Anekant Education Society's

Tuljaram Chaturchand College, Of Arts, Science & Commerce, Baramati

(Autonomous Institute)

Syllabus (CBCS) for M.Sc. Microbiology

w.e.f. June 2019

Anekant Education Society's
Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati

Autonomous

Course Structure for M.Sc. -II: Microbiology (2019 Pattern)

Semester	Paper Code	Title of Paper	No. of Credits
III	MICRO5301	Immunology	4
	MICRO5302	Molecular Biology I	4
	MICRO5303	Industrial Waste Water Treatment	4
	MICRO5304	Biophysical Techniques	4
	MICRO5305	Practical Course: Practical course based on Immunology, Pharmaceutical Microbiology and Industrial waste water treatment	4
	MICRO5306	Practical Course: Practical course based on Molecular Biology (I and II) and Microbial Technology	4
	CC029	Certificate Course: Research Methodology	2
	SD23	Skill Development: Spectroscopic Techniques	2
IV	MICRO5401	Pharmaceutical Microbiology	4
	MICRO5402	Molecular Biology II	4
	MICRO5403	Microbial Technology	4
	MICRO5404	Medical Microbiology	4
	MICRO5405	Dissertation I	4
	MICRO5406	Dissertation II	4
	SD24	Skill Development: Chromatographic Techniques	2

SYLLABUS (CBCS) FOR M.Sc. II Microbiology
(w. e. from June, 2020)
Academic Year 2020-2021

Class : M. Sc. II (Semester- IV)
Paper Code : MICRO5401
Paper : I
Title of Paper : Pharmaceutical Microbiology
Credit : 4
No. of lectures : 60

Course Objective:

- To inculcate the knowledge regarding the drug designing, pharmacokinetics and pharmacodynamics
- To aware students with the concepts of pharmaceuticals.
- To understanding Drug Discovery Process
- To gain a comprehensive understanding of the drug discovery process, from target identification to clinical trials.
- To explore the principles of rational drug design and computational methods for designing new drugs.
- ToLearn the basics of drug toxicology and safety assessments.
- Understand preclinical testing, including in vitro and in vivo models for assessing drug efficacy
- Explore the regulatory requirements and processes involved in bringing a drug from discovery to market

Course Outcome:

CO1. In addition to drug development students will also understand the concepts of drug discovery
CO2. They will be able to know pharmacokinetics and pharmacodynamics.
CO3. Proficiency in various drug screening methods, including high-throughput screening, virtual screening, and biochemical assays.
CO4. They will be able to know medicinal chemistry principles to design and optimize drug candidates.
CO5. An understanding of the pharmacological aspects of drug development, including mechanisms of action, pharmacokinetics, and pharmacodynamics.
CO6. Knowledge of safety assessment procedures and understanding of potential toxicity issues associated with drug candidates.
CO7. Proficiency in developing drug formulations and delivery systems.
CO8. Awareness of the regulatory pathways for drug approval, as well as ethical considerations in drug development.

UNIT 1: Drug Discovery and Development (15L)

Contributions and postulates of Paul Ehrlich Significance of terms - Lead compound, Lead optimization, Candidate selection

A. Drug Discovery:
   I. Conventional Process Bio-prospecting (Medicinal Chemistry) – Extraction and purification principles, Purification and characterization of bioactive molecules from natural sources
   II. Rational Drug Design – Principle (Structure activity relationship-SAR) and Tools (applications of High Through Put Screening, Combinatorial synthesis,

Pharmaco-genomics)

B. Drug Development
   I. Preclinical developmen: Toxicity testing – acute, sub-acute and chronic toxicity
   II. Clinical development: Clinical trials – (Aims, Objectives, Conduct): I, II, III and IV

UNIT 2: Biopharmaceuticals –Regulations and Sources (15L)

Regulatory authorities and its role: FDA and Pharmacopeia (IP, UK, US)
Drug formulations - Carriers and delivery systems, targeted drug delivery, sustained release
Pharmacokinetic – ADME / Bioavailability studies
E. coli as a source of recombinant, therapeutic proteins

UNIT 3: Development of Anti-infectives: (15L)

Therapeutic ratio, MIC and MBC
Susceptibility Testing:

A. Use of liquid and solid media
B. Factors affecting susceptibility testing, CLSI guidelines
C. Diffusion methods –agar dilution technique, gradient plate techniques, E-test, Kirby Bauer, Stokes method
D. Susceptibility testing for:
   1. Anti-mycobacterial agents
   2. Anti-fungal agents
   3. Anti-protozoan agents
   4. Anti-viral agents

UNIT 4: Quality Assurance and Validation in Pharmaceutical Industry (15L)

A. Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry.
B. Quality assurance and quality management in pharmaceuticals ISO, WHO and US certification. Safety in microbiology laboratory.
C. Safety profile of drugs:
   i. Pyrogenicity testing
   ii. Mutagenicity and Carcinogenicity testing
   iii. Teratogenicity testing
   iv. Adverse Drug Reactions
   v. In vivo and in vitro drug interactions

Text / Reference Books:

- Agarwal S. S. and Paridhavi M., (2007), *Herbal Drug Technology*, Universities Press (India) Pvt. Ltd
- Altreuter D., and D S. Clark, (1999), *Combinatorial Biocatalysis: Taking the Lead From Nature*, Curr. Opin. Biotechnol. **10,** 130.
- Bentley's Textbook of Pharmaceutics, Ed. E. A. Rawlins, 8th Ed.(2002), Bailliere Tindall, London
- Burn J. H. (1957) *Principles of Therapeutics*, Blackwell Scientific Pub. O. Ltd. Oxford.
- Chatwal G. P. (2003) *Bio-pharmaceutics and Pharmacokinetics*, Himalaya Publishing House, Mumbai.
- Paul W. Erhardt, (2006), *Medicinal Chemistry in the New Millennium: A Glance into the Future*, Ed. Chorghade Mukund S. in Drug discovery and development Volume I:

Drug Discovery, Wiley-Interscience, John Wiley and Sons Inc. USA, 17-102.
- Committee for the Purpose of Control and Supervision on Experiments on Animals (CPCSEA), www.cpcsea.com
- Dewick Paul M., (2002), *Medicinal natural products: A biosynthetic approach*, 2nd Ed., John Wiley and Sons
- Graly John O. and Pieter H. Joubert, (1997), *Handbook of Phase I / II clinical drug trials*, CRC Press
- Iyengar M. A. (1974) *Pharmacology of Powdered Crude Drugs*, Manipal
- Micheles P. S., Y. L. Khmelnitsley, J. S. Dordick and D. S. Clark, (1998), *Combinatorial Biocatalysis, A Natural Approach to Drug Discovery*, Trends in Biotechnol. **16,** 197.
- Satoskar R. S. & S. D. Bhandarkar (1991) *Pharmacology and Pharmacotherapeutics*, 12th Ed., Vol. 1 & 2, Popular Prakashan, Mumbai.
- Vyas S. P and Dixit V. R. (2002), *Pharmaceutical Biotechnology*, CBS Publishers and Distributors, New Delhi
- Kokate C. K., Purohit A. P., Gokhale A. B. (2000) *Pharmacology*, 4th Ed., Nirali Prakashan.
- Mannfred A. Holliger, (2008), *Introduction to pharmacology*, 3rd Ed., CRC Press **38**
- Sylvie E. Blondelle, Enrique Pe´Rez-Paya, And Richard A. Houghten, (1996), *Synthetic Combinatorial Libraries: Novel Discovery Strategy for Identification of Antimicrobial Agents*, Antimicrobial Agents and Chemotherapy, 1067–1071
- Walsh Gary, (2003), *Biopharmaceuticals Biochemistry And Biotechnology*, 2nd Ed., John Wiley & Sons Ltd, England
- Franklin T. J. and Snow G. A., (1975), *Biochemistry of Antimicrobial Action*, Chapman and Hall, London, 1-22 and 160-174
- Gale E. F., Cundliffe E., Reynolds P. E., Richmond M. H. and Waring M. J., (1972), *The molecular basis of antibiotic action*, John Wiley and Sons, London
- Goldstein A., Aronow L., and Kalman S. M. (1969) *Principles of Drug Action, The Basis of Pharmacology*, Harper international edition New York.
- Lorian V., (1986), *Antibiotics in laboratory medicine*, 2nd Ed, Williams & Wilkins Publication
- National Committee for Clinical Laboratory Standards (now Clinical and Laboratory Standards Institute, CLSI). *Methods for dilution antimicrobial susceptibility testing for bacteria that grows aerobically. Approved Standards M7-A4*. Villanova, PA: NCCLS, 1997.
- National Committee for Clinical Laboratory Standards (now Clinical and Laboratory Standards Institute, CLSI). *Performance standards for antimicrobial susceptibility testing; 12th information supplement (M100-S1)*. Villanova, PA; NCCLS: 2002
- MAron Dorothy M. and Bruce N. Ames, (1983), *Revised methods for the Salmonella mutagenicity test*, Mutation Research, 113:173-215
- Osol Arther (1975) *Remington's Pharmaceutical Sciences*, 15th Ed., Mack Pub. Co., Pennsylvania.

Mapping of Program Outcomes with Course Outcomes

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)									
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2		2	2	2					
CO 2	2	2								
CO 3										
CO 4		2								
CO 5	2									
CO 6						2				
CO 7										
CO8									3	

Justification for the mapping

1. **Disciplinary Knowledge:**

CO1: Understanding drug discovery is essential for students pursuing careers in drug development, pharmacology, and healthcare
Co2: understanding pharmacokinetics is justified in the field of pharmaceutical and medical sciences because it is a core component of disciplinary knowledge
CO5: A strong grasp of pharmacokinetics is essential for optimizing drug dosing, ensuring therapeutic efficacy, and minimizing adverse effects.

2. **Critical Thinking and Problem solving:**

CO 2: Pharmacokinetics involves the study of how the body absorbs, distributes, metabolizes, and eliminates drugs, which is essential for optimizing drug dosages, minimizing side effects, and ensuring their therapeutic efficacy.
CO4: In the field of pharmacokinetics, students need to critically assess research papers, clinical trials, and data. Critical thinking enables them to discern the validity and relevance of various sources of information.

3. **Social competence:.**

CO 1: This knowledge is crucial for students to contribute to advancements in healthcare and the pharmaceutical industry.

4. **Research-related skills and Scientific temper:**

CO 1: Drug Discovery is at forefront of Scientific Innovation And Research By grasping this concept student are better equipped to engage in innovative research project and potentially to break ground breaking discoveries

5. Trans-disciplinary knowledge

CO 1: Drug discovery involves multidisciplinary approach encompassing chemistry biology and pharmacology . teaching drug discovery

6. **Personal and professional competence:**

CO6: Understanding drug discovery is essential for students pursuing careers in drug development, pharmacology, and healthcare

9. **Self-directed and Life-long learning: .**

CO8: Healthcare professionals, researchers, and regulators need this knowledge to make informed decisions about drug administration and patient safety.

