Kurukshetra University, Kurukshetra

(Established by the State Legislature Act-XII of 1956)
("A++" Grade, NAAC Accredited)

Syllabus
for
Under-Graduate Programme

Subject: Industrial Microbiology
(Semester 5th and 6th)

Under Multiple Entry-Exit, Internship and CBCS-LOCF in accordance to NEP-2020
With effect from the session 2025-26

Kurukshetra University, Kurukshetra

Syllabus for UG Programme Subject - Industrial Microbiology

Semester 5th and 6th

Session: 2025-26			
Part A - Introduction			
Subject	INDUSTRIAL MICROBIOLOGY		
Semester	V		
Name of the Course	IMMUNOLOGY		
Course Code	B23-IMB-501		
Course Type:	**CC-5/ MCC-9**		
Level of the course (As perAnnexure-I	300-399		
Pre-requisite for the course (if any)	---		
Course Learning Outcomes (CLO): CLO5 is related to practical component	After completing this course, the learner will be able to: 1. To acquaint with Basic of immunology. 2. To impart knowledge about various antigens and antibodies 3. To give theoretical knowledge of MHC and complement system. 4. To understand about basics of various types of immune related disorders. 5. To use the knowledge of immunology in diagnosis based on immunity.		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30
End Term Exam Marks	50	20	70
Exam Duration	3 hours	4 hours	
Maximum Marks 100			

Part B- Contents of the Course

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	**Concept of Innate and Adaptive immunity**; Contributions of following scientists to the development of the field of immunology - Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, MacFarlane Burnet, Neils K Jerne. **Structure, Functions and Properties of:** Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT	13
II	**Antigens:** Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T & B cell epitopes); T-dependent and T-independent antigens; Adjuvants **Antibodies:** Structure, Types, Functions and Properties of antibodies; Antigenic Determinants on antibodies (Isotypic, allotypic, idiotypic); Monoclonal and Chimeric antibodies	12
III	**Major Histocompatibility Complex** Organization of MHC locus (Mice & Human); Structure and Functions of MHC I & II molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways) **Components of the Complement system;** Activation pathways (Classical, Alternative, and Lectin pathways); Biological consequences of complement Activation.	10
IV	**Generation of Immune Response Primary and Secondary Immune Response**; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co- stimulatory signals). Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies; Animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak- Higashi syndrome, Leukocyte adhesion deficiency, CGD; Types of tumors, tumor Antigens, causes cancers.	10
V*	**PRACTICAL** • Identification of human blood groups. • Determination of total leucocytes count • Determination of differential leucocytes count • Determination of total erythrocytes count • Perform immunodiffusion by Ouchterlony method	30

Suggested Evaluation Methods	
Internal Assessment: ➢ **Theory** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.:5 • Mid-Term Exam: 10 ➢ **Practicum** • Class Participation: NA • Seminar/Demonstration/Viva-voce/Lab records etc.:10 • Mid-Term Exam: NA	**End Term Examination:** Theory -50 Written Exam Practical-20 Demonstration/Viva-voce/Lab records

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. 1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 5th edition W.H. Freeman and Company, New York.
4. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
5. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
6. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

PLO CLO MAPPING of B23-IMB-501

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO1	1	1	1	1	1	1	1	1.5	1
CLO2	1.5	1	2	1	1	1.5	1	1.5	1
CLO3	1	1	2	1.5	1.5	1.5	1	1.5	1
CLO4	1.5	1	2	1.5	1.5	1	1	1.5	1
CLO5	1	1	2	1.5	1.5	1	1	1.5	1

Session: 2025-26			
Part A - Introduction			
Subject	INDUSTRIAL MICROBIOLOGY		
Semester	V		
Name of the Course	AGRICULTURE MICROBIOLOGY		
Course Code	B23-IMB-502		
Course Type:	**MCC-10**		
Level of the course (As per Annexure-I	300-399		
Pre-requisite for the course (if any)	---		
Course Learning Outcomes (CLO): CLO5 is related to practical component	After completing this course, the learner will be able to: 1. CO1: understand different MO present in soil ecosystem and their role and different interactions for sustainable agriculture. 2. CO2: Understand the concept of plant nutrition through biological nitrogen fixation and other biofertilizers. 3. CO3: understand role of microorganisms in different biodegradation strategies of different organic matter, organic polymers, and pesticides. 4. CO4: Understand mechanism of different biocontrol and transgenic approaches for protection of plant from diseases. 5. To impart practical to isolate the microorganism for cellulose degradation and will be able to identify pathogenic fungi from plants		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30
End Term Exam Marks	50	20	70
Exam Duration	3 hours	4 hours	
Maximum Marks100			

Part B- Contents of the Course

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	**Soil microbial ecology:** Soil biota, types of organisms in different soils; Soil microbial biomass; Factors influencing the soil microflora. Different Agriculturally important beneficial microorganisms – free living, symbiotic (rhizobial, mycorrhizal, actinorhizal) **Microbial interactions:** Different interfaces of interactions - Plant-microbe, microbe-microbe, soilmicrobe, soil-plant-microbe interactions leading to symbiotic, associative, endophytic and pathogenic interactions.	13
II	**Introduction to biofertilizers**- definition, types of biofertilizers; Characteristic features of the following biofertilizer organisms: *Azospirillium*, *Azotobacter*, *Bacillus, Pseudomonas, Rhizobium*, *Frankia, Anabaena* and *Nostoc*. **Biological nitrogen fixation**- Biochemistry of N2fixation, nif operon, mechanism of nitrogen fixation. Symbiotic nitrogen fixation: Rhizobium-Legume association, Actinorhizal associations, contribution of symbiotic nitrogen fixation. Denitrification.	12
III	Microbial transformations of nitrogen, phosphorus, sulphur, iron and manganese in soil. Biodegradation of pesticides, Organic wastes and their use for production of biogas and manures. **Microbial degradation of polymers**: lignin, cellulose, hemicelluloses. Factors affecting the degradation of organic matter.	10
IV	Biocontrol – Concept, types, mode of action, uses and practical constraints & applications of biocontrol agents. Biocontrol agent for sustainable agriculture. Different types of biocontrol agents. Biopesticides and bioherbicides, Biopesticides- classification, advantages. Major biopesticides based on bacteria, viruses & fungi (Bacillus thuringiensis (Bt) toxin, Boverin,	10
V*	**PRACTICAL** 1. To demonstrate the reduction of nitrates to nitrogen gas (denitrification). 2. Isolation of rhizosphere and nonrhizosphere microflora. 3. Isolation of cellulose degrading microorganisms from soil. 4. Isolation of Rhizobium from root nodules. 5. To study the microbial interactions.	30

