

Department of Microbiology
Dr. Harisingh Gour Vishwavidyalaya, Sagar
(A Central University/ A+ accredited by NAAC)

Under Graduate Curriculum Framework
Based on NEP-2020
B.Sc. Industrial Microbiology

Level 8 (4th Year)

Semester 7

Nature of Course	Course Code	Course Title	Credits
Discipline Specific Major 1	MIC-DSM-711	Principles of Industrial Microbiology (Theory)	04
	MIC-DSM-712	Principles of Industrial Microbiology (Practical)	02
Discipline Specific Major 2	MIC-DSM-713	Genetic Engineering and Recombinant DNA Technology (Theory)	04
	MIC-DSM-714	Genetic Engineering and Recombinant DNA Technology (Practical)	02
Multi-Disciplinary Major (Discipline Specific Research Methodology)	MIC-MDM-711	Research Methodology (Theory)	04
	MIC-MDM-712	Research Methodology (Practical)	02
Internship/ Experiential Learning/ Field Work/ Minor Project	MIC-SEC-711	Project work/ Internship/ Industrial visit on Microbiological Aspect	02

Semester 8

Nature of Course	Course Code	Course Title	Credits
Discipline Specific Major 1	MIC-DSM-811	Biosafety and Intellectual Property Rights (IPR) (Theory)	04
	MIC-DSM-812	Biosafety and Intellectual Property Rights (IPR) (Practical)	02
Discipline Specific Major 2	MIC-DSM-813	Microbial Enzymes and Catalysis (Theory)	04
	MIC-DSM-814	Microbial Enzymes and Catalysis (Practical)	02
Disciplinary Specific Dissertation	MIC-DSM-815	Dissertation work	12

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B.Sc. Syllabus
(2025-26)
Semester VII

Name of Course	Course Code	Course Title	Course Credit	Contact Hours	Marks
Discipline Specific Major 1	MIC-DSM-711	Principles of Industrial Microbiology (Theory)	4	60	100

Course Objectives:

The major objective of this paper is to build a strong knowledge in pharmaceutical microbiology with exposure to industrially important concepts.

Course Learning Outcomes:

Upon successful completion of the course, the student:

- Will be able to comprehend pharmaceutically relevant practices like GLP, cGMP.
- Will be aware of various lab testing of pharma-based products.
- Will be able to describe the importance and role of preservatives in pharma products.

Unit 1:

Good laboratory practices (GLP), Good microbiological practices. Good Manufacturing Practices (GMP) and Current Good Manufacturing Practices (cGMP), Reimbursement of drugs and biological. Use of Biosafety cabinets, Importance of protective clothing. Discarding biohazardous waste, Methodology of Disinfection, Autoclaving & Incineration.

Unit 2:

Culture and microscopic methods: Standard plate count, Most probable numbers (MPN), Direct microscopic counts, Biochemical and immunological methods: Limulus lysate test for endotoxin, gel diffusion, sterility testing for pharmaceutical products. Molecular methods: Nucleic acid probes, PCR based detection, biosensors.

Unit 3:

Enrichment culture technique, Detection of specific microorganisms on XLD agar, Salmonella Shigella Agar, Mannitol salt agar, EMB agar, McConkey Agar, Sabouraud Agar. Ascertaining microbial quality of milk by MBRT, Rapid detection methods of microbiological quality of milk at milk collection centres (COB, Resazurin assay).

Unit 4:

Hazard analysis of critical control point (HACCP), Principles, flow diagrams, limitations Microbial Standards for Different Foods and Water. BIS standards for common foods and drinking water.

Unit 5:

Development of antibiotic resistance, Mechanism of antibiotic resistance, Antimicrobial Peptides: History, properties, sources, mode of action, application. Phage therapy: introduction to phages, lytic cycle, types of phages involved in phage therapy. Plant based therapeutic agents. Principles of preservation: objectives of preservation, features of ideal preservative, Preservative stability and efficacy. methods of Preservative evaluation and testing.