SYLLABUS (CBCS) FOR M.Sc. II Microbiology
(w. e. from June, 2020)
Academic Year 2020-2021

Class	: M. Sc. II (Semester- IV)
Paper Code	: MICRO5402
Paper	: II
Title of Paper	: Molecular Biology II
Credit	: 4
No. of lectures	: 60

Course objective:

1. To understand various gene cloning techniques such as the preparation of gene and genome libraries, cDNA libraries, PCR cloning, and alternatives.
2. To gain proficiency in site-directed mutagenesis techniques and protein engineering methods for modifying and designing proteins with specific properties.
3. To comprehend methods for cloning and manipulating large DNA fragments (YAC, BAC, HAC) and gene transfer techniques used to introduce foreign DNA into host cells.
4. To understand the principles and applications of expression vectors for the efficient expression of genes in host cells.
5. To explore the synthesis of commercial products such as amino acids, ascorbic acid, antibiotics, peptide antibodies, and biopolymers using recombinant DNA technology.
6. To learn about unconventional microbial systems used in the production of high-quality protein drugs.
7. To understand the process of bioremediation involving the degradation of xenobiotics and the engineering of degradative pathways in GMOs.
8. To comprehend the utilization of starch and cellulose for the production of fructose, alcohol, and silage, using genetically modified organisms.
9. To evaluate and discuss social and ethical issues surrounding genetically modified organisms.
10. To explore applications of GMOs in medicine, including prevention, early disease detection, and therapies, as well as their applications and examples in agriculture. They will analyze the advantages, disadvantages, and examples of transgenic plants producing useful molecules.

Course outcome:

CO1. Students will acquire comprehensive knowledge of diverse gene cloning techniques, including gene and genome library preparation, cDNA libraries, PCR cloning, and alternative methodologies.

CO2. Students will demonstrate an understanding of methods for manipulating large DNA fragments (YAC, BAC, HAC) and gene transfer techniques used to introduce foreign DNA into host cells.

CO3. Students will explore and comprehend the process of synthesizing various commercial products (amino acids, ascorbic acid, antibiotics, peptide antibodies, biopolymers) using recombinant DNA technology.

CO4. Students will understand the process of bioremediation involving the degradation of xenobiotics and the engineering of pathways for degradation in genetically modified organisms.

CO5. Students will comprehend the utilization of starch and cellulose for the production of fructose, alcohol, and silage, utilizing genetically modified organisms.

CO6. Students will critically assess and discuss the social and ethical issues associated with genetically modified organisms.

CO7. Students will explore the various applications of GMOs in medicine, including disease prevention, early detection, therapies, as well as their uses in agriculture. They will analyze the advantages, disadvantages, and instances of transgenic plants producing beneficial molecules.

UNIT 1: Gene technology (15L)

- Gene cloning strategies: preparation of gene, genome libraries, cDNA libraries, PCR cloning and alternatives. Library screening
- Site directed mutagenesis and protein engineering
- Cloning and manipulating large fragments of DNA; YAC BAC HAC
- Gene transfer to host cells.
- Expression vectors

UNIT 2: Applications of recombinant DNA technology – Production of Secondary Metabolites (15L)

Synthesis of commercial products: Amino acids, ascorbic acid, novel antibiotics, peptide antibodies, biopolymers: gum, rubber, polyhydroxyalkanoates. Unconventional microbial systems for production of high quality protein drugs.

UNIT 3: Bioremediation and biomass utilization with the help of GMOs (15L)

Degradation of xenobiotics, engineered degradative pathways.
Utilization of starch and cellulose for fructose, alcohol and silage production

UNIT 4: Genetically modified Microbes, plants and animals (15L)

- Genetically modified organisms- social and ethical issues
- Applications in medicine – prevention, early detection and cure of diseases
- Gene augmentation, gene therapy
- Applications in agriculture – examples of transgenic plants advantages and disadvantages Producing useful molecules examples

Text / Reference Books:

- R. Glick, J.J. Pasterneck, Principles and applications of recombinant DNA, 3rd Ed., ASM press.
- James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Loswick (2004) *Molecular Biology of the Gene*, 5th Edition, Pearson Education, Inc. and Dorling Kindersley Publishing, Inc.
- Lewin's Genes XI, (2014) Jones and Bartelett Publishers Inc.
- Malom Campbell and L. J. Heyer, Discovering genomics, Proteomics and Bioinformatics, 2nd Ed., Pearson Publication, 2009.
- S.B Primrose and R M Twyman 2006 7th edition. Blackwell publishing
- Walker J.M., Rapley R. (eds.) Molecular Biology and Biotechnology, 4th Ed., 2009, Royal Society Press, U.K.

Mapping of Program Outcomes with Course Outcomes

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)								
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3								
CO 2	3								
CO 3	3								
CO 4	3			2				2	
CO 5	3								
CO 6		3	3			2	3		
CO 7					2				

Justification for the mapping

PO1: Disciplinary Knowledge

CO1: Demonstrates a strong (3) correlation, as thorough knowledge of gene cloning techniques significantly contributes to disciplinary expertise.

CO2: Strongly aligns (3) with disciplinary knowledge, as understanding gene manipulation techniques is integral to the field.

