecology and aerobiology. Today & Tomorrow's Printers & Publishers. p222
5. Tilak S.T. 1987 “Air monitoring practical Manual”, Vaijanti Prakashan, Aurangabad.

Suggested Readings:

1. Introduction to soil microbiology by Alexander, Martin. John. Wiley & Sons Inc., NY.
2. Bioremediation by Barker, KH, & Herson, D.S. Mc Craw Hill Inc., New York.
3. Andersen, A. A. (1958) New sampler for the collection, sizing and enumeration of viable airbone particles. Journal of Bacteriology 5: 470-484
4. May, K.R. (1966) Multistage liquid impinger. Bacteriological Reviews 30(3): 559-570

Department of Microbiology						
Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	**Microbiology**	**II**	**MIC EC 223**	**Methods in Molecular Biology (Theory)**	**Mid Sem 40 End Sem 60**	**03**

Unit 1 9 hours

Electrophoresis- Basic concept of electrophoresis, types of electrophoresis, factors affecting electrophoretic mobility of charged particle, Gel electrophoresis, Isoelectric point, Isolectric focusing, applications of electrophoresis.

Unit 2: 9 hours

Native and SDS- PAGE, Western blotting, Immunoprecipitation, Pull down Assay, proteomics as a tool for identification of proteins involved in disease conditions, applications of proteomics, Studying intracellular localization of proteins.

Unit 3 9 hours

Isolation of plasmid DNA, genomic DNA and RNA, cDNA synthesis, PCR & real time PCR, Southern and Northern blotting, DNA fingerprinting, DNA foot printing

Unit 4 9 hours

Basics of cloning, Restriction Enzymes, Vectors, Transformation, Transfection, Selectable Markers, Reporter Genes, applications of genomics.

Unit 5 9 hours

Microarray, 2-Dimensional gel electrophoresis, analysis of protein-protein interactions, 2-Hybrid systems, RNA interference, Ribonuclease protection assay.

Department of Microbiology						
Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	**Microbiology**	**II**	**MIC EC 224**	**Methods in Molecular Biology (Practical)**	**Mid Sem 40 End Sem 60**	**01**

30 Hours

List of Practicals

1. Transformation of *E. coli* cells.
2. Restriction digestion of Plasmid DNA.
3. Isolation of Plasmid DNA from *E. coli* cells.
4. Restriction analysis of DNA.
5. Measurement of DNA quantity by Spectrophotometer.
6. PCR amplification of DNA
7. Isolation of genomic DNA.
8. Visualization of DNA on agarose gel.
9. Separation of proteins by PAGE.

Essential Readings:

1. Biochemistry, Stryer 5th edition W.H. Freeman 2001.
2. Principles of Biochemistry, Lehniger, 3rd edition by Nelson and Cox (Worth) 2000.
3. Genetics By Gardner.
4. Microbial Genetics By David Freifelder.

Suggested Readings:

1. Molecular cloning Vol I, II and III Maniatis, Sambrook and Ffritz
2. Biophysical Chemistry by Upadhyay, Upadhyay, and Nath.

Department of Microbiology						
Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	**Microbiology**	**II**	**MIC OE 221**	**World of Microbes (Theory)**	**Mid Sem 40 End Sem 60**	**2**

Unit 1 6 hours

Development and Scope of Microbiology, Bacteriology: Bacteriology: Structure of different cell components of Eubacteria. Characteristic features, classification and importance of Actinomycetes, Mycoplasma and Cyanobacteria

Unit 2 6 hours

Mycology: Morphological features, classification (taxonomy) and characteristics of (Slime moulds) Myxomycetes (Slime moulds), Oomycetes, Zygomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes.

Unit 3 6 hours

Virology: General Morphological features and ultrastructure of viruses; Classification of viruses. Related viral agents, viroids and prions. Life cycle of RNA and DNA viruses. Lytic cycle, Lysogeny; one step growth curve. Viroids, prions.

Unit 4 6 hours

Industrial Microbiology

Concept and scope. Nature and range of industrial products from microorganisms. Concept of industrial strains, Strain development. A general knowledge of microbes used in production of food, dairy, chemicals (solvents), bioactive molecules (antibiotics; enzymes).

Unit 5 6 hours

Tools and Techniques in Microbiology

Culture media: preparation and types - defined, differential, selective and enrichment culture media. Isolation techniques: Pour plate, spread plate, streak plate, serial dilution method. Sterilization:. Principle and methods of sterilization, physical and chemical agents of sterilization; Disinfectants, Antiseptics, Phenol coefficient

Department of Microbiology						
Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	**Microbiology**	**III**	**MIC CC 321**	**Medical Microbiology and Immunology (Theory)**	**Mid Sem 40 End Sem 60**	**04**

Unit 1 12 hours

Epidemiology, pathogenicity, diagnosis & Control of important bacterial diseases: Tuberculosis, Anthrax, Typhoid, Diptheria, Leprosy. Diseases caused by Rickettsia & Chlamydia. Antibiotics, Vaccines and their use in diseases control. Drug resistance in bacteria.