Suggested Evaluation Methods	
Internal Assessment: ➢ **Theory** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.:5 • Mid-Term Exam: 10 ➢ **Practicum** • Class Participation: NA • Seminar/Demonstration/Viva-voce/Lab records etc.:10 • Mid-Term Exam: NA	**End Term Examination:** Theory -50 Written Exam Practical-20 Demonstration/Viva-voce/Lab records

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Paul EA. Soil Microbiology, Ecology and Biochemistry. 3rd Ed. Academic Press.
2. Varnam AH & Evans MG. Environmental Microbiology, Manson Publishing Ltd.
3. Christon J.Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills. Manual of Environmental Microbiology, ASM Press
4. Spencer JFT, Alicia L & Ragout de Spencer. Environmental Microbiology: Methods and Protocols. Springer,
6. Burlage R.S., Atlas R., Stahl D., Geesey G. & Sayler G. Techniques in Microbial Ecology. Oxford University press, Inc.
7 Gaur A.C. Handbook of organic farming and biofertilizer, Ambika book agency, Jaipur

PLO CLO MAPPING of B23-IMB-502

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO1	1	1	1	1	1	1.5	1	1.5	1
CLO2	1.5	1	2	1	1.5	1.5	1	1.5	1
CLO3	1	1	2	1.5	1	1.5	1	1.5	1.5
CLO4	1.5	1	1	1	1	1.5	1	1.5	1
CLO5	1	1	1	1	1	1.5	1	1.5	1.5

Session: 2025-26			
Part A - Introduction			
Subject	INDUSTRIAL MICROBIOLOGY		
Semester	V		
Name of the Course	SOIL MICROBIOLOGY		
Course Code	B23- IMB- 503		
Course Type:	**DSE-2**		
Level of the course (As perAnnexure-I	300-399		
Pre-requisite for the course (ifany)	---		
Course Learning Outcomes(CLO): CLO5 is related to practical component	After completing this course, the learner will be able to: 1. Understand soil as a complex microbial habitat including its physicochemical properties. 2. Describe microbial diversity in soil and its ecological roles. 3. Explain nutrient cycling and plant-microbe interactions. 4. Apply the knowledge in areas like biofertilizer production, bioremediation, and sustainable agriculture. 5. Perform core microbiological techniques related to soil analysis..		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30
End Term Exam Marks	50	20	70
Exam Duration	3 hours	4 hours	
Maximum Marks 100			
Part B- Contents of the Course			
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	Soil formation and classification. Composition of soil – physical, chemical, and biological components. Soil profile and soil horizons. Soil as a reservoir of microbial diversity. Factors affecting microbial communities in soil – pH, temperature, organic matter, oxygen, moisture. Types of soils found in India and their microbiological relevance. Rhizosphere and phyllosphere – definitions and microbial populations.	13
II	Types of soil microorganisms – bacteria, fungi, actinomycetes, protozoa, algae. Isolation and enumeration techniques of soil microbes. Beneficial and harmful interactions – symbiosis, commensalism, antagonism. Biological nitrogen fixation – Symbiotic associative and free-living. Mycorrhizae – ecto- and endo-mycorrhizae.	12
III	Nitrogen cycle: ammonification, nitrification, denitrification, nitrogen fixation. Carbon cycle: degradation of cellulose, lignin, and other organic matter. Phosphorus and sulfur transformation. Role of microorganisms in humus formation and organic matter decomposition.	10
IV	Biofertilizers – types (Rhizobium, Azotobacter, Azospirillum, Cyanobacteria, PSM), mode of action, application, and significance. Microbial biopesticides. Soil microbiome and sustainable agriculture. Bioremediation and composting – microbial involvement in solid waste degradation and compost quality improvement.	10
V*	**PRACTICAL** • pH and moisture content estimation of different soil types • Isolation and enumeration of different types of soil microorganisms. • Isolation of nitrogen fixing microorganisms from root nodules • Composting of organic matter. • Ammonification Test in Soil Using Nessler's Reagent. • Study of Mycorrhizal Association in Plant Roots	30

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.:5 • Mid-Term Exam: 10 ➢ **Practicum** • Class Participation: NA • Seminar/Demonstration/Viva-voce/Lab records etc.:10 • Mid-Term Exam: NA	**End Term Examination:** Theory -50 Written Exam Practical-20 Demonstration/Viva-voce/Lab records

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Alexander, M. (1999). *Introduction to Soil Microbiology*, 2nd Ed., Wiley.
2. Sylvia D.M. et al. (2005). *Principles and Applications of Soil Microbiology*, Pearson.
3. Subba Rao, N.S. (2001). *Soil Microorganisms and Plant Growth*, Oxford & IBH.
4. Paul, E.A. (2015). *Soil Microbiology, Ecology and Biochemistry*, Elsevier
5. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
6. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA

PLO CLO MAPPING of B23-IMB-503

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO1	1	1	1	1	1.5	1	1	1.5	1
CLO2	1.5	1	2	1	1.5	1.5	1	1.5	1
CLO3	1	1	2	1	1.5	1.5	1	1.5	1.5
CLO4	1.5	1	1	1	1	1	1	1.5	1.5
CLO5	1	1	1	1	1	1	1	1.5	1.5

