

# **KURUKSHETRA UNIVERSITY KURUKSHETRA**

## **Scheme of Examination and Syllabus for Under-Graduate Programme Subject: Industrial Microbiology**

**Under Multiple Entry-Exit, Internship and  
CBCS-LOCF in accordance to NEP-2020  
w.e.f. 2023-24 (in phased manner)**

**KURUKSHETRA UNIVERSITY, KURUKSHETRA**  
**Scheme of Examination for Under-Graduate Programme**  
**Under Multiple Entry-Exit, Internship and CBCS-LOCF in accordance to NEP-2020**  
**w.e.f. 2023-24 (in phased manner), Course: Industrial Microbiology**

**(First Year)**

Remarks	Course	Paper(s)	Nomenclature of Paper	Credits	Hours/Week	Internal marks	External Marks	Total Marks	Exam Duration
<b>FIRST YEAR: SEMESTER-1</b>									
<b>Scheme A &amp; C</b>	<b>CC-1/ MCC-1 4 credit</b>	B23-IMB- 101	Introduction to Microbiology	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
<b>Scheme C</b>	<b>MCC-2 4 credit</b>	B23-IMB-102	Bacteriology	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
<b>Scheme A</b>	<b>CC-M1 2 credit</b>	B23-IMB-103	General Microbiology	1	1	10	20	30	3 hrs.
			Practical	1	2	5	15	20	4 hrs.
<b>Scheme A &amp; C</b>	<b>MDC-1 3 credit</b>	B23-IMB-104	Introduction and Scope of Microbiology	2	2	15	35	50	3 hrs.
			Practical	1	2	5	20	25	4 hrs.
<b>Scheme C</b>	<b>CC-M1 4 credit</b>	From Available CC-M1 of 4 credits as per NEP							
<b>Scheme A &amp; C</b>	<b>AEC-1 2 credit</b>	From Available AEC-1 of 2 credits as per NEP							
	<b>SEC-1 3 credit</b>	From Available SEC-1 of 3 credits as per NEP							
	<b>VAC-1 2 credit</b>	From Available VAC-1 of 2 credits as per NEP							
<b>FIRST YEAR: SEMESTER-2</b>									
<b>Scheme A &amp; C</b>	<b>CC-2/ MCC-3 4 credit</b>	B23- IMB-201	Microbial Biochemistry, Physiology and Metabolism	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
<b>Scheme C</b>	<b>DSEC-2 4 credit</b>	B23-IMB-202	Microbes in Environment	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
<b>Scheme A</b>	<b>CC-M2 2 credit</b>	B23-IMB-203	Applied Microbiology	1	1	10	35	50	3 hrs.
			Practical	1	2	5			
<b>Scheme A &amp; C</b>	<b>MDC-2 3 credit</b>	B23-IMB-204	Outlines of Microbial Characters, Physiology and Metabolism	2	2	15	35	50	3 hrs.
			Practical	1	2	5	20	25	4 hrs.
<b>Scheme C</b>	<b>CC-M2 4 credit</b>	From Available CC-M2 of 4 credits as per NEP							
<b>Scheme A &amp; C</b>	<b>AEC-2 2 credit</b>	From Available AEC-2 of 2 credits as per NEP							
	<b>SEC-2 3 credit</b>	From Available SEC-2 of 3 credits as per NEP							
	<b>VAC-2 2 credit</b>	From Available VAC-2 of 2 credits as per NEP							
<b>Internship of 4 credits of 4-6 weeks duration after 2<sup>nd</sup> Semester</b>									

**(Second Year)**

Remarks	Course	Paper(s)	Nomenclature of Paper	Credits	Hours/Week	Internal marks	External Marks	Total Marks	Exam Duration
<b>SECOND YEAR: SEMESTER-3</b>									
<b>Scheme A, B &amp; C</b>	<b>CC-3/ MCC-4 4 credit</b>	B23-IMB-301	Basics of Microbial Genetics	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
<b>Scheme B &amp; C</b>	<b>MCC-5 4 credit</b>	B23-IMB-302	Microbial Diversity	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
<b>Scheme A, B &amp; C</b>	<b>MDC-3 3 credit</b>	B23-IMB-303	Microbes in Human Welfare	2	2	15	35	50	3 hrs.
			Practical	1	2	5	20	25	4 hrs.
<b>Scheme A &amp; C</b>	<b>CC-M3 4 credits</b>	From Available CC-M3 of 4 credits as per NEP							
<b>Scheme B only</b>	<b>CC-M3 (V) 4 credits</b>	From Available CC-M3(V) of 4 credits as per NEP							
<b>Scheme A, B &amp; C</b>	<b>AEC-3 2 credit</b>	From Available AEC-3 of 2 credits as per NEP							
	<b>SEC-3 3 credit</b>	From Available SEC-3 of 3 credits as per NEP							
<b>Scheme C only</b>	<b>VAC-3 2 credits</b>	From Available VAC-3 of 2 credits as per NEP							
<b>Scheme B only</b>	<b>MCC-3</b>	MCC-2 FROM SCHEME C OF FIRST SEMESTER							
<b>SECOND YEAR : SEMESTER-4</b>									
<b>Scheme A, B &amp; C</b>	<b>CC-4 / MCC-6 4 credit</b>	B23-IMB-401	Basics of Different Disciplines of Microbiology	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
<b>Scheme B &amp; C</b>	<b>MCC-7 4 credit</b>	B23-IMB-402	Food and Dairy Microbiology	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
<b>Scheme B &amp; C</b>	<b>MCC-8 4 credit</b>	B23-IMB-403	Virology	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
<b>Scheme B &amp; C</b>	<b>DSE-1 4 credit Select one Option</b>	B23-IMB-404	Fermentation Technology	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
		B23-IMB-405	Medical Lab. Technology	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
<b>Scheme A, B &amp; C</b>	<b>CC-M4 (V) 4 credits</b>	From Available CC-M4(V) of 4 credits as per NEP							
	<b>AEC-4 2 credit</b>	From Available AEC-4 of 2 credits as per NEP							
<b>Scheme C</b>	<b>VAC-4 2 credits</b>	From Available VAC-4 of 2 credits as per NEP							
<b>Scheme A &amp; B</b>	<b>VAC-3 2 credits</b>	From Available VAC-3 of 2 credits as per NEP							
<b>Internship of 4 credits of 4-6 weeks duration after 4th Semester (if not done after second semester)</b>									

(Third Year)