Unit 2 12 hours

Epidemiology, diagnosis and treatment of the Fungal diseases: Important human diseases caused by fungi (Mycoses); Fungal Dermatitis, Allergies, Aspergillosis. Host defences & control against fungi.

Unit 3 12 hours

Virology**:** Classification and nomenclature of animal viruses that causes diseases in animals. General account of viral diseases- Herpes, Adeno, Picorna (Polio), Orthomyxo (Influenza), Paramyxo (Mumps & Measles), Oncoviruses, HIV-AIDS, Rhabdo (Rabies), Hepatitis, SARS and Swine flu Viruses. Viroids & Prions. Cultivation of viruses in embryonated eggs, experimental animals and Cell culture. Identification and Serological assay of viruses. Control of viral infections.

Unit 4 12 hours

Epidemiology, diagnosis and treatment of the Protozoan/Zoonotic diseases: Medical importance of parasites & parasitic diseases, Classification & structure of protozoa (Sarcomastigophora, Ciliophora, Apicomplexa, Microspora). Malaria. Classification, structure & physiology of Metazoa (Helminthes & Arthropods).

Unit 5 12 hours

Serological methods in disease diagnosis: Immunodiagnostics, In-vitro antigen-antibody reactions: precipitation, agglutination, ELISA, RIA. Prophylaxis and Chemotherapy of bacterial Viral & fungal diseases.

Department of Microbiology						
Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	**Microbiology**	**III**	**MIC CC 322**	**Medical Microbiology and Immunology (Practical)**	**Mid Sem 40 End Sem 60**	**02**

60 Hours

List of Practicals

1. Experiment to show normal body flora and understanding the disease pathogenesis
2. Simple and differential staining to show bacterial colony from blood/stool samples.
3. Screening of Antibiotics.
4. MIC & Drug resistant calculation by Disc diffusion
5. Culture of Virus
6. Experiments to define immunodiagnostics of important diseases.

Essential Readings:

1. Text book of Microbiology by Ananthanarayan. R. and. Paniker C.K.J
2. Text Book of Medical Microbiology by Chaapra. H.L.
3. Mackis and Mccontney practical Medical Microbiology Edited by Coffee, Dugmiol, Fraser and Marmion.

Suggested Readings:

1. Microbiology Including Immunology and Molecular Genetics. III Ed. By Davis.. Dulbecco, Eisen and Ginsberg.

2. Medical Laboratory Manual for Tropical Countries. Vol. II by Cheesbrough, M.

Department of Microbiology						
Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	**Microbiology**	**III**	**MIC CC 323**	**Microbial Genetics & Molecular Biology (Theory)**	**Mid Sem 40 End Sem 60**	**04**

Unit 1 12 hours

Genome structure (viruses, eubacteria, eukaryotes). Selfish DNA, C-DNA paradox. DNA replication. DNA damage and DNA repair system. Targeting DNA replication for controlling microbial infections

Unit2 12 hours

Mutations, Molecular basis of mutations. Types of mutations. Types of mutagens. Genetic analysis of mutants. Mutations affecting structure and function. Random mutagenesis-Induction, screening and isolation. Correlation between mutagenicity and carcinogenesis. Mutagens as a tool in biology.

Unit 3 12 hours

RNA: Structure of RNA (mRNA, tRNA, rRNA). Synthesis of RNA-Transcription, The genetic code, Protein synthesis-Translation (in prokaryotes). Regulation of gene expression. Transcription and translation as drug target.

Unit 4 12 hours

Genetic recombination in bacteria (transformation, transduction-generalized and specialized, conjugation), U-tube experiment, Molecular mechanism of recombination-Homologous and site specific, Transposons and mobile genetic elements, DNA & RNA sequencing, Southern blotting, PCR & Real Time PCR.

Unit 5 12 hours

In vitro manipulation of DNA, Nucleases, Restriction Endonucleases, polynucleotide kinase, S1 nuclease, DNA ligase, Alkaline phosphatase. Cloning vectors. Restriction mapping, DNA & RNA vectors, construction of genomic libraries, c-DNA synthesis, construction of c-DNA libraries, Site directed mutagenesis, Applications of genetic engineering, Gene therapy.