CO3: Exhibits a strong (3) relationship, as understanding commercial product synthesis through recombinant DNA technology is directly linked to disciplinary knowledge.

CO4: Strongly correlates (3) with disciplinary knowledge, as understanding bioremediation and engineered degradation pathways directly aligns with the field.

CO5: Demonstrates a strong (3) correlation, as knowledge of utilizing genetically modified organisms for producing specific compounds directly contributes to disciplinary knowledge.

PO2: Critical Thinking and Problem Solving

CO6: Strongly aligns (3) with critical thinking, as the critical evaluation and discussion of social and ethical aspects related to GMOs directly engage critical thinking skills.

PO3: Social Competence

CO6: Strongly relates (3) to social competence, as discussing the social and ethical dimensions of GMOs directly pertains to social awareness and understanding.

PO4: Research-related Skills and Scientific Temper

CO4: Moderately correlates (2) with research-related skills, as understanding bioremediation involves some aspects of research skills in application.

PO5: Trans-disciplinary Knowledge

CO7: Moderately aligns (2) with trans-disciplinary knowledge, as exploring various applications of GMOs in medicine and agriculture contributes partially to interdisciplinary understanding.

PO6: Personal and Professional Competence

CO6: Moderately relates (2) to personal and professional competence, as the critical evaluation and discussion of social and ethical considerations indirectly contribute to personal and professional growth.

PO7: Effective Citizenship and Ethics

CO6: Strongly aligns (3) with effective citizenship and ethics, as ethical considerations associated with GMOs directly align with ethical awareness and responsibilities.

PO8: Environment and Sustainability

CO4: Moderately correlates (2) with environment and sustainability, as understanding bioremediation partially contributes to knowledge regarding environmental sustainability.

SYLLABUS (CBCS) FOR M.Sc. II Microbiology
(w. e. from June, 2020)
Academic Year 2020-2021

Class	: M. Sc. II (Semester- IV)
Paper Code	: MICRO5403
Paper	: III
Title of Paper	: Microbial Technology
Credit	: 4
No. of lectures	: 60

Course Objective:

1. To comprehend various bioreactor design and the factors influencing the process.
2. To furnish students with a thorough comprehension of microbial technology, including its principles and application.
3. To acquaint students with the variety of microorganisms and their functions in diverse industrial processes.
4. To investigate the methods and techniques employed in microbial technology, encompassing the isolation, cultivation and manipulation of microorganisms.
5. To enhance students' proficiency in employing microbial tools and techniques for biotechnological application.
6. To advocate for ethical considerations and conscientious practices in the realm of research.
7. To improve students' comprehension of the economic, social, and environmental consequences associated with microbial technology.

Course Outcome:

CO1. Thorough comprehension of diverse bioreactor designs and variables in the process.
CO2. Comprehend the basic principles of microbial technology, encompassing microbial physiology, genetics, and metabolism.
CO3. Recognize and categorize various microorganism types, comprehending their functions in diverse industrial processes.
CO4. Show proficiency in techniques employed for microbial isolation, cultivation, and maintenance in laboratory environments.
CO5. Utilize understanding of microbial technology to address practical issues and formulate solutions in biotechnology.
CO6. Examine and interpret data derived from microbial experiments, drawing sound conclusions.
CO7. Assess the ethical considerations and societal repercussions of microbial technology across diverse sectors, including healthcare, agriculture, and environmental remediation.

UNIT 1: Bioreactor Design (15L)

A. Designing of bioreactors - Design aspects CSTRs: The dimensional ratios of the outer shell, and the operational aspects such as working volume and impellers.
B. The configuration (placement) of impellers in a vessel and the different types of impellers (types of turbines and propellers, and their combinations)
C. Immobilized cell reactors and air-lift reactors – Design and operation.
D. Batch, Fed-batch and Continuous operation: Applications, advantages and limitations of each type.

UNIT 2: Process Variables and Monitoring (15L)

A. **Process Variables**:

I. Aeration - Theory of oxygen transfer in bubble aeration, Oxygen transfer kinetics (Oxygen Uptake Rate –OUR; Oxygen Transfer Rate OTR; Ccrit), determination of KLa.

II. Agitation - Functions of agitation. Flow patterns with different types of impellers.

III. Fermentation broth rheology and power requirements for agitation – Concept of Newtonian and non-Newtonian fluids, effect of broth rheology on heat, nutrient and oxygen transfer, Reynold's number, Power number, Aeration number

B. **Monitoring of process variables**:

Use of various types of sensors and biosensors for monitoring environmental parameters (pressure, pH, temperature, DO and DCO2), Basic principles of operation, types of biosensors

UNIT 3: Microbial Processes (15L)

I. Upstream, Fermentation and Downstream Processing for the following:

II. Antibiotics (Rifamycin)

III. Microbial enzymes (Chitinase)

IV. Exopolysaccharides (Pullulan)

V. Use of immobilized cells / enzymes to produce protease

UNIT 4: Principles of Validation Process / Method Validation and IPR (15L)

a. The concept of ISO Certification.

b. Preparation of SOPs

c. Validation protocols for methods in:

i. Quality Control

ii. Process validation

The above should be discussed within WHO Norms. Exercises on preparation of SOPs, operation and validation for analytical methods

Intellectual Property Rights (IPR):

i. Basic concepts of IPR

ii. Introduction to forms of IPR – Patents and Designs

Text / Reference Books:

- Bioreactor Design and Product Yield (1992), BIOTOL series, Butterworths Heinemann.
- Doran Pauline (1995) Bioprocess Engineering Principles, Academic Press.
- Lydersen B., N. a. D' Elia and K. M. Nelson (Eds.) (1993) Bioprocess Engineering: Systems, Equipment and Facilities, John Wiley and Sons Inc.
- Ratledge C and Kristiansen B eds. (2001) Basic Biotechnology 2nd Ed. Cambridge Univ. Press. Cambridge
- Operational Modes of Bioreactors, (1992) BIOTOL series, Butterworths Heinemann.
- Shuichi and Aiba. Biochemical Engineering. Academic Press. 1982
- Stanbury and Whittaker. Fermentation technology
- Klegerman, M.E and Groves M.J. (1992) Pharmaceutical Biotechnology: Fundamentals and Essentials. Interpharm Press Ltd. Buffalo Grove IL
- Peppler H. J. and D. Perlman (1970) Microbial Technology Volume 1 and 2,

Academic Press New York.
- Ponkhshe S. (1988) Management of Intellectual Property, Bhate and Ponkhshe Prakasham, Pune
- Reed G. Ed. Prescott and Dunn's Industrial Microbiology. 4th Ed., CBS Pub. New Delhi.
- Van Damme E. J. (1984) Biotechnology of Industrial Antibiotics, Marcel Dekker Inc. New York.
- Wiseman A.(1985) Topics in Enzyme and Fermentation - Biotechnology, Vol. 1 and 2, John Wiley and Sons, New York
- Supplementary Training Modules on Good Manufacturing Practice. Validation-WHO Technical Report Series, No.937, 2006, Annex 4.
- The FDA's draft process validation Guidance-A perspective from industry. By Naula Calnan, Alice Redmond and Stan O' Neill. Process Validation Guidance

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Weightage:1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)								
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1					3				
CO 2	3	2							
CO 3	2								
CO 4						3			
CO 5									3
CO 6				2		2			
CO 7			2					2	

Justification for the mapping

PO1: Disciplinary Knowledge

CO2: Microbiology is a discipline that specifically studies microorganisms, including bacteria, fungi, viruses, and other microscopic organisms. Understanding the different types of microorganisms and their functions is crucial in various industrial processes such as fermentation, bioremediation, food production, pharmaceuticals, and biofuel production.
CO3: Students will develop a deep understanding of the principle of sterilization necessory for fermentation because sterilization destroy all microorganisms

PO2: Critical Thinking and Problem Solving

CO2: Students can apply critical thinking skills to identify potential issues or challenges in microbial technology and propose effective solutions. They can analyze data, make informed decisions, and troubleshoot problems that may arise during the application of microbial technology in various fields such as biotechnology, environmental science, and pharmaceuticals.

PO3: Social competence

CO7: Social competence in assessing the ethical considerations and societal repercussions of microbial technology, individuals can ensure that decisions and actions related to its use are

informed, responsible, and aligned with the values and needs of society. This competence promotes a comprehensive understanding of the social dimensions of microbial technology and facilitates the development of sustainable and socially responsible practices in its application across diverse sectors.

PO4: Research related skills and scientific temper.
CO6: Having a scientific temper is equally important. It involves adopting a critical and objective mindset, being open to new ideas, and valuing evidence-based reasoning. A scientific temper encourages students to approach microbial experiments with curiosity, skepticism, and a willingness to challenge existing knowledge. It also promotes ethical conduct, attention to detail, and a commitment to accuracy and precision in data interpretation. By developing research-related skills and cultivating a scientific temper, students are better equipped to engage in microbial experiments, analyze data effectively, and draw sound conclusions. These abilities are crucial for advancing scientific knowledge, making informed decisions, and contributing to the field of microbiology.

PO5: Trans-disciplinary Knowledge
CO1: Bioreactor design encompasses various aspects such as engineering principles, fluid dynamics, and material science. Understanding the different types of bioreactors, their configurations, and their operating principles requires knowledge from these diverse disciplines. Similarly, process variables in bioreactors involve considerations such as temperature, pH, dissolved oxygen, and nutrient concentrations, which require an understanding of biology, chemistry, and control systems.

PO6: Personal and Professional Competence
CO6: Competence ensures a solid understanding of fermentation processes, including microbial activities, nutrient requirements, and environmental conditions, enabling effective management of fermentation systems.
CO4: Demonstrates a researcher's ability to effectively isolate, cultivate, and maintain microbial cultures, forming a foundational skill set essential for conducting experiments and investigations in various scientific domains. Enhances the reliability and precision of experimental outcomes by ensuring the purity and viability of microbial cultures, contributing to the credibility of research findings.

PO8: Environmental and sustainability.
CO7: Fermentation often utilizes renewable resources, such as agricultural by-products or waste, contributing to a reduction in the overall carbon footprint compared to traditional manufacturing processes heavily reliant on fossil fuels. Certain fermentation processes are inherently more energy-efficient than conventional chemical synthesis methods. This increased efficiency aligns with sustainability goals by minimizing energy consumption and associated greenhouse gas emissions.

PO9: Self-directed and Life-long Learning
CO5: Lifelong learning enables individuals to continually optimize fermentation processes. This includes understanding new approaches to enhance yields, improve product purity, and streamline overall production efficiency. With the emergence of innovative bioprocessing technologies, self-directed learners can readily adapt to new tools and methodologies, fostering innovation and efficiency in fermentation processes.