Remarks	Course	Paper(s)	Nomenclature of Paper	Credits	Hours/Week	Internal marks	External Marks	Total Marks	Exam Duration
<b>THIRD YEAR: SEMESTER-5</b>									
<b>Scheme A, B &amp; C</b>	<b>CC-5 / MCC-9 4 credit</b>	B23- IMB-501	Immunology	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
<b>Scheme B &amp; C</b>	<b>MCC-10 4 credit</b>	B23-IMB-502	Agriculture Microbiology	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
<b>Scheme B &amp; C</b>	<b>DSE-2 4 credit Select one Option</b>	B23- IMB- 503	Soil Microbiology	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
		B23-IMB-504	Molecular Biology	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
<b>Scheme B &amp; C</b>	<b>DSE-3 4 credit Select one Option</b>	B23- IMB- 505	Microbial Pathogenesis	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
		B23-IMB-506	Industrial Microbiology	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
<b>Scheme A &amp; C</b>	<b>CC-M5 (V) 4 credits</b>	From Available CC-M5(V) of 4 credits as per NEP							
<b>Scheme A, B &amp; C</b>	<b>Internship 4 credits</b>	Internship#4 credit after 4th semester							
<b>THIRD YEAR : SEMESTER-6</b>									
<b>Scheme A, B &amp; C</b>	<b>CC-6 MCC-11 4 credit</b>	B23-IMB-601	Instrumentation and Biotechniques	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
<b>Scheme B &amp; C</b>	<b>MCC-12 4 credit</b>	B23-IMB-602	Medical Microbiology	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
<b>Scheme B &amp; C</b>	<b>DSE-4 4 credit Select one Option</b>	B23-IMB-603	Biofertilizers and Biopesticides	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
		B23-IMB-604	Genetic Engineering	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
<b>Scheme B &amp; C</b>	<b>DSE-5 4 credit Select one Option</b>	B23-IMB-605	Biosafety and IPR	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
		B23-IMB-606	Basics of Bioinformatics	3	3	20	50	70	3 hrs.
			Practical	1	2	10	20	30	4 hrs.
<b>Scheme A</b>	<b>CCM6 4 credits</b>	From Available CC-M6 of 4 credits as per NEP							
<b>Scheme A</b>	<b>CC-M7(V) 4 credits</b>	From Available CC-M7(V) of 4 credits as per NEP							
<b>Scheme B</b>	<b>CC-M5(V) 4 credits</b>	From Available CC-M5(V) of 4 credits as per NEP							
<b>Scheme C</b>	<b>CC-M6(V) 4 credits</b>	From Available CC-M6(V) of 4 credits as per N							
<b>Scheme C</b>	<b>SEC-4 2 credit</b>	From Available SEC-4 of 2 credits as per NEP							

**(Fourth Year)**

Remarks	Course	Paper(s)	Nomenclature of Paper	Credits	Hours/Week	Internal Marks	External Marks	Total Marks	Exam Duration
<b>FORTH YEAR: SEMESTER-7 (FOR HONOURS/HONOURS WITH RESEARCH IN INDUSTRIAL MICROBIOLOGY)</b>									
<b>For Honours in Industrial Microbiology /Honours with Research Industrial Microbiology (For Scheme B &amp; C)</b>	<b>CC-H1 4 credit</b>	B23-IMB-701	Biostatistics and Computers	4	4	30	70	100	3 hrs.
	<b>CC-H2 4 credit</b>	B23-IMB-702	Advances in Microbiology	4	4	30	70	100	3 hrs.
	<b>CC-H3 4 credit</b>	B23-IMB-703	Advances in Microbial Biotechnology	4	4	30	70	100	3 hrs.
	<b>DSE-H1 4 credit Select one Option</b>	B23-IMB-704	Environment Microbiology	4	4	30	70	100	3 hrs.
		B23-IMB-705	Computational Biology	4	4	30	70	100	3 hrs.
	<b>PC-H1 4 credit</b>	B23-IMB-706	Practical Based on B23-IMB-701 to 704/705	4	8	30	70	100	6 hrs.
	<b>CC-HM1 4 credit</b>	From Available Minor of 4 credits as per NEP							
<b>SEMESTER-8 (FOR HONOURS IN INDUSTRIAL MICROBIOLOGY)</b>									
<b>For Honours in Industrial Microbiology</b>	<b>CC-H4 4 credit</b>	B23-IMB-801	Genomics and Proteomics	4	4	30	70	100	3 hrs.
	<b>CC-H5 4 credit</b>	B23-IMB-802	Food Safety and Quality Management	4	4	30	70	100	3 hrs.
	<b>CC-H6 4 credit</b>	B23-IMB-803	Entrepreneurship and Innovations in Microbiology	4	4	30	70	100	3 hrs.
	<b>DSE-H2 4 credit Select one option</b>	B23-IMB-804	Plant Pathology	4	4	30	70	100	3 hrs.
		B23-IMB-805	Vaccine Production Technology	4	4	30	70	100	3 hrs.
	<b>PC-H2 4 credit</b>	B23-IMB-806	Practical Based on B23-IMB-801 to 804/805	4	8	30	70	100	6 hrs.
	<b>CC-HM2 4 credit</b>	From Available Minor of 4 credits as per NEP							
<b>OR SEMESTER-8 (FOR HONOURS WITH RESEARCH IN INDUSTRIAL MICROBIOLOGY)</b>									
<b>For Honours with Research Industrial Microbiology</b>	<b>CC-H4 4 credit</b>	B23-IMB-801	Genomics and Proteomics	4	4	30	70	100	3 hrs.
	<b>CC-H5 4 credit</b>	B23-IMB-802	Food Safety and Quality Management	4	4	30	70	100	3 hrs.
	<b>Project / Dissertation 12 credit</b>	B23-IMB-806	Project / Dissertation	8+4	-	-	-	-	-
	<b>CC-HM2 4 credit</b>	From Available Minor of 4 credits as per NEP							

### **Programme Learning Outcomes (PLOs) for UG courses of Faculty of Life Sciences**

1. Inculcate comprehensive knowledge and acquire skills in the field's biology
2. Develop experimenting skills in laboratory that enhances critical thinking skills, logical application these skills in problem solving
3. To equip students with necessary theoretical and practical skills to enable them to pursue multidisciplinary courses at Post Graduate level
4. Demonstrate the abilities to work in collaborative activities and inculcate leadership qualities
5. Identify and follow the ethical issues related to Biology, biosafety, and perform unbiased and truthful actions
6. Capability for raising relevant questions relating to basic understanding and applications biology and planning, executing and reporting the results of an experiment or investigation

**CC-1/MCC-1**

<b>Session: 2023-24</b>			
<b>Part A - Introduction</b>			
Subject	INDUSTRIAL MICROBIOLOGY		
Semester	I		
Name of the Course	INTRODUCTION TO MICROBIOLOGY		
Course Code	B23-IMB-101		
Course Type:	CC/MCC		
Level of the course (As per Annexure-I)	100-199		
Pre-requisite for the course (if any)	---		
Course Learning Outcomes(CLO):	After completing this course, the learner will be able to: 1. To acquaint with History and Scope of microorganisms 2. To give theoretical knowledge of isolation and growth of microorganisms 3. To impart knowledge of maintenance of cultures and sterilization techniques 4. To give detailed knowledge about structure of bacteria 5. To impart practical knowledge of isolation culturing maintenance, Sterilization and staining of microorganisms		
CLO5 is related to practical component			
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
<b>Internal Assessment Marks</b>	20	10	30
<b>End Term Exam Marks</b>	50	20	70
<b>Exam Duration</b>	3 hours	4 hours	
Maximum Marks 100			
<b>Part B- Contents of the Course</b>			
<b><u>Instructions for Paper- Setter:</u></b> Nine questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining eight questions will be set taking two questions			

from each unit. The candidates will be required to attempt Q.No.1 & four others selecting one question from each unit. All questions carry equal marks.