Session: 2025-26			
Part A - Introduction			
Subject	INDUSTRIAL MICROBIOLOGY		
Semester	V		
Name of the Course	**MOLECULAR BIOLOGY**		
Course Code	B23- IMB- 504		
Course Type:	**DSE-2**		
Level of the course (As per Annexure-I	300-399		
Pre-requisite for the course (if any)	---		
Course Learning Outcomes(CLO): CLO5 is related to practical component	After completing this course, the learner will be able to: 1. Understand mechanisms regulating gene expression in prokaryotes and eukaryotes. 2. Describe the structure and function of operons and regulatory proteins. 3. Explain mechanisms of RNA processing and splicing. 4. Gain insight into recombinant DNA technology and molecular tools. 5. Perform basic molecular techniques used in genetic engineering and gene expression analysis.		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30
End Term Exam Marks	50	20	70
Exam Duration	3 hours	4 hours	
Maximum Marks 100			
Part B- Contents of the Course			
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	**Transcription:** General principle and steps of transcription: basic apparatus, initiation, elongation and termination. Classes of RNA: rRNA, mRNA and tRNA, structure and function. Types of RNA polymerases: prokaryotic and eukaryotic, Monocistronic and polycistronic RNA, structure of promoter, Brief idea of transcription in eukaryotes.	13
II	**Structure and Processing of RNA transcript –** Structure of primary RNA transcript. RNA splicing (introns, exons). Capping and polyadenylation. Differences in RNA processing between prokaryotes and eukaryotes.	10
III	**Translation:** Basic features of genetic code: Triplet code, deciphering of genetic code, degeneracy, characteristics of genetic code, variation in different organisms, universality, significance of genetic code. Central dogma, Basic steps of translation: basic apparatus, initiation, elongation, termination. Initiation, elongation and termination factors, Brief idea of translation in eukaryotes.	12
IV	**Regulation in Prokaryotes and Eukaryotes** – Introduction to gene regulation. Operon concept: lac operon– structure and regulation. Positive and negative control. Basic idea of regulation of gene expression in eukaryotes.	10
V*	**PRACTICAL** • Estimation of DNA using Diphenylamine Method. • Estimation of RNA using Orcinol Method • Estimation of Protein Using Lowry Method • Estimation of Protein Using Bradford Assay • Ninhydrin Assay for Amino Acids	30

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.:5 • Mid-Term Exam: 10 ➢ **Practicum** • Class Participation: NA • Seminar/Demonstration/Viva-voce/Lab records etc.:10 • Mid-Term Exam: NA	**End Term Examination:** Theory -50 Written Exam Practical-20 Demonstration/Viva-voce/Lab records

Part C-Learning Resources

Recommended Books/e-resources/LMS:

- Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2008). *Molecular biology of the gene* (6th ed.). Cold Spring Harbor Laboratory Press, Pearson Education.
- Becker, W. M., Kleinsmith, L. J., Hardin, J., & Bertoni, G. P. (2009). *The world of the cell* (7th ed.). Pearson Benjamin Cummings.
- De Robertis, E. D. P., & De Robertis, E. M. F. (2006). *Cell and molecular biology* (8th ed.). Lippincott Williams & Wilkins.
- Karp, G. (2010). *Cell and molecular biology: Concepts and experiments* (6th ed.). John Wiley & Sons.
- Sambrook, J., & Russell, D. W. (2001). *Molecular cloning: A laboratory manual* (4th ed.). Cold Spring Harbor Laboratory Press.
- Krebs, J., Goldstein, E., & Kilpatrick, S. (2013). *Lewin's essential genes* (3rd ed.). Jones & Bartlett Learning.
- Gardner, E. J., Simmons, M. J., & Snustad, D. P. (2008). *Principles of genetics* (8th ed.). Wiley-India.

PLO CLO MAPPING of B23-IMB-504

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO1	1	1	1	1	1.5	1	1	1.5	1
CLO2	1.5	1	2	1	1.5	1.5	1	1.5	1
CLO3	1	1	2	1	1.5	1.5	1	1.5	1.5
CLO4	1.5	1	1	1	1	1	1	1.5	1.5
CLO5	1	1	1	1	1	1	1	1.5	1.5

Session: 2025-26			
Part A - Introduction			
Subject	INDUSTRIAL MICROBIOLOGY		
Semester	V		
Name of the Course	MICROBIAL PATHOGENESIS		
Course Code	B23-IMB-505		
Course Type:	**DSE-3**		
Level of the course (As per Annexure-I	300-399		
Pre-requisite for the course (if any)	---		
Course Learning Outcomes (CLO): CLO5 is related to practical component	After completing this course, the learner will be able to: 1. Student will be able to understand the basics of classical molecular microbial pathogenicity. 2. Student will be able to understand the spread of microbes through body, their strategies and mechanism to cause the damage. 3. Students will understand the emergence of new infections as well as various methods of molecular microbial epidemiology. 4. Students will be able to understand the various mechanisms of antimicrobial resistance and new rapid diagnostic principles. 5. To impart practical knowledge of isolation culturing maintenance of food, agriculture and industrial microorganisms.		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30
End Term Exam Marks	50	20	70
Exam Duration	3 hours	4 hours	
Maximum Marks 100			

Part B-Contents of the Course

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	Concept of pathogenesis; Differences between pathogens, commensals, and opportunistic microbes. Historical perspectives: Koch's and Molecular Koch's postulates; Microbial structures associated with virulence; Mechanisms of adhesion, colonization, and invasion. Toxins: Exotoxins (A-B toxins, superantigens) and endotoxins; Genetic regulation of virulence: pathogenicity islands	13
II	Entry routes: mucosal surfaces, vectors, wounds. Strategies for immune evasion (antigenic variation, secretion systems) Survival inside host cells (e.g., Mycobacterium, Salmonella) Host cell manipulation via effector proteins. Spread of microbes through the body. Biofilms, quorum sensing, and chronic infections; Impact on antibiotic resistance.	10
III	Host immune responses (TLRs, phagocytosis, antigen presentation); Cytokine signaling and inflammation; Pattern recognition receptors and danger signals. Immune escape via molecular mimicry; Host microbiome and infection outcomes; Genetic susceptibility to infections. Mechanisms of emergence of new pathogens.	10
IV	Diagnostic techniques: microscopy, culture, biochemical tests Molecular diagnostics: PCR, RT-PCR, BACTAC, Vitek Treatment strategies: antibiotics, antivirals, antifungals; Mechanisms of antimicrobial resistance. Vaccine design: live-attenuated vs. mRNA platforms; Herd immunity and vaccination strategies.	12
V*	**PRACTICAL** • To perform antibiotic susceptibility testing (Kirby-Bauer method) • To perform blood smear analysis and differential count • To study Hemolysis assay on blood agar plates • To perform Enzyme assays (e.g., coagulase, urease tests)	30
Suggested Evaluation Methods		