SYLLABUS (CBCS) FOR M.Sc. II Microbiology
(w. e. from June, 2020)
Academic Year 2020-2021

Class	: M. Sc. II (Semester- IV)
Paper Code	: MICRO5404
Paper	: IV
Title of Paper	: Medical Microbiology
Credit	: 4
No. of lectures	: 60

Course Objectives:

1. To define and classify different types of microorganisms, including bacteria, viruses, fungi, and parasites and basic structure, morphology, and physiology of microorganisms.
2. To develop critical thinking skills in analyzing and solving microbiological problems and apply knowledge to assess and address real-world challenges in the field of medical microbiology.
3. To explain the mechanisms by which microorganisms cause disease in humans and understand the host-pathogen interactions and the factors influencing microbial virulence.
4. To develop basic research skills in the field of medical microbiology and understand how to critically review and analyze scientific literature in microbiology.
5. To learn laboratory techniques for the isolation, identification, and characterization of microorganisms and interpret microbiological test results and correlate them with clinical conditions.
6. To understand the principles of epidemiology as they apply to infectious diseases and analyze the transmission and spread of infectious agents in populations.
7. To discuss the ethical considerations related to microbiological research and clinical practice and emphasize the importance of professionalism and responsibility in working with infectious agents.
8. To learn about antimicrobial drugs, their mechanisms of action, their applications in treating infectious diseases and understand the concepts of antibiotic resistance and strategies to combat it.
9. To discuss strategies for preventing the spread of infectious diseases in healthcare settings and the community, understand the role of public health measures in controlling outbreaks and Correlate microbiological concepts with clinical cases and real-world examples, understand how microbiological principles are applied in diagnosing and treating infectious diseases.

Course Outcome:

CO1. Demonstrate proficiency in laboratory techniques used for the identification and characterization of microorganisms and understand the principles of diagnostic microbiology, including specimen collection, culture, and sensitivity testing.

CO2. Explain the mechanisms by which microorganisms cause diseases in humans and understand host-pathogen interactions and the immune response to microbial infections.

CO3. Analyze the epidemiology of infectious diseases, including transmission modes and risk factors and discuss the role of medical microbiology in public health and disease prevention.

CO4. Describe the mechanisms of action of antimicrobial agents and understand the

development of antimicrobial resistance and its implications for treatment.

CO5. Correlate microbiological concepts with clinical manifestations of infectious diseases and apply knowledge to the diagnosis and management of infectious diseases in a clinical setting.

CO6. Develop critical thinking skills in the analysis of scientific literature related to medical microbiology.

CO7. Demonstrate awareness of ethical considerations in the practice of medical microbiology and understand the importance of professional conduct and communication in healthcare settings.

CO8. Communicate microbiological concepts effectively through written and oral presentations.

UNIT 1 & 2: Determinants of Microbial Pathogenicity (30L)

a. Adhesion and Colonization
b. Invasion
c. Evasion
d. Toxigenesis (mode of action and *in vitro* and *in vivo* assay systems for diphtheria, cholera, tetanus toxins and endotoxins of Gram negative bacteria)
e. Bacterial resistance to host defenses: phagocytosis, nonspecific and specific humoral factors
f. Molecular basis of bacterial pathogenicity – cytoskeletal modulation of host cell, virulence genes and pathogenicity islands

UNIT 3: Clinical Microbiology (15L)

Epidemiological and investigational approaches for emerging infectious diseases:

A. Viral diseases:
SARS (severe acute respiratory syndrome), Avian and Swine influenza, COVID-19

B. Diseases by multi-drug resistant bacterial pathogens:
Mechanisms of development of drug resistance
Vancomycin resistant Enterococci (VRE),
Methicillin resistant *Staphylococcus aureus (*MRSA),
Vancomycin resistant *Staphylococcus aureus (*VRSA),
Extended Spectrum Beta Lactamase (ESBL) producers

UNIT 4: Discovery of anti-infectives (15L)

A. Drug targets in bacteria with examples of established drugs: Cell wall biosynthesis, Cell membrane function, Proteins synthesis and Nucleic acid synthesis and metabolism

B. Methods to quantify growth / inhibition and metabolic changes in microbial population on exposure to anti-infectives, for evaluation of antiinfective activity and developing insight in its' mode of action:
1. Direct counts (Counting chambers, calibrated smears, proportionate counts),
2. Tubidometry and nephalometry,
3. Electrical Resistance, Electrical impendance,
4. Microcalorimetry,
5. Flow cytometry and
6. Radiometric methods
7. Radiolabelling techniques

C. Laboratory methods to assess activity of antimicrobial combinations (antagonism, Synergism, and addictive effect)

- **Text / Reference Books:**
- Babych E. M., Ryzhkova T. A., Kalinichenko S. V. and Sklyar N. I., (2008), *General Characteristic of the methods for detection of diphtheria toxin,* Annals of Mechnikov Institute, 19-21 (www.imiamn.org/journal.htm)
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Mapping of Program Outcomes with Course Outcomes

Weightage: 1=weakorlowrelation,2=moderateorpartialrelation,3=strongordirectrelation

	Programme Outcomes (POs)								
Course Outcomes	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	2				3				
CO2	2		3			2			
CO3		3	3	2		3			
CO4	3	2		3				3	

CO5		2		2	2				
CO6		3		2			3		3
CO7			2			2	2		3

Justification for the mapping

PO1: Disciplinary Knowledge

CO1: Students will able to understand and demonstrate proficiency in laboratory techniques used for the identification and characterization of .

CO2: Students will be able to comprehend the mechanisms by which microorganisms cause diseases in humans and understand host-pathogen interactions.