Unit	Topics	Contact Hours
I	<p><b>Introduction and Classification</b>            History of Microbiology; Microbiology in India; Application of microbiology: Food and industry; Microbes in genetic engineering and biotechnology; Microbes in environmental microbiology (microbes in biogeochemical cycles); Microbes in pollution microbiology; Microbes in medical microbiology            Microbial diversity; five kingdom classification; three domain classification; taxonomy, General methods of classifying bacteria; Genetic relatedness (DNA-DNA hybridization, 16S rRNA sequencing, classification and identification of bacteria); Bacterial nomenclature; Bergey's system of bacterial classification</p>	3 Hours/week
II	<p><b>Methods in Microbiology</b>            Isolation and culture of microorganisms- Mixed Cultures; Serial dilution method, Viable plate count by Streaking, spread plate method and Pour plate method, Isolation of anaerobic microbes, Culture Characteristics – Colony appearance, Colony forms, Colony elevation, Colony margins, Optical density, Colony colour, Colony Odour, Colony consistency. Microbial growth: Growth curve of bacteria – Measurement of growth, batch culture. Synchronous growth, Diauxic growth Culture</p>	
III	<p><b>Medium, Preservation and Control of microbe</b>            Characteristics of a medium, Types of media ( liquid, semisolid, solid, selective, enrichment, differentia) Preparation of Media, requirements of medium, Nutritional types of microbe Preservation method: Lyophilisation, Liquid nitrogen, Serial subculture, Refrigeration, stocks of soil; Physical control: Autoclave, Hot air oven, Boiling, Tyndallisation; Chemical control : Alcohol, Halogens, ethylene oxide, Formaldehyde.</p>	
IV	<p><b>Morphology and Fine Structure</b>            Morphology of bacteria – Size and Shape; Arrangements. Structure of Bacterial cells – Capsule, Flagella, Locomotion, Fimbriae or pili; Chemotaxis; The cell wall Plasma membrane; Mesosomes; Cytoplasm : Ribosomes; Nucleoid, Plasmids; Cytoplasmic inclusions, (granules, lipid granules, glycogen, sulfur granules, magnetosomes, gas vesicles, gas vacuoles), Spores and cysts, Cell Structure of cyanobacteria, Algae, Fungi, Viruses : Cultivation, Cell cycle, Lysogenic and lytic phages, Protozoa</p>	
V*	<p><b>PRACTICAL</b></p> <ul style="list-style-type: none"> <li>• Laboratory rule</li> <li>• Laboratory equipment's : Autoclave, Hot air oven, Laminar Air flow, Incubator</li> </ul>	2 Hours/week



<ul style="list-style-type: none"> <li>• Microscope, parts and handling <ul style="list-style-type: none"> <li>• Staining: Simple, Differential, endospore</li> <li>• Medium : Nutrient agar, Potato dextrose agar, Nutrient broth</li> <li>• Measurement of pH</li> <li>• To operate centrifuge</li> <li>• To study common bacteria ,fungi and alga</li> <li>• Isolation of microorganism by Streaking</li> <li>• Isolation of microorganisms by spread plate method</li> <li>• Isolation of microorganisms by pour plate method</li> <li>• Report on safe handling techniques applied</li> </ul> </li> </ul>	
<b>Suggested Evaluation Methods</b>	
<p style="text-align: center;"><b>Internal Assessment:</b></p> <p>➤ <b>Theory</b></p> <ul style="list-style-type: none"> <li>• Class Participation: 5</li> <li>• Seminar/presentation/assignment/quiz/class test etc.:5</li> <li>• Mid-Term Exam: 10</li> </ul> <p>➤ <b>Practicum</b></p> <ul style="list-style-type: none"> <li>• Class Participation: NA</li> <li>• Seminar/Demonstration/Viva-voce/Lab records etc.:10</li> <li>• Mid-Term Exam: NA</li> </ul>	<p><b>End Term Examination:</b></p> <p>Theory -50 Written Exam Practical-20 Demonstration/Viva-voce/Lab records</p>
<b>Part C-Learning Resources</b>	
<p><b>Recommended Books/e-resources/LMS:</b></p> <ol style="list-style-type: none"> <li>1. Powar,C.B. &amp; Daginawala, H.F.: General Microbiology Vol.1, Himalaya Publishing House, Bombay</li> <li>2. P.D. Sharma: Microbiology</li> <li>3. R.C Dubey: A text book of Biotechnology S Chand and Company Ltd</li> <li>4. Prescott, L.M. et al. (2005 &amp; 2007).Microbiology, McGraw Hill International Edition, USA.</li> <li>5. Pelczar, M.J., Chan, E.C.S. &amp; Krieg, N.R.: Microbiology, Tata Mc Graw-Hill Publishing Company Limited, New Delhi.</li> </ol>	

<b>PLO CLO MAPPING of B23-IMB-101</b>						
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	1	1	1	1	1	1
CLO2	1	2	2	2	1.5	2
CLO3	2	2	2.5	2.5	1.5	2
CLO4	1	1	1	1	1	1
CLO5	1	2	2	2	1.5	2

**MCC-2**

<b>Session: 2023-24</b>			
<b>Part A - Introduction</b>			
Subject	INDUSTRIAL MICROBIOLOGY		
Semester	I		
Name of the Course	BACTERIOLOGY		
Course Code	B23-IMB-102		
Course Type:	MCC		
Level of the course (As per Annexure-I)	100-199		
Pre-requisite for the course (if any)	---		
Course Learning Outcomes(CLO):	After completing this course, the learner will be able to: 1. Will be able to briefly explain methods of asexual reproduction in bacteria. 2. Will understand different phases of growth curve and be able to define generation time and growth rate. 3. Can define and differentiate various types of classifications. Will gain insight into techniques used in polyphasic bacterial taxonomy. 4. Will get acquainted with differences between archaea and eubacteria		
CLO5 is related to practical component	5. will be able to make different types of media and counting and staining of bacteria.		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
<b>Internal Assessment Marks</b>	20	10	30
<b>End Term Exam Marks</b>	50	20	70
<b>Exam Duration</b>	3 hours	4 hours	
Maximum Marks 100			
<b>Part B- Contents of the Course</b>			

**Instructions for Paper- Setter:**

Nine questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining eight questions will be set taking two questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting one question from each unit. All questions carry equal marks.