Internal Assessment: ➢ **Theory** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.:5 • Mid-Term Exam: 10 ➢ **Practicum** • Class Participation: NA • Seminar/Demonstration/Viva-voce/Lab records etc.:10 • Mid-Term Exam: NA	**End Term Examination:** Theory -50 Written Exam Practical-20 Demonstration/Viva-voce/Lab records

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Carroll KC, Hobdon JA, Miller S, Morse SA, Mietzner TA. 27th edition. Jawetz, Melnick, & Adelberg's Medical Microbiology Lange Publication.

2. Edward DJ and Holt KE. Beginner's guide to comparative genome analysis using next generation sequence data. Microbial Informatics and Experimentation, 3:2, https://doi.org/10.1186/2042-5783-3-2.

3. Wilson BA, Salyers AA, Whitt DD and Winkler ME. Bacterial Pathogenesis: A molecular approach. 3rd edition. American Society for Microbiology Press, Washington, DC USA.

4. Locht C and Simonet M. Bacterial Pathogenesis: Molecular and Cellular Mechanisms. Caister Academic Press.

5. Persing DH, Tenover FC, Hayden R, Leven M, Miller MB, Nolte FS, Tang YW, Belkum AAV. Molecular Microbiology: Diagnostic Principles and Practice. 3rd edition. Washington, American Society for Microbiology Press.

PLO CLO MAPPING of B23-IMB-505

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO1	1	1.5	1	1	1	1.5	1	1.5	1.5
CLO2	1.5	1	2	1	1	1.5	1	1.5	1
CLO3	1	1.5	2	1	1	1.5	1	1.5	1.5
CLO4	1.5	1	1	1	1	1.5	1	1.5	1
CLO5	1	1.5	1	1	1	1.5	1	1.5	1.5

Session: 2025-26			
Part A - Introduction			
Subject	INDUSTRIAL MICROBIOLOGY		
Semester	V		
Name of the Course	INDUSTRIAL MICROBIOLOGY		
Course Code	B23- IMB- 506		
Course Type:	**DSE-3**		
Level of the course (As per Annexure-I	300-399		
Pre-requisite for the course (if any)	---		
Course Learning Outcomes(CLO): CLO5 is related to practical component	After completing this course, the learner will be able to: **CLO1**: Understand microbial biotransformation and their industrial applications. **CLO2**: Describe industrial enzymes and methods of microbial/enzymatic immobilization. **CLO3**: Explain microbial production of bioplastics, biofuels, biofertilizers, and biopesticides. **CLO4**: Understand contamination sources and quality control in microbial industries. **CLO5**: Perform basic industrial microbiology experiments related to the course.		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30
End Term Exam Marks	50	20	70
Exam Duration	3 hours	4 hours	
Maximum Marks 100			
Part B- Contents of the Course			
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	**Microbial Biotransformations** – Concept and scope of biotransformations. Types: oxidation, reduction, hydrolysis, isomerization. Microbial synthesis of steroids and value-added products. Role of whole cells and isolated enzymes in biocatalysis**.**	13
II	**Industrial Enzymes and Immobilization Technology** – Overview of industrial enzymes: amylase, protease, cellulase. Methods of immobilization: adsorption, entrapment, covalent binding. Applications of immobilized enzymes and microbes in food and detergent industries.	12
III	**Microbial Products and Industrial Applications** –elementary idea of production and applications of Biofertilizers, Biofuels, Fermented foods like yogurt, solvents like ethyl alcohol.	10
IV	**Contamination Control and Quality Assurance in Industries** – Common microbial contaminants in industrial setups. Sources and detection of contamination. Methods for control: sterilization, filtration, aseptic techniques. Concepts of GMP, GLP, and QA/QC in industrial microbiology.	10
V*	**PRACTICAL** • To check whether bacteria produce amylase to break down starch. • To observe gas (CO_2) formation from sugar by yeast. • To observe starch breakdown using saliva. • To make curd using milk and starter culture.	30

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.:5 • Mid-Term Exam: 10 ➢ **Practicum** • Class Participation: NA • Seminar/Demonstration/Viva-voce/Lab records etc.:10 • Mid-Term Exam: NA	**End Term Examination:** Theory -50 Written Exam Practical-20 Demonstration/Viva-voce/Lab records

Part C-Learning Resources

Recommended Books/e-resources/LMS:

- Patel, A. H. (1996). *Industrial microbiology* (1st ed.). Macmillan India Limited.
- Okafor, N. (2007). *Modern industrial microbiology and biotechnology* (1st ed.). BIOS Scientific Publishers.
- Waites, M. J., Morgan, N. L., Rockey, J. S., & Higton, G. (2001). *Industrial microbiology: An introduction* (1st ed.). Wiley-Blackwell.
- Glaze, A. N., & Nikaido, H. (1995). *Microbial biotechnology: Fundamentals of applied microbiology* (1st ed.). W. H. Freeman and Company.
- Casida, L. E. (1991). *Industrial microbiology* (1st ed.). Wiley Eastern Limited.
- Crueger, W., & Crueger, A. (2000). *Biotechnology: A textbook of industrial microbiology* (2nd ed.). Panima Publishing Co.
- Stanbury, P. F., Whitaker, A., & Hall, S. J. (2006). *Principles of fermentation technology* (2nd ed.). Elsevier Science.