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Name of Course	Course Code	Course Title	Course Credit	Contact Hours	Marks
Discipline Specific Major 1	MIC-DSM-712	Principles of Industrial Microbiology (Practical)	2	60	100

Practical Syllabus:

1. Demonstration of different sterilization techniques.
2. Use of different media to isolate and screen microbes on pharmaceutical or food products.
3. Demonstration of working on antibiotics (discs, solution via well diffusion).
4. Finding the most probable number (MPN) in water samples.
5. Demonstration of mode of action of food preservatives.

Essential Readings:

1. "Pharmaceutical Biotechnology", by S.S. Purohit, H.N. Kakarni and A.K. Saluja, Agrobios (India).
2. "Basic Biotechnology", edited by Colin Ratledge and Bjorn Kristiansen, 2001, Cambridge University Press, New York.
3. "Biotechnology: A Text Book of Industrial Microbiology", 2nd edition by Wulf Crueger and Anneliese Crueger (Third Indian reprint 2005), Panima Publishing Corporation New Delhi
4. "Microbial Technology", 2nd edition, volume I, edited by Peppler, H. J. and Perlman, D. 1979 Academic Press, New York.
5. "Microbial Technology", 2nd edition, volume II, edited by Peppler, H. J. and Perlman, D. 1979 Academic Press, New York.

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Name of Course	Course Code	Course Title	Course Credit	Contact Hours	Marks
Discipline Specific Major 2	MIC-DSM-713	Genetic Engineering and Recombinant DNA Technology (Theory)	4	60	100

Course Objectives:

The major objective of this paper is to build a strong knowledge in the application of microbial biotechnology using genetic modification of microbe to produce useful products.

Course Learning Outcomes:

Upon successful completion of the course, the student:

- Will be able to describe advancements in recombinant DNA technologies.
- Will get in depth analysis about steps used in RDT.
- Will be aware of growing field application of RDT.

Unit 1:

History of nucleic acid isolation, Discovery of microbial genetics (Transformation, Conjugation and Transduction) and involvement of DNA, Discovery of Restriction enzymes, reverse transcriptase.

Unit 2:

Cloning enzymes: Restriction enzymes, DNA polymerases, Terminal deoxynucleotidyl transferase, kinases, phosphatases, DNA ligases. Cloning Vectors: General structure and properties of plasmid vectors (pBR), Bacteriophage lambda vectors. Importance of Cosmids and Bacterial artificial chromosomes (BACs). Expression vectors of *E. coli* based on Lac and T7 promoters (e.g. pET vectors).

Unit 3:

Recombinant vector delivery in bacteria (Transformation of DNA): Calcium chloride method, Electroporation. Gene delivery in higher organism: Microinjection, biolistic method (gene gun), liposome and Agrobacterium mediated delivery.

Unit 4:

DNA, RNA and Protein analysis: Agarose gel and SDS-Polyacrylamide gel electrophoresis, Southern, Northern and Western blotting. PCR: Basics of PCR, Colony PCR, Real-Time PCR (qPCR). Sanger's method of DNA Sequencing.

Unit 5:

For human therapeutic related - insulin, hGH, antisense molecules. For plant related - Bt transgenic cotton. Recombinant vaccines. Site directed mutagenesis.

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Name of Course	Course Code	Course Title	Course Credit	Contact Hours	Marks
Discipline Specific Major 2	MIC-DSM-714	Genetic Engineering and Recombinant DNA Technology (Practical)	2	60	100

Practical Syllabus:

1. Demonstration of Bacterial Transformation and calculation of transformation efficiency.
2. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis.
3. Ligation of DNA fragments.
4. Cloning of DNA insert and Blue white screening of recombinants.
5. Designing of primers for DNA amplification.
6. Demonstration of Amplification of DNA by PCR.