Unit	Topics	Contact Hours
I	Reproduction in Bacteria Sexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate Microbiological techniques Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria, and accessing non-culturable bacteria.	3 Hours/week
II	Bacterial Systematics Concepts of systematics, taxonomy, taxa, species, strains, phenetic classification, phylogenetic classification, genotypic classification, polyphasic taxonomy, evolutionary chronometers, rRNA oligonucleotide sequencing and signature sequences. Conventional (classical characteristics, numerical taxonomy), molecular (nucleic acid hybridization, nucleic acid sequencing) and recent approaches (genomic fingerprinting: MLSA, ribotyping) to study polyphasic bacterial taxonomy	
III	Bergeys Manual Archaeobacteria: General characteristics, phylogenetic overview, genera belonging to Nanoarchaeota (Nanoarchaeum), Crenarchaeota (Sulfolobus, Thermoproteus) and Euryarchaeota [Methanogens thermophiles, and Halophiles] Gram Positive: Low G+ C (Firmicutes): General characteristics with suitable examples High G+C (Actinobacteria): General characteristics with suitable examples Cyanobacteria: An Introduction	
IV	Gram Negative- General characteristics with suitable examples of : Non proteobacteria, Alpha proteobacteria, Beta proteobacteria, Gamma proteobacteria, Epsilon proteobacteria.	
V*	Practical: • Preparation of different media: Synthetic Media (BG11), Complex media (Nutrient Agar, MacConkey agar).	2 Hours/week

	<ul style="list-style-type: none"> <li>• Isolation of pure cultures of bacteria by Quadrant streaking method.</li> <li>• Enumeration of bacteria by CFU count using spread plate method/pour plate method.</li> <li>• To observe size, shape and arrangement of given bacterial sample using simple and negative staining.</li> <li>• To differentiate between different types of bacteria using differential staining methods: Gram staining, Capsule staining, Spore staining, Acid fast staining (Permanent slides)</li> <li>• Demonstration of motility by hanging drop method</li> </ul>	
<b>Suggested Evaluation Methods</b>		
<p style="text-align: center;"><b>Internal Assessment:</b></p> <p>➤ <b>Theory</b></p> <ul style="list-style-type: none"> <li>• Class Participation: 5</li> <li>• Seminar/presentation/assignment/quiz/class test etc.:5</li> <li>• Mid-Term Exam: 10</li> </ul> <p>➤ <b>Practicum</b></p> <ul style="list-style-type: none"> <li>• Class Participation: NA</li> <li>• Seminar/Demonstration/Viva-voce/Lab records etc.:10</li> <li>• Mid-Term Exam: NA</li> </ul>	<p><b>End Term Examination:</b></p> <p>Theory -50 Written Exam Practical-20 Demonstration/Viva-voce/Lab records</p>	
<b>Part C-Learning Resources</b>		
<p style="text-align: center;"><b>Recommended Books/e-resources/LMS:</b></p> <ol style="list-style-type: none"> <li>6. Powar,C.B. &amp; Daginawala, H.F.: General Microbiology Vol.1, Himalaya Publishing House, Bombay</li> <li>7. P.D. Sharma: Microbiology</li> <li>8. R.C Dubey: A text book of Biotechnology S Chand and Company Ltd</li> <li>9. Prescott, L.M. et al. (2005 &amp; 2007).Microbiology, McGraw Hill International Edition, USA.</li> <li>10. Pelczar, M.J., Chan, E.C.S. &amp; Krieg, N.R.: Microbiology, Tata Mc Graw-Hill Publishing Company Limited, New Delhi.</li> </ol>		

<b>PLO CLO MAPPING of B23-IMB-102</b>						
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	1	1	1	1	1	1
CLO2	1	2	2	2	1	2
CLO3	2	2	2	2	1.5	2
CLO4	1.5	1.5	1.5	1.5	1.5	1.5
CLO5	1	1.5	1.5	2.5	2.5	2

## CC-M1

<b>Session: 2023-24</b>			
<b>Part A - Introduction</b>			
Subject	INDUSTRIAL MICROBIOLOGY		
Semester	I		
Name of the Course	GENERAL MICROBIOLOGY		
Course Code	B23-IMB-103		
Course Type:	CC-M		
Level of the course (As per Annexure-I)	100-199		
Pre-requisite for the course (if any)	--		
Course Learning Outcomes(CLO):	After completing this course, the learner will be able to:		
CLO5 is related to practical component	<ol style="list-style-type: none"><li>1. To acquaint with History and Scope of microorganisms</li><li>2. To give theoretical and practical knowledge of isolation and growth of microorganisms</li><li>3. To impart knowledge of maintenance of cultures and sterilization techniques</li><li>4. To give detailed knowledge about structure of bacteria</li><li>5 To impart practical knowledge of isolation culturing maintenance, Sterilization and staining of microorganisms</li></ol>		
Credits	Theory	Practical	Total
	1	1	2
Contact Hours	1	2	3
<b>Internal Assessment Marks</b>	10	5	15
<b>End Term Exam Marks</b>	20	15	35
<b>Exam Duration</b>	3 hours	4 hours	
Maximum Marks 50			
<b>Part B- Contents of the Course</b>			
<b><u>Instructions for Paper- Setter:</u></b>			
Nine questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining eight questions will be set taking two questions			

from each unit. The candidates will be required to attempt Q.No.1 & four others selecting one question from each unit. All questions carry equal marks.

Unit	Topics	Contact Hours
I	<p><b>Introduction</b>            History of Microbiology, Microbiology in India; Application of microbiology: Food and industry; Genetic Engineering and biotechnology; Environmental microbiology, Medical microbiology, Fermentation technology, Agriculture Microbiology</p>	1 hour/week
II	<p><b>Methods in Microbiology</b>            Isolation and culture of microorganisms- Mixed Cultures; Serial dilution method , Viable plate count by Streaking, spread plate method and Pour plate method , Isolation of anaerobic microbes,             Microbial growth: Growth curve of bacteria – Measurement of growth, batch culture. Synchronous growth, Diauxic growth Culture</p>	
III	<p><b>Morphology and Fine Structure</b>            Characteristics of a medium, Types of media( liquid, semisolid, solid, selective, enrichment, differentia) Preparation of Media , requirements of medium, Nutritional types of microbe             Preservation method: Lyophilisation , Liquid nitrogen, Serial subculture, Refrigeration, stocks of soil ; Physical control: Autoclave, Hot air oven ,Boiling, Tyndallisation ; Chemical control : Alcohol, Halogens, ethylene oxide, Formaldehyde.</p>	
IV	<p><b>Morphology and Fine Structure</b>            Morphology of bacteria – Size and Shape; Arrangements . Structure of Bacterial cells – Capsule, Flagella, Locomotion , Fimbriae or pili; Chemotaxis ; The cell wall Plasma membrane; Mesosomes; Cytoplasm : Ribosomes; Nucleoid , Plasmids; Cytoplasmic inclusions, ( granules, lipid granules, glycogen, sulfur granules, magnetosomes, gas vesicles, gas vacuoles), Spores and cysts, Cell Structure of cyanobacteria, Algae ,Fungi ,Viruses ,Protozoa</p>	
V*	<p><b>PRACTICAL</b></p> <ul style="list-style-type: none"> <li>• Laboratory rule</li> <li>• Laboratory equipment's : Autoclave, Hot air oven, Laminar Air flow ,Incubator</li> <li>• Microscope, parts and handling</li> <li>• Staining: Simple, Differential, endospore</li> <li>• Medium : Nutrient agar, Potato dextrose agar, Nutrient broth</li> </ul>	2 hours/week