PLO CLO MAPPING of B23-IMB-506

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO1	1	1	1	1	1.5	1	1	1.5	1
CLO2	1.5	1	2	1	1.5	1.5	1	1.5	1
CLO3	1	1	2	1	1.5	1.5	1	1.5	1.5
CLO4	1.5	1	1	1	1	1	1	1.5	1.5
CLO5	1	1	1	1	1	1	1	1.5	1.5

Session: 2025-26			
Part A - Introduction			
Subject	INDUSTRIAL MICROBIOLOGY		
Semester	VI		
Name of the Course	INSTRUMENTATION AND BIOTECHNIQUES		
Course Code	B23-IMB-601		
Course Type:	**CC-6/MCC-11**		
Level of the course (As per Annexure-I	300-399		
Pre-requisite for the course (if any)	---		
Course Learning Outcomes(CLO): CLO5 is related to practical component	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		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30
End Term Exam Marks	50	20	70
Exam Duration	3 hours	4 hours	
Maximum Marks 100			

Part B- Contents of the Course

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	**Laboratory Instruments and Their Principles** – pH meter, colorimeter, centrifuge (types and applications), autoclave, laminar airflow, incubator, and hot air oven. Concepts of calibration and safety precautions in labs.	10
II	**Microscopy and Sterilization Techniques** – Working and applications of light microscope, phase contrast, fluorescence microscope. Sterilization methods: dry heat, moist heat, filtration, radiation, and chemical sterilant. Concept of disinfection vs sterilization.	12
III	**Chromatography Techniques** – Principles and applications of paper chromatography, thin-layer chromatography (TLC), column chromatography, ion-exchange chromatography, and gel filtration. Overview of HPLC and gas chromatography.	10
IV	**Electrophoretic and Spectroscopic Techniques –** Principle of electrophoresis; types – agarose gel and SDS-PAGE. Introduction to spectrophotometry: Beer-Lambert law. Absorption vs fluorescence. Instrumentation and applications. UV visible spectroscopy.	10
V*	PRACTICAL 1. To learn how to operate and calibrate a digital pH meter. 2. To determine absorbance and concentration of a colored solution. 3. Separation of components of a given mixture using a laboratory scale centrifuge. 4. Separation of mixtures by paper / thin layer chromatography 5. To separate DNA using agarose gel electrophoresis. **6.** Separation of protein mixtures by Polyacrylamide Gel Electrophoresis (PAGE)	30

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.:5 • Mid-Term Exam: 10 ➢ **Practicum** • Class Participation: NA • Seminar/Demonstration/Viva-voce/Lab records etc.:10 • Mid-Term Exam: NA	**End Term Examination:** Theory -50 Written Exam Practical-20 Demonstration/Viva-voce/Lab records

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Cooper, G. M., & Hausman, R. E. (2009). *The cell: A molecular approach* (5th ed.). ASM Press; Sinauer Associates.
2. De Robertis, E. D. P., & De Robertis, E. M. F. (2006). *Cell and molecular biology* (8th ed.). Lippincott Williams & Wilkins.
3. Karp, G. (2010). *Cell and molecular biology: Concepts and experiments* (6th ed.). John Wiley & Sons.
4. Nelson, D. L., & Cox, M. M. (2008). *Lehninger principles of biochemistry* (5th ed.). W. H. Freeman and Company.
5. Nigam, A., & Ayyagari, A. (2007). *Lab manual in biochemistry, immunology and biotechnology*. Tata McGraw-Hill.
6. Wilson, K., & Walker, J. (2010). *Principles and techniques of biochemistry and molecular biology* (7th ed.). Cambridge University Press.
7. Willey, M. J., Sherwood, L. M., & Woolverton, C. J. (2013). *Prescott, Harley and Klein's microbiology* (9th ed.). McGraw-Hill.

PLO CLO MAPPING of B23-IMB-601

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO1	1	1	1	1.5	1	1	1	1.5	1.5
CLO2	1.5	1	2	1	1.5	1.5	1	1.5	1
CLO3	1	1	2	1.5	1	1.5	1	1.5	1.5
CLO4	1.5	1	1	1	1.5	1	1	1.5	1
CLO5	1	1	1	1.5	1	1	1	1.5	1.5

Session: 2025-26			
Part A - Introduction			
Subject	INDUSTRIAL MICROBIOLOGY		
Semester	VI		
Name of the Course	MEDICAL MICROBIOLOGY		
Course Code	B23-IMB-602		
Course Type:	**MCC-12**		
Level of the course (As per Annexure-I	300-399		
Pre-requisite for the course (if any)	---		
Course Learning Outcomes (CLO): CLO5 is related to practical component	After completing this course, the learner will be able to: 1. understood the diverse nature of the normal microflora of the body and its significance as well as mode of infections. 2. gain in depth knowledge about the spectrum of diseases caused by bacterial pathogens, and an understanding of the course of disease development 3. become acquainted with the spectrum of diseases caused by viral pathogens. 4. understand the causation of fungal and protozoal diseases and methods of prevention and control. 5. learnt basic concepts of handling clinical specimens and approaches used to aid in detection/diagnosis of diseases		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30
End Term Exam Marks	50	20	70
Exam Duration	3 hours	4 hours	
Maximum Marks 100			

Part B-Contents of the Course

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	Significance of Microbiology in Medicine, Classification of medically important microbes, Normal microbial flora of the human body: normal flora of skin, eye, throat, gastrointestinal tract and urogenital tract. Infections- Sources, types – opportunistic, nosocomial and community acquired infections. Mode of transmission, carriers and their types. sepsis and septic shock	10
II	Human diseases caused by bacterial pathogens: List of diseases of various organ systems and their causative agents. Symptoms, mode of transmission, prophylaxis and control of the following diseases: Respiratory diseases- caused by *Streptococcus pyogenes, Haemophilus influenzae, Mycobacterium tuberculosis*. Gastrointestinal diseases – caused by *Escherichia coli, Salmonella typhi, Vibrio cholerae, Helicobacter pylori*	13
III	Human diseases caused by viral pathogens: Symptoms, mode of transmission, prophylaxis and control of the following- Polio, Herpes, Hepatitis, Rabies, Dengue, AIDS, Influenza (swine flu and bird flu), Ebola, Chikungunya, Japanese Encephalitis, Rota virus, Zika.	10
IV	Human diseases caused by protozoan and fungal pathogens: Malaria, Kala-azar – causes, symptoms, diagnosis and treatments. Brief description of the following types of mycoses and one representative disease in detail: Cutaneous mycoses- Tinea pedis (Athlete's foot). Systemic mycoses, Histoplasmosis. Opportunistic mycoses - Candidiasis	12
V*	**PRACTICAL** • Study of bacterial flora of skin by swab method. • Study of composition and use of important differential media for identification of bacteria: EMB Agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS • Study of various stages of Malarial parasite in RBCs and Leishmania using permanent mounts/photomicrographs. • Identify bacteria, on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease and catalase tests.	30
Suggested Evaluation Methods		