CO3: Students will have the capability to comprehend analyze the epidemiology of infectious diseases, including transmission modes.

PO2: Critical Thinking and Problem Solving

CO3: Students will utilize their understanding epidemiology of infectious diseases, including transmission modes and risk factors and discuss the role of medical microbiology in public health and disease prevention.

CO4: Students will put their knowledge into practice describe the mechanisms of action of antimicrobial agents

CO5: Students will put their knowledge into correlate microbiological concepts with clinical manifestations of infectious diseases

CO6: Students will apply their knowledge of critical thinking skills in the analysis of scientific literature related to medical microbiology.

PO3: Social competence

CO2: Students will explore to the knowledge understand host-pathogen interactions and the immune response to microbial infections.

CO3: Students will learn about analyzing the epidemiology of infectious diseases, including transmission modes and risk factors

CO7: Demonstrate awareness of ethical considerations in the practice of medical microbiology and understand the importance of professional conduct and communication in healthcare settings.

PO4: Research-related skills and Scientific temper

CO3: Students will able to understand discuss the role of medical microbiology in public health and disease prevention.

CO4: Students will apply their knowledge of action of antimicrobial agents and understand the development of antimicrobial resistance and its implications for treatment.

CO5: Students will be able to comprehend knowledge of microbiological concepts with clinical manifestations of infectious diseases.

CO6: Develop critical thinking skills in the analysis of scientific literature related to medical microbiology

PO5: Trans-disciplinary Knowledge

CO5: Students will employ control on correlating microbiological concepts with clinical manifestations of infectious diseases and apply knowledge to the diagnosis and management of infectious diseases in a clinical setting.

PO6: Personal and Professional Competence

CO2: **Students will demonstrate the ability to the mechanisms by which microorganisms**

cause diseases in humans

CO3: Students will showcase their proficiency in interpreting knowledge of discuss the role of medical microbiology in public health and disease prevention.

CO7: Students will showcase their capacity for interpretation skills of demonstrating awareness of ethical considerations in the practice of medical microbiology and understand the importance of professional conduct and communication in healthcare settings.

PO7:Self-directed and Life-long Learning

CO6: Students will acquire the skill of learning develop critical thinking skills in the analysis of scientific literature related to medical microbiology.

CO7: Students will develop the ability to communicate microbiological concepts effectively through written and oral presentations

PO8: Environment and sustainability

CO4: Students will cultivate skills in understand the development of antimicrobial resistance and its implications for treatment.

PO9: self-directed and Life-long learning

CO6: Students will develop skills in learning and developing critical thinking skills in the analysis of scientific literature related to medical microbiology

CO7: Students will acquire proficiency in awareness of ethical considerations in the practice of medical microbiology and understand the importance of professional conduct and communication in healthcare settings.

SYLLABUS (CBCS) FOR M.Sc. II Microbiology
(w. e. from June, 2020)
Academic Year 2020-2021

Class	: M. Sc. II (Semester- IV)
Paper Code	: MICRO5405
Paper	: V
Title of Paper	: Dissertation I
Credit	: 4
No. of lectures	: 60

Course objective:

1. Introduce the application and research concepts within the realm of Microbiology to students.
2. Foster a sense of scientific responsibility among students.
3. Offer an understanding of the fundamental principles and concepts underpinning research methodology.
4. Cultivate critical thinking abilities essential for designing and executing research studies.
5. Introduce students to a range of research methods and techniques applied across different disciplines.
6. Empower students to evaluate and critique research studies published in academic journals.
7. Strengthen students' abilities in collecting, analyzing, and interpreting data effectively.
8. Advocate for ethical conduct in research and highlight the significance of research integrity.
9. Encourage students to effectively communicate research findings through both written and oral presentations.
10. Foster a research-centric mindset and underscore the importance of continuous learning within the research domain.

Course outcome:

CO1. Comprehend the research process, encompassing the formulation of research questions, hypotheses, and objectives.
CO2. Identify suitable research designs and methodologies based on specified research questions and objectives.
CO3. Critically assess and select relevant literature for conducting comprehensive literature reviews.
CO4. Develop research proposals outlining the research design, methodology, and ethical considerations.
CO5. Apply varied data collection methods, such as surveys, interviews, experiments, and observations.
CO6. Analyze and interpret both quantitative and qualitative data using suitable statistical and analytical methods.
CO7. Communicate research findings effectively through written reports and oral presentations.
CO8. Demonstrate adherence to guidelines for responsible research practices, exhibiting ethical conduct throughout the research process. Evaluate and critique research studies published in academic journals, identifying their strengths and limitations.

CO9. Cultivate a mindset geared toward research and emphasize the importance of continual learning within the research field.
CO10. Gain an understanding of the philosophy and ethical considerations inherent in research practices.
CO11. Demonstrate the ability to compose research proposals effectively.