	<ul style="list-style-type: none"> <li>Isolation of microorganism by Streaking</li> </ul>	
<b>Suggested Evaluation Methods</b>		
<p style="text-align: center;"><b>Internal Assessment:</b></p> <p>➤ <b>Theory</b></p> <ul style="list-style-type: none"> <li>Class Participation: 4</li> <li>Seminar/presentation/assignment/quiz/class test etc.: NA</li> <li>Mid-Term Exam: 6</li> </ul> <p>➤ <b>Practicum</b></p> <ul style="list-style-type: none"> <li>Class Participation: NA</li> <li>Seminar/Demonstration/Viva-voce/Lab records etc.:5</li> <li>Mid-Term Exam: NA</li> </ul>		<p style="text-align: center;"><b>End Term Examination:</b></p> <p>Theory -20 Written Exam Practical-15 Demonstration/Viva-voce/Lab records</p>
<b>Part C-Learning Resources</b>		
<b>Recommended Books/e-resources/LMS:</b>		
<p>11. Powar,C.B. &amp; Daginawala, H.F.: General Microbiology Vol.1, Himalaya Publishing House, Bombay</p> <p>12. Prescott, L.M. et al. (2005 &amp; 2007).Microbiology, McGraw Hill International Edition, USA.</p> <p>13. Pelczar, M.J., Chan, E.C.S. &amp; Krieg, N.R.: Microbiology, Tata Mc Graw-Hill Publishing Company Limited, New Delhi.</p>		

<b>PLO CLO MAPPING of B23-IMB-103</b>						
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	1	1	1	1	1	1
CLO2	1	2	2	2	1.5	2
CLO3	2	2	2.5	2.5	1.5	2
CLO4	1	1	1	1	1	1
CLO5	1	2	2	2	1.5	2

## MDC-1

<b>Session: 2023-24</b>			
<b>Part A - Introduction</b>			
Subject	INDUSTRIAL MICROBIOLOGY		
Semester	I		
Name of the Course	INTRODUCTION AND SCOPE OF MICROBIOLOGY		
Course Code	B23-IMB-104		
Course Type:	MDC		
Level of the course (As per Annexure-I)	100-199		
Pre-requisite for the course (if any)	--		
Course Learning Outcomes(CLO):	After completing this course, the learner will be able to: 1. To introduce the different kinds of microorganisms 2. To give knowledge about culturing , isolation and identification of microorganisms 3. To acquaint with methods of maintenance and sterilization 4. To introduce the latest developments in microbiology		
CLO5 is related to practical component	5* To give practical knowledge of growth, isolation, maintenance of microorganisms in addition to production of useful compounds		
Credits	Theory	Practical	Total
	2	1	3
Contact Hours	2	2	4
<b>Internal Assessment Marks</b>	15	5	20
<b>End Term Exam Marks</b>	35	20	55
<b>Exam Duration</b>	3 hours	4 hours	
Maximum Marks 75			
<b>Part B- Contents of the Course</b>			
<b><u>Instructions for Paper- Setter:</u></b>			
Nine questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining eight questions will be set taking two questions			



from each unit. The candidates will be required to attempt Q.No.1 & four others selecting one question from each unit. All questions carry equal marks.

Unit	Topics	Contact Hours
I	<b>Introduction ,Morphology and structure</b> History, Microbiology in India, Microbial diversity, Morphology of bacteria – Size and Shape; Arrangements . Structure of Bacterial cells – Capsule, Flagella, Fimbriae ; The cell wall Plasma membrane; Mesosomes; Cytoplasm : Ribosomes; Nucleoid, Plasmids, Spores and cysts, Cell Structure of cyanobacteria, Algae ,Fungi ,Viruses , Protozoa	2 Hours/week
II	<b>Methods in Microbiology</b> Isolation and culture of microorganisms- Mixed Cultures; Serial dilution method , Viable plate count by Streaking, spread plate method and Pour plate method , Isolation of anaerobic microbes, Microbial growth: Growth curve of bacteria – Measurement of growth, batch culture. Synchronous growth, Diauxic growth , Type and preparation of media , Preservation by serial subculture lyophilisation, liquid nitrogen, Sterilization Autoclave, Hot Air oven , UV rays , Ethyleneoxide	
III	<b>Commercial Products</b> Production of Yoghurt, Beer ,Wine , Single cell protein, Lactic acid, Biofertilizer, Biopesticide , Penicillin, Streptomycin	
IV	<b>Future Prospects</b> Biomining :Extraction of Iron , Copper , Microbially enhanced oil recovery, Production of Hydrogen, Bioconcrete	
V*	<b>PRACTICAL</b> <ul style="list-style-type: none"> <li>• Laboratory rule</li> <li>• Laboratory equipments : Autoclave, Hot air oven, Laminar Air flow ,Incubator</li> <li>• Microscope, parts and handling</li> <li>• Staining: Simple, Differential, endospore</li> <li>• Medium : Nutrient agar, Potato dextrose agar, Nutrient broth</li> <li>• Measurement of pH</li> <li>• To operate centrifuge</li> <li>• To study common bacteria ,fungi and alga</li> <li>• Isolation of microorganism by Streaking               <ul style="list-style-type: none"> <li>• Isolation of microorganisms by spread plate method</li> <li>• Isolation of microorganisms by pour plate method</li> <li>• Production of biofertilizer</li> <li>• Production of wine by <i>Saccharomyces</i></li> </ul> </li> </ul>	2 Hours/week