Department of Microbiology						
Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	**Microbiology**	**III**	**MIC CC 324**	**Microbial Genetics & Molecular Biology (Practical)**	**Mid Sem 40 End Sem 60**	**02**

60 Hours

List of practicals

1. Transformation of *E. coli* cells.
2. Restriction digestion of Plasmid DNA.
3. Isolation of Plasmid DNA from *E. coli* cells.
4. Restriction analysis of DNA.
5. Measurement of DNA quantity by Spectrophotometer.
6. PCR amplification of DNA
7. Isolation of genomic DNA.
8. Effect of UV light on mutation and its restoration by visible light.
9. Visualization of DNA on agarose gel.

Essential Readings:

1. Gene VII By Lewin, B. Oxford University Press.
2. Biochemistry By Stryer. L., W.H. Freedom and Company.
3. Foundations of genetics By A.C .Pai.
4. Genetics By P.K. Gupta.
5. Essential genetics By Russel.
6. Genetics By Gardner.
7. Principles of Biochemistry By Lehninger and Cox.
8. Microbial Genetics By David Freifelder

Suggested Readings:

1. Manual of methods for general bacteriology By Phillip. G
2. Molecular Biology of the gene By Watson, J. D.
3. Molecular cloning Vol I, II and III Maniatis, Sambrook and Fritz.

Department of Microbiology						
Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	**Microbiology**	**III**	**MIC EC 321**	**Food and Dairy Microbiology (Theory)**	**Mid Sem 40 End Sem 60**	**03**

Unit 1 9hours

Fundamentals of Food Microbiology: Microorganisms important in food microbiology- bacteria, fungi, yeast, bacteria. Principles of food spoilage: role of pH, water activity, redox potential, nutritional content of food. Mechanism of food spoilage: Olfactory changes, texture changes and visual changes in food. Principles of food preservation: Asepsis, Physical methods (anaerobic condition, high and low temperature, drying), Chemical preservation, food additives, canning

Unit 2: 9 hours

Microbiology of Dairy Products: Concept of dairy fermentation: Starter culture. Metabolic properties of lactic acid bacteria (LAB). Metabolic engineering of LABs for carbon metabolism using LDH inactivation and NOX-NICE system for production of Ethanol, Aroma (Diacetyle) and Sweetner (Alanine). Molecular organization of LABs for texture production in Cheese. Antibiosis activity of LABs.

Unit 3 9 hours

Microbiology of non-Dairy Products: Microbiology and methods for preparation of fermented none-Dairy productions: Rice based: Idli and Dosa; Fruit based: Wine; Soybean based: Tofu.

Unit 4 9 hours

Microbial identification and enumeration of food: Phenotypic methods: Overview, limitations and its possible solution. Methods used in current phenotypic identification of microbes. Genotypic methods, Traditional methods, subtractive hybridization method and 16S RNA method). Methods of probe detection: Blotting, PCR and LCR methods. Enumeration methods: Standard plate count, microscopic count, reductase test.

Unit 5 9 hours

Food related pathogens and diseases: Food borne infection (*Salmonella, Campylobacter, E.coli*), and viral, food borne intoxication (Bacterial: Staphylococcus, Clostridium; fungal: Mycotoxins, poisonous mushrooms). Preventive methods applied in toxic foods

Department of Microbiology						
Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	**Microbiology**	**III**	**MIC EC-322**	**Food and Dairy Microbiology (Practical)**	**Mid Sem 40 End Sem 60**	**01**

30 Hours

List of Practicals

1. Isolation, identification and standard plate count of various microorganisms from raw, processed or spoiled foods: Milk (raw/spoiled); Bread (bread mould); Vegetables (raw/spoiled).
2. Biochemical characteristics of spoilage bacteria.
3. Methylene blue reductase test (MBRT) for determination of quality of milk samples.
4. Effect of commercial chemical preservatives on survival of microorganisms (sodium benzoate, sodium glutamate, vinegar etc.).
5. Finding thermal death time for untreated milk and different water samples at various temperatures (60°C, 70°C and 80°C).

Essential Readings:

1. Food Microbiology by Frazier and Westhoff.
2. Fundamentals of Food Microbiology by Fields, M.L.
3. Food Microbiology By Adams M.R. and Moss, M.O. Royal Society of Chemistry Publication, Cambridge.
4. Basic Food Microbiology By Banwart, GJ (1989) CBS Publishers and Distributors, Delhi.
5. Food Science by Norman N. Potter and J.H. Hotchkiss, Springer

Suggested Readings:

1. Principles of Fermentation Technology. Stanbury, PF., Whittaker, A and Hall, S.J (1995) 2nd Edition. Pergamon Press

Department of Microbiology						
Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	**Microbiology**	**III**	**MIC EC 323**	**Principles of Bioimaging (Theory)**	**Mid Sem 40 End Sem 60**	**03**

Unit 1 9 hours

Properties of light, Light spectrum and its application. Microscopy lamps and their properties. Photoaffinity probes: Specific photoaffinity probes (Diazo, Azido and Benzophenone based probes) and Generalized hydrophobic probes. Properties and mode of action of photoaffinity probes. Caged compounds and their mode of action. Application of photolabeling technologies.