Internal Assessment: ➢ **Theory** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.:5 • Mid-Term Exam: 10 ➢ **Practicum** • Class Participation: NA • Seminar/Demonstration/Viva-voce/Lab records etc.:10 • Mid-Term Exam: NA	**End Term Examination:** Theory -50 Written Exam Practical-20 Demonstration/Viva-voce/Lab records

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Ananthanarayan, R. and Paniker, C.K.J. (2017). Textbook of Microbiology. 10th edition. Universities Press, India.
2. Carroll, K.C., Morse, S.A., Mietzner, T.A. and Miller, S. (2016). Jawetz, Melnick and Adelberg's Medical Microbiology. 27th edition. McGraw Hill Education.
3. Madigan, M.T. and Martinko, J.M. (2017). Brock Biology of Microorganisms. 15th edition. Prentice Hall International Inc., USA.
4. Tortora, G.J., Funke, B.R., Case, D., Weber, D. and Bair, W. (2019). Microbiology: An Introduction. 13th edition. Pearson Education, USA.
5. Willey, J. M., Sandman, K. and Wood, D. (2019). Prescott's Microbiology. 11th edition. McGraw Hill Higher Education, USA.

PLO CLO MAPPING of B23-IMB-602

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO1	1	1.5	1	1	1	1.5	1	1.5	1.5
CLO2	1.5	1	2	1	1	1.5	1	1.5	1
CLO3	1	1.5	2	1	1	1.5	1	1.5	1.5
CLO4	1.5	1	1	1	1	1.5	1	1.5	1
CLO5	1	1.5	1	1	1	1.5	1	1.5	1.5

Session: 2025-26			
Part A - Introduction			
Subject	INDUSTRIAL MICROBIOLOGY		
Semester	VI		
Name of the Course	BIOFERTILIZERS AND BIOPESTICIDES		
Course Code	B23- IMB- 603		
Course Type:	**DSE-4**		
Level of the course (As per Annexure-I	300-399		
Pre-requisite for the course (if any)	---		
Course Learning Outcomes(CLO): CLO5 is related to practical component	After completing this course, the learner will be able to: **CLO1**: Understand microbial biotransformation and their industrial applications. **CLO2**: Describe industrial enzymes and methods of microbial/enzymatic immobilization. **CLO3**: Explain microbial production of bioplastics, biofuels, biofertilizers, and biopesticides. **CLO4**: Understand contamination sources and quality control in microbial industries. **CLO5**: Perform basic industrial microbiology experiments related to the course.		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30
End Term Exam Marks	50	20	70
Exam Duration	3 hours	4 hours	
Maximum Marks 100			
Part B- Contents of the Course			
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	**Introduction to Biofertilizers** – Definition, need, and importance. Classification of biofertilizers: nitrogen-fixing, phosphate-solubilizing, and potassium-mobilizing microbes. Types of associations – free-living, symbiotic, associative. Examples: Rhizobium, Azotobacter, Azospirillum, Frankia, cyanobacteria.	13
II	**Mechanism of Biofertilizer Action –** Nitrogen fixation (symbiotic and asymbiotic), phosphate solubilization, siderophore production, phytohormone production (IAA, gibberellins), role in plant stress tolerance and growth promotion.	12
III	**Biopesticides –** Introduction and Classification – Types of biopesticides: bacterial (e.g., *Bacillus thuringiensis*), fungal (e.g., *Trichoderma*), viral (NPV), and botanical-based products. Mode of action of biopesticides.	10
IV	**Production and Application** – Mass production of biofertilizers and biopesticides: culture selection, carrier materials, formulation, quality control standards. Storage and application techniques: seed treatment, soil application.	10
V*	**PRACTICAL** • Isolation of *Rhizobium* from Root Nodules • Phosphate Solubilization by Soil Microorganisms on Pikovskaya's Agar • Isolation of Free-Living Nitrogen Fixing Bacteria (*Azotobacter*) from Soil • Detection of Indole Acetic Acid (IAA) Production by PGPR • Siderophore Production Assay using Chrome Azurol S (CAS) Medium • Dual Culture Technique to Test Antagonistic Activity of *Trichoderma* spp. • Viability Testing of Biofertilizer Formulation (CFU Counting)	30

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.:5 • Mid-Term Exam: 10 ➢ **Practicum** • Class Participation: NA • Seminar/Demonstration/Viva-voce/Lab records etc.:10 • Mid-Term Exam: NA	**End Term Examination:** Theory -50 Written Exam Practical-20 Demonstration/Viva-voce/Lab records

Part C-Learning Resources

Recommended Books/e-resources/LMS:

- Aggarwal, S. K. (2005). *Advanced environmental biotechnology*. APH Publishing.
- Kannaiyan, S. (2003). *Biotechnology of biofertilizers*. CHIPS.
- Rai, M. K. (2005). *Handbook of microbial biofertilizers*. The Haworth Press.
- Reddy, S. M., & Others. (2002). *Bioinoculants for sustainable agriculture and forestry*. Scientific Publishers.
- Saleem, F., & Shakoori, A. R. (2012). *Development of bioinsecticide*. LAP Lambert Academic Publishing GmbH KG.
- Subba Rao, N. S. (1995). *Soil microorganisms and plant growth*. Oxford and IBH Publishing Co. Pvt. Ltd.