<b>Suggested Evaluation Methods</b>	
<p style="text-align: center;"><b>Internal Assessment:</b></p> <p>➤ <b>Theory</b></p> <ul style="list-style-type: none"> <li>• Class Participation: 4</li> <li>• Seminar/presentation/assignment/quiz/class test etc.:4</li> <li>• Mid-Term Exam: 7</li> </ul> <p>➤ <b>Practicum</b></p> <ul style="list-style-type: none"> <li>• Class Participation: NA</li> <li>• Seminar/Demonstration/Viva-voce/Lab records etc.:5</li> <li>• Mid-Term Exam: NA</li> </ul>	<p><b>End Term Examination:</b></p> <p>Theory -35</p> <p>Written Exam</p> <p>Practical-20</p> <p>Demonstration/Viva-voce/Lab records</p>
<b>Part C-Learning Resources</b>	
<p><b>Recommended Books/e-resources/LMS:</b></p> <p>14. Powar,C.B. &amp; Daginawala, H.F.: General Microbiology Vol.1, Himalaya Publishing House, Bombay</p> <p>15. Prescott, L.M. et al. (2005 &amp; 2007).Microbiology, McGraw Hill International Edition, USA.</p> <p>16. Pelczar, M.J., Chan, E.C.S. &amp; Krieg, N.R.: Microbiology, Tata Mc Graw-Hill Publishing Company Limited, New Delhi.</p>	

<b>PLO CLO MAPPING of B23-IMB-104</b>						
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	1	1	1	1	1	1
CLO2	1	2	2	2	1	2
CLO3	2	2	2	2	1.5	2
CLO4	1.5	1.5	1.5	1.5	1.5	1.5
CLO5	1	1.5	1.5	2.5	2.5	2

**CC-2/MCC-3**

<b>Session: 2023-24</b>			
<b>Part A - Introduction</b>			
Subject	MICROBIAL BIOCHEMISTRY PHYSIOLOGY AND METABOLISM		
Semester	II		
Name of the Course	INDUSTRIAL MICROBIOLOGY		
Course Code	B23-IMB-201		
Course Type:	CC/MCC		
Level of the course (As per Annexure-I)	100-199		
Pre-requisite for the course (if any)	---		
Course Learning Outcomes(CLO):	After completing this course, the learner will be able to: 1. To acquaint with growth, measurement and factors affecting bacterial growth 2. To introduce concept of enzymology and methods of transport of compounds 3. To give information of carbohydrates, proteins and lipids 4. To acquaint with important metabolic pathways in microbes		
CLO5 is related to practical component	To provide technical expertise for isolating and culturing microorganisms and colorimetric method for carbohydrates and proteins, and handling enzyme		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
<b>Internal Assessment Marks</b>	20	10	30
<b>End Term Exam Marks</b>	50	20	70
<b>Exam Duration</b>	3 hours	4 hours	
Maximum Marks 100			
<b>Part B- Contents of the Course</b>			

**Instructions for Paper- Setter:**

Nine questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining eight questions will be set taking two questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting one question from each unit. All questions carry equal marks.

Unit	Topics	Contact Hours
I	<b>Microbial Growth</b> Definition of growth, expression of growth, Generation time, Growth curve in bacteria, Synchronous growth, diauxic growth, Prototroph, Auxotroph, Measurement of Growth (cell number, cell mass and cell constituent), Effect of environment on the microbial growth, (temperature, pH and oxygen).	3 Hours/week
II	<b>Membrane Transport and Enzymes</b> Types of cellular transport (diffusion, gaseous exchange, osmosis, plasmolysis, active & passive transport, facilitated transport). Enzymes- mechanism of action, Enzyme kinetics- effect of pH and temperature on enzyme activity, Classification	
III	<b>Metabolic Pathways</b> Metabolism Anabolism, Glycolysis, Entner Doudoroff pathway, Pentose phosphate pathway, Krebs cycle Substrate level and oxidative phosphorylation, Electrontransport chain	
IV	<b>Biochemistry</b> Classification of carbohydrate, Structure of Starch, Cellulose, Glycogen, glucose, fructose. Classification and structure of lipids, Structure of nucleotide. Structure, types and functions of DNA & RNA. Classification and Structure of amino acids, structure of proteins	
V*	<b>Practical</b> <ul style="list-style-type: none"> <li>• To study the effect of pH</li> <li>• To study the effect of temperature</li> <li>• To study the effect of oxygen</li> <li>• Isolation of protease producer</li> <li>• Isolation of amylase producer</li> <li>• To plot the growth curve of bacteria</li> <li>• Estimation of carbohydrate by colorimetric method</li> <li>• Estimation of proteins by colorimetric method</li> </ul>	2 Hours/week
<b>Suggested Evaluation Methods</b>		

<p style="text-align: center;"><b>Internal Assessment:</b></p> <p>➤ <b>Theory</b></p> <ul style="list-style-type: none"> <li>• Class Participation: 5</li> <li>• Seminar/presentation/assignment/quiz/class test etc.:5</li> <li>• Mid-Term Exam: 10</li> </ul> <p>➤ <b>Practicum</b></p> <ul style="list-style-type: none"> <li>• Class Participation: NA</li> <li>• Seminar/Demonstration/Viva-voce/Lab records etc.:10</li> <li>• Mid-Term Exam: NA</li> </ul>	<p style="text-align: center;"><b>End Term Examination:</b></p> <p style="text-align: center;">Theory -50 Written Exam Practical-20 Demonstration/Viva-voce/Lab records</p>
<b>Part C-Learning Resources</b>	
<b>Recommended Books/e-resources/LMS:</b>	
<p>17. Jain, J.L.: General Biochemistry- S. Chand &amp; Co.</p> <p>18. Nelson, David L. &amp; Cox, Michael M.: Lehninger : Principles of Biochemistry, Freeman, W.H. and company.</p> <p>19. Satyanarayan, U.: Biochemistry- Books &amp; allied Pvt Ltd</p> <p>20. Pelczar, M.J., Chan, E.C.S. &amp; Krieg, N.R.: Microbiology, Tata Mc Graw-Hill Publishing Company Limited</p>	

<b>PLO CLO MAPPING of B23-IMB-201</b>						
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	1.5	1	0.5	2.0	1	1.5
CLO2	1.5	2	2	1	2	2
CLO3	1.5	1	1	0.6	2	2
CLO4	2	1	2	3	2.7	2
CLO5	2.5	2	1	0.5	2	2.5

## DSEC-2

<b>Session: 2023-24</b>			
<b>Part A - Introduction</b>			
Subject	INDUSTRIAL MICROBIOLOGY		
Semester	II		
Name of the Course	MICROBES IN ENVIRONMENT		
Course Code	B23-IMB-202		
Course Type:	DSEC		
Level of the course (As per Annexure-I)	100-199		
Pre-requisite for the course (if any)	--		
Course Learning Outcomes(CLO):	After completing this course, the learner will be able to: <ol style="list-style-type: none"><li>1. Introduction to soil microbiology , characteristics of soil and effect of microorganisms</li><li>2. To acquaint with aeromicrobiology ,its significance and allergens</li><li>3. To discuss different geochemical cycles mediated by microorganism</li><li>4. To introduce the aquatic microbiology and microbial diversity.</li></ol>		
CLO5 is related to practical component	5*. To give technical expertise for isolation of microorganisms from different environments.		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
<b>Internal Assessment Marks</b>	20	10	30
<b>End Term Exam Marks</b>	50	20	70
<b>Exam Duration</b>	3 hours	4 hours	
Maximum Marks 100			
<b>Part B- Contents of the Course</b>			
<b><u>Instructions for Paper- Setter:</u></b> Nine questions will be set in all. Question No.1 comprising of objective/short answer type questions from			

the entire syllabus, will be compulsory. The remaining eight questions will be set taking two questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting one question from each unit. All questions carry equal marks.