Unit 2 9 hours

Classification of ion channels: Voltage gated and Ligand gated. General structure and properties of Voltage gated and ligand gated ion channels. Basics of Optogenetics: discovery of channelrhodopsin a light gated ion channel. General structure and properties of Channelrhodopsin and Halorhodopsin. Biomedical applications of optogenetics.

Unit 3 9 hours

Difference between UV-vis spectrophotometer and spectrofluorometer. Difference between compound microscope and fluorescence microscope. Optical system of microscope and concept of magnification. Aberrations in microscope lens (Chromatic, spherical) and their corrections. Flat image (Plan) objectives. Concept of , refractive index, numerical aperture and resolution. Types and properties of optical chambers for live cell imaging.

Unit 4 9 hours

Jablonski diagram and concept of absorption, non-radiative decay (vibrational relexation, internal conversion and inter system crossing) and radiative decay (fluorescence and phosphorescence). Characteristics of fluorescence (photochemistry, fluorescence lifetime, stokes shift, quantum yield and mirror image rule for absorption and emission spectra). Factor affecting fluorescence (intrinsic, physical and quenchers).

Unit 5 9 hours

Biosensors: Components and mechanism of Biosensing. Electrochemical based gluocose biosensor. Structure and properties of green fluorescent protein (GFP). Concept of FRET and factors affecting FRET. General structure of FRET based (Cameleon for Calcium, Cygnet for cGMP, EPAC for cAMP. as examples) and non-FRET based biosensors (FlincG for cGMP).

Department of Microbiology						
Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	**Microbiology**	**III**	**MIC EC 324**	**Principles of Bioimaging (Practical)**	**Mid Sem 40 End Sem 60**	**01**

30 Hours

List of Practicals

1. Demonstration of peak cut-off and effect of serial dilution on fluorophore spectra acquisition.
2. Demonstration of fluorescent image acquisition of yeast cell labelled with fluorescein.
3. Quantitative imaging of microbes for motility, cell size, vacuole, cell death etc).
4. Quantitative imaging of higher animals e.g. Zebrafish/other small fishes, and data interpretation.
5. Tour to Electron microscopy/confocal microscopy facility for high resolution imaging.

Essential Readings:

1. Essential Ion Channel Methods, 2010, By P. Michael Conn, Academic Press Publication.
2. Luciferases—Advances in Research and Application, 2012 Edition, Scholarly Editions.
3. Principles of Fluorescence Spectroscopy, 2007, 3e, By Joseph R. Lakowicz, Springer Publication.
4. Green Fluorescent Protein, By Barry W. Hicks, Humana Press, 10-Nov-2010.
5. Methods of Biochemical Analysis, Green Fluorescent Protein: Properties, Applications and Protocols, By Martin Chalfie, Steven R. Kain, John Wiley & Sons, 18-Nov-2005.
6. New photolabeling and crosslinking methods. By Brunner J., Ann Rev Biochem. 1993;62:483-514.

Suggested Readings:

1. Benzophenone photophores in biochemistry. By Dormán G1, Prestwich GD. Biochemistry. 1994 May 17;33(19):5661-73.
2. Improved genetically-encoded, FlincG-type fluorescent biosensors for neural cGMP imaging. By Bhargava Y, Hampden-Smith K, Chachlaki K, Wood KC, Vernon J, Allerston CK, Batchelor AM, Garthwaite J. Front Mol Neurosci. 2013 Sep 24;6:26. doi: 10.3389/fnmol.2013.00026. eCollection 2013.

Department of Microbiology						
Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	**Microbiology**	**IV**	**MIC CC 421**	**Project Work / Dissertation on any Microbiology related aspect**	**100**	**16**

Student will undergo a semester long dissertation work in the subject/topic related to scope of microbiology, microbial biotechnology, microbial enzymes, pathology, bioimaging, molecular biology or topics studied in their course etc. Student will submit hardbound copies of the dissertation/ project work in the departmental library.

Evaluation of Project Work / Dissertation

It will be based on periodic assessment of the progress of the project and End Semester Examination as follows:

(i)	First periodic assessment of the progress after 08 weeks	: 20 Marks
(ii)	Second periodic assessment after 04 weeks	: 20 Marks
(iii)	End Semester Examination will consist of :	
	(a) Evaluation of the project report	: 50 Marks
	(b) Viva-Voce of the project report	: 10 Marks