Essential Readings:

1. Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA.
3. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
4. Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.
5. Wiley JM, Sherwood LM and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education.
6. Brown TA. (2007). Genomes-3. Garland Science Publishers.
7. Primrose SB and Twyman RM. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.

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Semester VII

Name of Course	Course Code	Course Title	Course Credit	Contact Hours	Marks
Multi-Disciplinary Major (Discipline Specific Research Methodology)	MIC-MDM- 711	Research Methodology in Microbiology (Theory)	4	60	100

Course Objectives:

The main objective of this course is to introduce students about the concept of scientific research and its dimensions.

Course Learning Outcomes:

Upon successful completion of the course, the student:

- Will be able to find and define research problems.
- Will be able to formulate steps in data collections, their statistical analysis.
- Will be able to use the scientific methods to communicate their research work.

Unit 1:

Scientific Methods and Research: Concept, Definitions Purpose and Importance of research. _ Importance of literature survey and collection methods: Role of libraries, Internet, Databases (PubMed, Google scholar, ScienceDirect) in information retrieval. Indexing and abstracting services: Citation indexes (Web of Science and Scopus). Different referencing software: Endnote, Zotero, Mendeley.

Unit 2:

Research Problem: Definition, identification of problem, ways of understanding problem, criteria of a good problem, guidelines for selecting meaningful problem. Research Design: Introduction, Purposes, Characteristics of a research design, conceptual framework and its operationalization, Research Objective: Definition, broad and specific objectives, goals. Research Hypothesis: Meaning and importance of research hypothesis. Composition of a research proposal. Criteria for a good research proposal.

Unit 3:

Data collection, Numerical and graphical data analysis, Inferential statistics and interpretation of result. Different forms of data: Primary and secondary data, Cross section and categorical Data, Time series, spatial and ordered data. Types of data according to scales of measurement: Qualitative and quantitative data, nominal ordinal, interval and ratio scale data.

Unit 4:

Introduction and review of Sampling: Definition and characteristics of samples, sampling unit, sampling error and non-sampling error, advantages and disadvantages of sampling. Size of sample: Factor affecting size of sample, Testing the reliability of sample. Methods of estimating sample size, Process of selecting random sample. Principal Methods of Analysis and Interpretation: Uses of descriptive statistical Measures, Standard error, Testing hypothesis and Variance analysis

Unit 5:

Importance of dissertation and research papers, Composition of research papers: Guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript, Ethics of Research: Scientific Misconduct, Forms of Scientific Misconduct, Plagiarism, Unscientific practices in thesis work.

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Name of Course	Course Code	Course Title	Course Credit	Contact Hours	Marks
Multi-Disciplinary Major (Discipline Specific Research Methodology)	MIC-MDM- 712	Research Methodology in Microbiology (Practical)	2	60	100

Practical Syllabus:

1. Sketching a research proposal.
2. Designing a questionnaire for a survey / Designing an experimental work (field or lab).
3. Performing a study in related field (having small magnitude).
4. Report preparation of a survey / Report preparation of field experiment or lab experiment.
5. Presentation of report in class seminar on related topic.
6. Analysis of references and citation for at least 10 documents (books, journals, reports, theses, etc.)

Essential Readings:

1. M. L. Singh (1998). Understanding Research Methodology, J. M. Singh.
2. C. R. Kothari (1990). Research Methodology, Vishwa Prakashan, India.
3. Robert E. Slavin (1994). Research Methodology in Education: A practical guide, prentice Hall.
4. Robert A Day (1994). How to write and publish a scientific paper, Cambridge University press.
5. F. N. Kerlinger (2000). Foundations of Behavioural Research, Surjeet Publication, New Delhi.
6. S.R. Bajpai (1990). Methods of Social Survey and Research, Kitabghar, Kanpur.

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Name of Course	Course Code	Course Title	Course Credit	Contact Hours	Marks
Internship/ Experiential Learning/ Field Work/ Minor Project	MIC-SEC- 711	Project work/ Internship/ Industrial visit on Microbiological Aspect	2	60	100

Course Objectives:

The major objective of this paper is to expose students to scientific methods and research protocols.