Unit	Topics	Contact Hours
I	<b>Microbiology:</b> as dynamic ecosystem, Physical characteristics of soil, Microbial flora of soil, Interaction among soil microorganism (Neutralism, commensalism, mutualism, antagonism, competition, parasitism and predation).	3 hours /week
II	<b>Biogeochemical cycles</b> Factors affecting soil microflora (moisture content, oxygen content, pH, temperature). Biogeochemical cycles (carbon, nitrogen, sulphur, phosphorus, magnesium and iron cycle) Landfill, Composting	
III	<b>Air Microbiology</b> Distribution of microorganism in Air, Outdoor and indoor microflora, Allergic disorders by air microflora, Collection and enumeration of microflora of air (Liquid and solid impingement devices)	
IV	<b>Water Microbiology</b> Type of water (atmospheric, surface and stored), Microflora of aquatic environment (freshwater & marine microbiology), Coliforms ,Sewage water (physical, chemical & microbiological characteristics) BOD and COD, Water treatment (primary treatment, secondary treatment, tertiary treatment, water disinfection by chlorination.	
V*	<b>Practical</b> <ul style="list-style-type: none"> <li>• Isolation of fungi from soil</li> <li>• Isolation of bacteria from soil</li> <li>• Isolation of bacteria from water</li> <li>• To study air microflora</li> <li>• To isolate coliform from sewage sample</li> <li>• To isolate bacteria from water by filtration membrane</li> <li>• To calculate BOD of water sample</li> <li>• To calculate COD of water sample</li> <li>• To isolate antibiotic producing microorganism</li> </ul>	3 hours /week
<b>Suggested Evaluation Methods</b>		

<p style="text-align: center;"><b>Internal Assessment:</b></p> <p>➤ <b>Theory</b></p> <ul style="list-style-type: none"> <li>• Class Participation: 5</li> <li>• Seminar/presentation/assignment/quiz/class test etc.:5</li> <li>• Mid-Term Exam: 10</li> </ul> <p>➤ <b>Practicum</b></p> <ul style="list-style-type: none"> <li>• Class Participation: NA</li> <li>• Seminar/Demonstration/Viva-voce/Lab records etc.:10</li> <li>• Mid-Term Exam: NA</li> </ul>	<p><b>End Term Examination:</b></p> <p>Theory -50 Written Exam Practical-20 Demonstration/Viva-voce/Lab records</p>
<b>Part C-Learning Resources</b>	
<b>Recommended Books/e-resources/LMS:</b>	
<p>21. P.D. Sharma: Microbiology 22. R.C Dubey: A text book of Biotechnology 23. Atlas &amp; Bartha: Microbial ecology Fundaments &amp; applications 24. Tortora &amp; Funke: Microbiology 25. Coyne, MS: Soil Microbiology: An Exploratory Approach</p>	

<b>PLO CLO MAPPING of B23-IMB-202</b>						
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	1.5	1	0.5	2.0	1	1.5
CLO2	1.5	2	2	1	2	2
CLO3	1.5	1	1	0.6	2	2
CLO4	2	1	2	3	2.7	2
CLO5	2.5	2	1	0.5	2	2.5



**CC-M2**

<b>Session: 2023-24</b>			
<b>Part A - Introduction</b>			
Subject	INDUSTRIAL MICROBIOLOGY		
Semester	II		
Name of the Course	APPLIED MICROBIOLOGY		
Course Code	B23-IMB-203		
Course Type:	CC-M		
Level of the course (As per Annexure-I)	100-199		
Pre-requisite for the course (if any)	--		
Course Learning Outcomes(CLO):	After completing this course, the learner will be able to: 1. To acquaint with the useful food products of microorganism 2. To introduce concept of Biofertilizer and Biopesticide as ecofriendly compound 3. To give knowledge of future applications of microorganisms for sustainable development 4. To introduce the benefits of microorganisms in human welfare		
CLO5 is related to practical component	5*. To isolate rhizospheric and non rhizospheric microorganisms and basics testing of milk.		
Credits	Theory	Practical	Total
	1	1	2
Contact Hours	1	2	3
<b>Internal Assessment Marks</b>	10	5	15
<b>End Term Exam Marks</b>	20	15	35
<b>Exam Duration</b>	3 hours	4 hours	
Maximum Marks 50			
<b>Part B- Contents of the Course</b>			

**Instructions for Paper- Setter:**

Nine questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining eight questions will be set taking two questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting one question from each unit. All questions carry equal marks.

<b>Unit</b>	<b>Topics</b>	<b>Contact Hours</b>
I	<b>Food and Industrial Microbiology</b> Production of Yoghurt, Bread, Beer, Wine, Sauerkraut, Vinegar, Lactic acid, Single cell protein	1 hour/week
II	<b>Medical Microbiology</b> Production of Interferons , Insulin , Antibiotics: penicillin, Streptomycin, Vaccines : Inactivated ,Live attenuated, mRNA, Subunit , Recombinant, Toxoid ,Biopharming	
III	<b>Future Prospects</b> Biomining :Extraction of Iron , Copper , Microbially enhanced oil recovery, Production of Hydrogen, Bioconcrete	
IV	<b>Agricultural and Environmental Microbiology</b> Production of Biofertilizer of , <i>Rhizobium</i> , <i>Azotobacter</i> , Biopesticide (Bt), Mushroom, BOD, COD, Effluent treatment, Bioremediation, Petroleum degradation	
V*	Practical <ul style="list-style-type: none"><li>• Isolation of <i>Rhizobium</i> from root nodules.</li><li>• Determination of BOD/ COD of sewage water (treated and untreated)</li><li>• To perform methylene blue reduction test of raw and pasteurized milk.</li><li>• Isolation of Lactobacilli and Streptococci from curd.</li><li>• Isolation of important bacteria involved in food spoilage (<i>Bacillus</i>, <i>Escherchia</i>, <i>Staphylococcus</i>)</li></ul>	2 hours/week