PLO CLO MAPPING of B23-IMB-603

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO1	1	1	1	1	1.5	1	1	1.5	1
CLO2	1.5	1	2	1	1.5	1.5	1	1.5	1
CLO3	1	1	2	1	1.5	1.5	1	1.5	1.5
CLO4	1.5	1	1	1	1	1	1	1.5	1.5
CLO5	1	1	1	1	1	1	1	1.5	1.5

Session: 2025-26			
Part A - Introduction			
Subject	INDUSTRIAL MICROBIOLOGY		
Semester	VI		
Name of the Course	GENETIC ENGINEERING		
Course Code	B23- IMB- 604		
Course Type:	**DSE-4**		
Level of the course (As per Annexure-I	300-399		
Pre-requisite for the course (if any)	---		
Course Learning Outcomes(CLO): CLO5 is related to practical component	After completing this course, the learner will be able to: Understand the principles and tools of genetic engineering. Explain various cloning strategies and expression systems. Describe the use of vectors and host organisms in gene manipulation. Gain insight into genome editing techniques like CRISPR-Cas9. Perform basic genetic engineering experiments such as transformation and screening.		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30
End Term Exam Marks	50	20	70
Exam Duration	3 hours	4 hours	
Maximum Marks 100			
Part B- Contents of the Course			
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	**Tools of Genetic Engineering –** Restriction endonucleases, DNA ligases, alkaline phosphatase, reverse transcriptase. Characteristics of ideal cloning vectors: plasmids (pUC18), cosmids, phagemids, BACs, YACs..	12
II	**Cloning Strategies –** Gene cloning steps: DNA isolation, cutting, ligation, transformation, and selection. Different strategies for identification of recombinants. DNA libraries: genomic and cDNA libraries,	12
III	Conventional sequencing methods: Sanger sequencing, Maxam-Gilbert sequencing. Expression of Cloned Genes – Prokaryotic and eukaryotic expression vectors. Expression cassette: Promoters, terminators, reporter genes and their regulation.	10
IV	Genome Editing Technologies: Site-directed mutagenesis and protein engineering. RNA interference, Applications in medicine, agriculture, and industry. Bioethics in genetic research and therapy.	10
V*	PRACTICAL 1. Preparation of competent cells for transformation. 2. 1. Isolation of Genomic DNA 3. Quantification of DNA and RNA 4. Extraction of plasmid DNA using alkaline lysis method. 5. Transformation of *E. coli* with plasmid DNA 6. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis.	30

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.:5 • Mid-Term Exam: 10 ➢ **Practicum** • Class Participation: NA • Seminar/Demonstration/Viva-voce/Lab records etc.:10 • Mid-Term Exam: NA	**End Term Examination:** Theory -50 Written Exam Practical-20 Demonstration/Viva-voce/Lab records

Part C-Learning Resources

Recommended Books/e-resources/LMS:

- Brown, T. A. (2007). *Genomes 3*. Garland Science.
- Brown, T. A. (2010). *Gene cloning and DNA analysis* (6th ed.). Blackwell Publishing.
- Clark, D. P., & Pazdernik, N. J. (2009). *Biotechnology: Applying the genetic revolution*. Elsevier Academic Press.
- Primrose, S. B., & Twyman, R. M. (2006). *Principles of gene manipulation and genomics* (7th ed.). Blackwell Publishing.
- Primrose, S. B., & Twyman, R. M. (2008). *Genomics: Applications in human biology*. Blackwell Publishing.
- Sambrook, J., & Russell, D. (2001). *Molecular cloning: A laboratory manual* (3rd ed.). Cold Spring Harbor Laboratory Press.
- Willey, J. M., Sherwood, L. M., & Woolverton, C. J. (2008). *Prescott, Harley and Klein's microbiology*. McGraw-Hill Higher Education.

PLO CLO MAPPING of B23-IMB-604

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO1	1	1	1	1	1.5	1	1	1.5	1
CLO2	1.5	1	2	1	1.5	1.5	1	1.5	1
CLO3	1	1	2	1	1.5	1.5	1	1.5	1.5
CLO4	1.5	1	1	1	1	1	1	1.5	1.5
CLO5	1	1	1	1	1	1	1	1.5	1.5

Session: 2025-26			
Part A - Introduction			
Subject	INDUSTRIAL MICROBIOLOGY		
Semester	VI		
Name of the Course	BIOSAFETY AND IPR		
Course Code	B23-IMB-605		
Course Type:	**DSE-5**		
Level of the course (As perAnnexure-I	300-399		
Pre-requisite for the course (if any)	---		
Course Learning Outcomes (CLO): CLO5 is related to practical component	After completing this course, the learner will be able to: 1. Get an insight into Biosafety guidelines and to Analyze and Manage the Risks involved with GMOs 2. Understand the International Agreements and Regulations with respect to Biosafety. 3. Gain Knowledge about Intellectual Property Rights to protect biological inventions. 4. Understand process of filing a patent, about different treaties, rights and duties of Patent owner. 5. Understand the Process involved in Patenting, Patent Search and the protocols for ethical permissions and procedures.		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30
End Term Exam Marks	50	20	70
Exam Duration	3 hours	4 hours	
Maximum Marks 100			
Part B- Contents of the Course			
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	Introduction, biosafety issues; Biological Safety Cabinets & their types; Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms. Biosafety Guidelines: Biosafety guidelines and regulations (National and International); GMOs/LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees (IBSC), RCGM, GEAC etc. for GMO applications in food and agriculture;	10
II	National regulatory bodies, Biosafety of Genetically engineered products, Genetically engineered products and recombinant DNA technology, Risk assessment of RDT products, Regulating recombinant DNA technology, Web based information of biosafety on GMO, Biosafety database. Good Laboratory biosafety practices and Importance of good laboratory practices.	12
III	Introduction to Intellectual Property and History. Patents, Trademarks, Copyright , Trade secrets, Industrial Design and Rights, Traditional Knowledge, Geographical Indications - importance of IPR – patentable and non patentable – patenting life – legal protection of biotechnological inventions – World Intellectual Property Rights Organization (WIPO), Ethics, Pros and Cons of IP protection.	10
IV	Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures; Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner. Agreements and Treaties: GATT, TRIPS Agreements; WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; UPOV & Brene conventions; Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recent amendments. Patenting Living Organisms	13
V*	**PRACTICAL** • Understanding the Structure and working of Biosafety committees. • Case studies of different types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition • Study of Biotechnology and Patent laws: patenting living beings , Patents for Chemicals, Pharmaceuticals. • To operate Biosafety cabinets and understand GLP- Good Laboratory biosafety Practices. • Case studies on the patent infringements and revocations. • Searching of Patent databases a. Indian Patent office b. USPTO c. WIPO	30