Course Learning Outcomes:

Upon successful completion of the course, the student:

- Will be able to plan and execute short projects.
- Will be able to frame research objectives.
- Will be aware of time-management to complete the project.

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B.Sc. Syllabus
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Semester VIII

Name of Course	Course Code	Course Title	Course Credit	Contact Hours	Marks
Discipline Specific Major 1	MIC-DSM-811	Biosafety and Intellectual Property Rights (IPR) (Theory)	4	60	100

Course Objectives:

The major objective of this paper is to build a strong knowledge about the importance of biosafety and intellectual property rights like patents.

Course Learning Outcomes:

Upon successful completion of the course, the student:

- Will be able to know about levels of biosafety and role of various regulating bodies to regulate GMOs.
- Will get in depth knowledge about different government bodies regulating GMOs and biosafety procedures.
- Will be able to know the importance of global treaties in protecting IPR.

Unit 1

Biosafety: Introduction, need and levels of biosafety in Biological research. Bio-Safety Cabinets, their types and working. Primary Containment for Biohazards. Biosafety Levels of Genetically Modified Microbes (GMOs).

Unit 2

Biosafety Guidelines: Highlights of Biosafety guidelines and regulations at National and International level. GMOs: Concerns and Challenges; Applications of GMOs in food and agriculture. Environmental release of GMOs.

Unit 3: Biosafety Committees and risk analysis

Role and composition of Institutional Biosafety Committees (IBSC), Genetic Engineering Appraisal Committee (GEAC). Risk Analysis: Risk Assessment; Risk management and communication; Overview of International Agreements - Cartagena Protocol.

Unit 4

Introduction to Intellectual Property: Patents, Trademarks, Copyright and Industrial Design. Importance of IPR, patentable and non-patentable items. Indian Patent Office and zones. Types of patent applications: Ordinary and PCT. Steps in Indian Patent filing procedures. Patent infringement: Its meaning and scope. Rights and Duties of patent owner.

Unit 5

History and role and importance of agreements and treaties: GATT, TRIPS Agreements, Hague Agreement, WIPO Treaties, Budapest Treaty on international recognition of the deposit of microorganisms. Main features and highlights of Indian Patent Act 1970 & recent amendments.

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Name of Course	Course Code	Course Title	Course Credit	Contact Hours	Marks
Discipline Specific Major 1	MIC-DSM-812	Biosafety and Intellectual Property Rights (IPR) (Practical)	4	60	100

Practical Syllabus:

1. Study of components and design of a BSL-III laboratory.
2. Making presentations about steps in Indian Patent filing applications.
3. Discussion on any given international patent (download from Google website).
4. Any case study about GMOs ethics, problem and field trials.

Essential Readings:

1. Bare Act, 2007. Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., New Delhi.
2. Kankanala C (2007). Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd. New Delhi.
3. Mittal, D.P. (1999). Indian Patents Law, Taxmann, Allied Services (p) Ltd.
4. Singh K K (2015). Biotechnology and Intellectual Property Rights: Legal and Social Implications, Springer India.
5. Goel D & Prashar S (2013). IPR, Biosafety and Bioethics. Pearson.
6. Senthil Kumar Sadhasivam and Mohammed Jaabir, M. S. 2008. IPR, Biosafety and biotechnology Management. Jasen Publications, Tiruchirappalli, India.

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B.Sc. Syllabus
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Semester VIII

Name of Course	Course Code	Course Title	Course Credit	Contact Hours	Marks
Discipline Specific Major 2	MIC-DSM-813	Microbial Enzymes and Catalysis (Theory)	4	60	100

Course Objectives:

The major objective of this paper is to build a strong knowledge in enzymology and its application at industrial scale.