**Suggested Evaluation Methods**

<p style="text-align: center;"><b>Internal Assessment:</b></p> <p>➤ <b>Theory</b></p> <ul style="list-style-type: none"> <li>• Class Participation: 4</li> <li>• Seminar/presentation/assignment/quiz/class test etc.: NA</li> <li>• Mid-Term Exam: 6</li> </ul> <p>➤ <b>Practicum</b></p> <ul style="list-style-type: none"> <li>• Class Participation: NA</li> <li>• Seminar/Demonstration/Viva-voce/Lab records etc.:5</li> <li>• Mid-Term Exam: NA</li> </ul>	<p><b>End Term Examination:</b></p> <p>Theory -20</p> <p>Practical-15</p>
<b>Part C-Learning Resources</b>	
<b>Recommended Books/e-resources/LMS:</b>	
<p>26. Powar, C.B. &amp; Daginawala, H.F.: General Microbiology Vol.1, Himalaya Publishing House, Bombay</p> <p>27. Prescott, L.M. et al. (2005 &amp; 2007). Microbiology, McGraw Hill</p> <p>28. Pelczar, M.J., Chan, E.C.S. &amp; Krieg, N.R.: Microbiology, Tata Mc Graw-Hill Publishing Company Limited, New Delhi.</p> <p>29. P.D. Sharma: Microbiology</p> <p>30. R.C Dubey: A text book of Biotechnology S Chand and Company Ltd</p> <p>31. Atlas &amp; Bartha: Microbial ecology Fundaments &amp; applications</p> <p>32. Tortora &amp; Funke: Microbiology.</p>	

<b>PLO CLO MAPPING of B23-IMB-203</b>						
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	1	1	1	1	1	1
CLO2	1	2	2	2	1	2
CLO3	2	2	2	2	1.5	2
CLO4	1.5	1.5	1.5	1.5	1.5	1.5
CLO5	1	1.5	1.5	2.5	2.5	2

## MDC-2

<b>Session: 2023-24</b>			
<b>Part A - Introduction</b>			
Subject	INDUSTRIAL MICROBIOLOGY		
Semester	II		
Name of the Course	OUTLINES OF MICROBIAL CHARACTERS, PHYSIOLOGY AND METABOLISM		
Course Code	B23-IMB-204		
Course Type:	MDC		
Level of the course (As per Annexure-I)	100-199		
Pre-requisite for the course (if any)	--		
Course Learning Outcomes(CLO):	After completing this course, the learner will be able to: <ol style="list-style-type: none"><li>1. To acquaint with growth, its measurement and factors affecting bacterial growth</li><li>2. To discuss the methods of transport of compounds</li><li>3. To acquaint with important metabolic pathways in microbes.</li><li>4. To give information of morphology and nutrition of microorganisms.</li></ol>		
CLO5 is related to practical component	5*. To impart technical skills related to growth, isolation, identification of microorganisms in addition to handling enzyme.		
Credits	Theory	Practical	Total
	2	1	3
Contact Hours	2	2	4
<b>Internal Assessment Marks</b>	15	5	20
<b>End Term Exam Marks</b>	35	20	55
<b>Exam Duration</b>	3 hours	4 hours	
Maximum Marks 75			
<b>Part B- Contents of the Course</b>			
<b><u>Instructions for Paper- Setter:</u></b>			

Nine questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining eight questions will be set taking two questions from each unit. The candidates will be required to attempt Q.No.1 & four others selecting one question from each unit. All questions carry equal marks.

<b>Unit</b>	<b>Topics</b>	<b>Contact Hours</b>
I	<b>Microbial Growth</b> Definition of growth, expression of growth, Generation time, Growth curve in bacteria, Synchronous growth, diauxic growth, Prototroph, Auxotroph, Measurement of Growth (cell number, cell mass and cell constituent), Effect of environment on the microbial growth, (temperature, pH and oxygen).	2 Hours/week
II	<b>Membrane Transport and Enzymes</b> Types of cellular transport (diffusion, gaseous exchange, osmosis, plasmolysis, active & passive transport, facilitated transport), Enzymes in metabolism, enzyme kinetics- effect of pH and temperature on enzyme activity, allosteric enzyme, classification	
III	<b>Metabolic Pathways</b> Metabolism Anabolism, Glycolysis, Entner Doudoroff pathway, Pentose phosphate pathway, Krebs cycle Substrate level and oxidative phosphorylation, Electron transport chain	
IV	<b>Microbial characters</b> The structure and morphology of Bacteria (cell shape, size, arrangement, Cell wall, Endospore, Flagella, Pili, Plasmid, Chromatin, Cytoplasm), Algae, Fungi, Viruses, Protozoa, Nutritional types of bacteria, Colony morphology of bacteria	
V*	<b>Practical</b> <ul style="list-style-type: none"> <li>• Preparation of Nutrient Agar</li> <li>• Preparation of PDA</li> <li>• Effect of temperature on growth</li> <li>• Effect of pH on growth</li> <li>• Effect of oxygen on growth</li> <li>• Staining of bacteria simple and differential</li> <li>• To study common bacteria</li> <li>• To study common fungi</li> <li>• To study common algae</li> </ul>	2 Hours/week
<b>Suggested Evaluation Methods</b>		

<p style="text-align: center;"><b>Internal Assessment:</b></p> <p>➤ <b>Theory</b></p> <ul style="list-style-type: none"> <li>• Class Participation: 4</li> <li>• Seminar/presentation/assignment/quiz/class test etc.:4</li> <li>• Mid-Term Exam: 7</li> </ul> <p>➤ <b>Practicum</b></p> <ul style="list-style-type: none"> <li>• Class Participation: NA</li> <li>• Seminar/Demonstration/Viva-voce/Lab records etc.:5</li> <li>• Mid-Term Exam: NA</li> </ul>	<p style="text-align: center;"><b>End Term Examination:</b></p> <p style="text-align: center;">Theory -35 Written Exam Practical-20 Demonstration/Viva-voce/Lab records</p>
<b>Part C-Learning Resources</b>	
<b>Recommended Books/e-resources/LMS:</b>	
<p>33. Powar, C.B. &amp; Daginawala, H.F.: General Microbiology Vol.18, Himalaya Publishing House, Bombay</p> <p>34. Prescott, L.M. et al. (2005 &amp; 2007). Microbiology, McGraw Hill International Edition, USA.</p> <p>35. Pelczar, M.J., Chan, E.C.S. &amp; Krieg, N.R.: Microbiology, Tata Mc Graw-Hill Publishing Company Limited, New Delhi</p> <p>36. Satyanarayan, U.: Biochemistry- Books &amp; allied Pvt Ltd</p>	

<b>PLO CLO MAPPING of B23-IMB-204</b>						
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
CLO1	1.5	1	0.5	2.0	1	1.5
CLO2	1.5	2	2	1	2	2
CLO3	1.5	1	1	0.6	2	2
CLO4	2	1	2	3	2.7	2
CLO5	2.5	2	1	0.5	2	2.5