Suggested Evaluation Methods	
Internal Assessment: ➢ **Theory** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.:5 • Mid-Term Exam: 10 ➢ **Practicum** • Class Participation: NA • Seminar/Demonstration/Viva-voce/Lab records etc.:10 • Mid-Term Exam: NA	**End Term Examination:** Theory -50 Written Exam Practical-20 Demonstration/Viva-voce/Lab records

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Shomini Parashar, Deepa Goel IPR, Biosafety and Bioethics Pearson India 2013.
2. Diane O. Fleming, Debra L. Hunt Biological Safety: Principles and Practices, 4th Edition. ASM 2006
3. Singh, I. and Kaur, B., Patent law and Entrepreneurship, Kalyani Publishers (2006).
4. Essentials of Intellectual Property: Law, Economics, and Strategy By Alexander I. Poltorak; Paul J. Lerner Wiley, 2011 (2nd edition).

PLO CLO MAPPING of B23-IMB-605

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO1	1	1	1	1	1	1	1	1.5	1
CLO2	1.5	1	2	1	1	1.5	1	1.5	1
CLO3	1	1	2	1.5	1.5	1.5	1	1.5	1
CLO4	1.5	1	2	1.5	1.5	1	1	1.5	1
CLO5	1	1	2	1.5	1.5	1	1	1.5	1

Session: 2025-26			
Part A - Introduction			
Subject	INDUSTRIAL MICROBIOLOGY		
Semester	VI		
Name of the Course	BASICS OF BIOINFORMATICS		
Course Code	B23-IMB-606		
Course Type:	**DSE-5**		
Level of the course (As perAnnexure-I	300-399		
Pre-requisite for the course (if any)	---		
Course Learning Outcomes (CLO): CLO5 is related to practical component	After completing this course, the learner will be able to: 1. understand the basics of bioinformatics like file formats, databases, etc. 2. understand the basic alignments tools like BLAST, PAM, etc 3. understand the different types multiple sequence alignment tools for analysis and will get to know about the basics of genome and transcriptome. 4. Students will be able to understand the various methods of phylogenetic analysis. 5. different protein database and protein modeling tools and to do sequence alignments using BLAST and able to construct phylogenetic tree.		
Credits	Theory	Practical	Total
	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	20	10	30
End Term Exam Marks	50	20	70
Exam Duration	3 hours	4 hours	
Maximum Marks 100			
Part B- Contents of the Course			
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	**Introduction, overview and needs of bioinformatics technology**. Biological databases – nucleic acid, genome, protein sequence and structure, gene expression databases, Database of metabolic pathways, SNP, chemical, metabolic pathways, signalling pathways, general human genetics, cancer gene. **Mode of data storage** - File formats - FASTA, Genbank and Uniprot, Data submission & retrieval from NCBI, EMBL, DDBJ, Uniprot, PDB.	10
II	**Introduction to sequence alignment and its applications.** Pair wise sequence alignment: Concept of global and local alignment, Dot Plot, algorithm for pair wise sequence alignment (Needleman Wunsch, Smith-watterman methods). **Introduction to BLAST:** types of BLAST, algorithm of BLAST and interpretation of its result. Substitution matrices: Introduction to substitution matrices: PAM and BLOSUM matrices, concept of log odd ratio.	12
III	**Multiple sequence alignment:** Methods of multiple sequence alignment, Tools of MSA– ClustalW, TCoffee; Position specific scoring matrices, introduction to consensus sequences, motifs and profiles. **Significance of alignments:** E value, Scores Diversity of Genomes: Viral, prokaryotic & eukaryotic genomes.	10
IV	**Phylogenetic Analysis:** Introduction to phylogenetic analysis and its application. Types of phylogenetic trees, Different approaches of phylogenetic tree construction - UPGMA, Neighbour joining, Maximum Parsomony, Maximum likelihood. **Genome Annotation:** Concept of genome annotation, methods of gene identification. Tools of gene identification: GenScan, Grail, GeneID and Glimmer.	13
V*	**PRACTICAL** • Introduction to various protein databases. • To perform protein modeling using SWISS-MODEL. • Visualization of 3D structures of proteins. • Sequence retrieval using BLAST. • Sequence alignment & phylogenetic analysis using clustal omega & phylip. • To analyze the given 16srRNA sequences by using BLAST and construct a phylogenetic tree based on the comparison results	30

Suggested Evaluation Methods	
Internal Assessment: ➢ **Theory** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.:5 • Mid-Term Exam: 10 ➢ **Practicum** • Class Participation: NA • Seminar/Demonstration/Viva-voce/Lab records etc.:10 • Mid-Term Exam: NA	**End Term Examination:** Theory -50 Written Exam Practical-20 Demonstration/Viva-voce/Lab records

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Baxevanis AD, Ouellette BFF. Bioinformatics: A practical guide to the analysis of genes and proteins (John Wiley and Sons).

2. Rastogi S.C., Mendiratta N. and Rastogi P. Bioinformatics: methods and applications, genomics, proteomics and drug discovery, 2nd ed. Prentice Hall India Publication

3. Lesk M.A. Introduction to Bioinformatics. Oxford Publication, 3rd International Student Edition

4. Primrose and Twyman. Principles of Genome Analysis & Genomics. Blackwell 5. Attwood TK & Parry-Smith DJ. Introduction to Bioinformatics. Pearson Edu.

PLO CLO MAPPING of B23-IMB-606

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO1	1	1	1	1	1	1	1	1.5	1
CLO2	1.5	1	2	1	1	1.5	1	1.5	1
CLO3	1	1	2	1.5	1.5	1.5	1	1.5	1
CLO4	1.5	1	2	1.5	1.5	1	1	1.5	1
CLO5	1	1	2	1.5	1.5	1	1	1.5	1