Course Learning Outcomes:

Upon successful completion of the course, the student:

- Will be able to know the structure, functions and the mechanism of action of enzymes.
- Will get in depth knowledge about immobilization of enzyme.
- Will be able to describe enzyme catalysis, isoenzymes, multi enzymes.

Unit 1:

Introduction to catalysis and Kinetics: Enzymes Definition, types and Classification, IUB system, rationale, overview and specific examples. Characteristics of enzymes, enzyme substrate complex. Concept of binding sites, stereospecificity and ES complex formation. Factors affecting catalytic efficiency, Isoenzymes. Activation energy.

Unit 2:

Michaelis-Menten Equation, steady state enzyme kinetics. Significance of V_{max} and K_m . Graphical procedures and significance in enzymology. Examples of Sigmoidal Behaviour in enzyme kinetics: Cooperative Oxygen Binding by Haemoglobin. Enzyme Inhibition: Introduction, Reversible Inhibition, Competitive Inhibition, Uncompetitive Inhibition, Non-Competitive Inhibition, Substrate Inhibition, Allosteric Inhibition, Irreversible Inhibition. International units of enzyme activity, specific activity, turnover number, end point kinetic assay.

Unit 3:

Structure-Function Relationship and importance of enzymes: Lysozyme, ribonuclease, trypsin, carboxypeptidase, phosphorylase, glutamine synthetase and phosphofructo kinase. Multi enzyme complexes - pyruvate dehydrogenase and fatty acid synthetase; Na - K ATPase.

Unit 4:

Protein ligand binding including measurements, analysis of binding isotherms, co-operativity, Hill and Scatchard plots and kinetics of allosteric enzymes. Enzyme Regulation, Product inhibition, feedback control, enzyme induction and repression and covalent modification. Allosteric regulation.

Unit 5:

Enzymes Production, immobilization and its industrial applications. Application of Enzymes in Medicine and Diagnostics. Enhancement of enzyme activity & thermostability using nanotechnology.

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Name of Course	Course Code	Course Title	Course Credit	Contact Hours	Marks
Discipline Specific Major 2	MIC-DSM-814	Microbial Enzymes and Catalysis (Practical)	2	60	100

Practical Syllabus:

1. Partial Purification of Acid Phosphatase from Germinating Mung Bean by Ammonium Sulfate Fractionation.
2. Effect of pH on Enzyme Activity.
3. Determination of Km and Vmax using Lineweaver – Burk graph.
4. Continuous Assay of Lactate Dehydrogenase.
5. Starch hydrolysis by bacterial amylase using well diffusion assay.
6. Protease assay using Casein agar method.

Essential Readings:

1. "Understanding Enzymes", by T. Palmer, Ellis Horwood limited.
2. "Lehninger Principles of Biochemistry", by David L. Nelson and Michel M. Cox, 4th edition, 2005, W. H. Freeman and Co. New York.
3. "Pharmaceutical Biotechnology", by S.S. Purohit, H.N. Kakarni and A.K. Saluja, 2007, Agrobios (India).
4. "Basic Biotechnology", edited by colin Ratledge and Bjorn Kristiansen, 2001, Cambridge University, Press, New York.
5. "Enzyme Biotechnology", by G. Tripathi.
6. "Fundamentals of Enzymology", 2nd edition, by Nicholas C. Price and Lewis Stevens, 1989, Oxford University press, New York.

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Semester VIII

Name of Course	Course Code	Course Title	Course Credit	Contact Hours	Marks
Disciplinary Specific Dissertation	MIC-DSM-815	Dissertation work	12	60	100

Course Objectives:

The major objective of this paper is giving a complete sense of project management from the idea to execution using scientific methods learnt till now.

Course Learning Outcomes:

Upon successful completion of the course, the student:

- Will be able to write the thesis with clear objectives.
- Will be able to independently plan and execute any research projects.
- Will be able to use statistical methods to generate inferences.
- Will be able to confidently present their work to scientific audiences.

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