1. A dissertation can be carried out by a single student or by group of students where the group should not contain more than four students. The dissertation report will be prepared as per the thesis format. Submission of the dissertation report will be at least three days before the date of examination. One copy of the report will be preserved in the department. If there is more than one student carrying out a single dissertation, a single report can be submitted and these students will be assessed based on single oral presentation. In such case, presentation should be carried out by all the students carrying out the same work; dividing the presentation equally among them.
2. At the time of presentation, the external and internal examiners appointed by the university will be present; the dissertation guide may or may not be present.
3. Presentation should be carried out to an audience comprising of examiners appointed by the university, departmental teaching staff and the postgraduate students of the department. Oral presentation can be carried out using posters, blackboard, transparencies, model or LCD projector. The allotted time for each oral presentation (one project) should be 10 to 12 minutes, followed by question-answer session of 5 to 8 minutes. The audience can participate in this session.
4. The assessment of the dissertation I is for total of 100 marks, out of which the end-semester - will be for 60 marks and the in-semester assessment will be for 40 marks.
5. The assessment of in-semester examination will be carried out by the guide who has supervised the work of the candidate(s) throughout the semester. The assessment will be carried out on the basis of the points, as per the accompanied format. Head of the department should communicate this point wise assessment system to the dissertation supervisor (Guide), well in advance. Guide will give appropriate marks, point-wise and submit it in a sealed envelope to the Head of the respective department, three days prior to examination and project presentation. On the day of examination, Head of the department will hand over these unopened envelopes to the examiners.

Points for Evaluation	**Max. Marks**	**Evaluation**
Intellectual potential – Understanding of the research problem by the student	4	
Research aptitude – 1. Depth of literature survey for the proposed work. 2. Inputs of student in development of plans and protocols for the experimentation 3. Ability to analyze data and formulate a solution 4. Analytical and reasoning abilities of the student for interpretation of data, inputs in discussion	 4 8 4 6	
Motivation – punctuality, meeting dead-lines and seriousness	2	
Ability to work with others	2	
Maturity of scientific thoughts	2	
Communication skill – oral and written	8	
Total	**40**	

6. Assessment of end-semester examination will be carried out (i.e. oral presentation) for individual student at the time of examination jointly by internal and external examiners. The assessment will be carried out on the basis of the points as per the accompanied format.

Points for Evaluation	**Max. Marks**	**Evaluation**
Proficiency of presentation skills – use of audio-visual aids, preparation of graphs, charts, models, etc., use of scientific language	24	
Quality of the work, results and interpretation, outcome of the study and possible future plans, publication potential of the work	12	
Submission of progress reports, the dissertation report preparation (scientific writing) and its contents	18	
Abilities of satisfactory responses to the queries from the audience	6	
Total	**60**	

7. Students should be made aware of the assessment parameters, on which they will be assessed at the end of the fourth semester.
8. The external and internal examiners by mutual agreement will appropriately settle the marks given by the guide (reconsider, if necessary) and marks of oral presentation.

Mapping of Program Outcomes with Course Outcomes

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)								
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1		3		3					
CO 2		3		3					
CO 3		3		3					
CO 4		3		3					
CO 5		3		3					
CO 6		3		3					
CO 7		3		3					
CO 8		3		3			2		
CO 9		3		3					2
CO 10		3		3					
CO 11		3		3					

Justification for the mapping

2. Critical Thinking and Problem solving:

CO1, CO2, CO3, CO4, CO5, CO6, CO7, CO8, CO9, CO10, CO11: Critical thinking and problem-solving skills are vital when undertaking a dissertation. A dissertation is a substantial piece of independent research that demands a high level of critical thinking, analysis, and problem-solving. These skills not only contribute to the successful completion of the

dissertation but also prepare students for future academic and professional endeavors.

4. Research-related skills and Scientific temper:
CO1, CO2, CO3, CO4, CO5, CO6, CO7, CO8, CO9, CO10, CO11: Engaging in dissertation work requires a strong foundation in research-related skills and the cultivation of a scientific temper. These skills and temper are essential for planning, conducting, and completing a rigorous and independent research project like a dissertation.

7. Effective Citizenship and Ethics:
CO8: By demonstrating ethical conduct in their own research and critically evaluating published studies while adhering to ethical guidelines, students contribute to the responsible and ethical practice of research in their academic and professional communities. These principles are essential for maintaining the integrity and trustworthiness of scientific and scholarly work.

9. Self-directed and Life-long learning:
CO9: By fostering a research mindset and embracing the importance of continuous learning, student position themself to make meaningful contributions to their field and adapt to the evolving landscape of research. This approach supports self-directed and lifelong learning while helping them maintain a fresh and innovative perspective in their research endeavors.

SYLLABUS (CBCS) FOR M.Sc. II Microbiology
(w. e. from June, 2020)
Academic Year 2020-2021

Class	: M. Sc. II (Semester- IV)
Paper Code	: MICRO5406
Paper	: VI
Title of Paper	: Dissertation II
Credit	: 4
No. of lectures	: 60

Course objective:

1. Introduce the application and research concepts within the realm of Microbiology to students.
2. Foster a sense of scientific responsibility among students.
3. Offer an understanding of the fundamental principles and concepts underpinning research methodology.
4. Cultivate critical thinking abilities essential for designing and executing research studies.
5. Introduce students to a range of research methods and techniques applied across different disciplines.
6. Empower students to evaluate and critique research studies published in academic journals.
7. Strengthen students' abilities in collecting, analyzing, and interpreting data effectively.
8. Advocate for ethical conduct in research and highlight the significance of research integrity.
9. Encourage students to effectively communicate research findings through both written and oral presentations.
10. Foster a research-centric mindset and underscore the importance of continuous learning within the research domain.

Course outcome:

CO1. Comprehend the research process, encompassing the formulation of research questions, hypotheses, and objectives.
CO2. Identify suitable research designs and methodologies based on specified research questions and objectives.
CO3. Critically assess and select relevant literature for conducting comprehensive literature reviews.
CO4. Develop research proposals outlining the research design, methodology, and ethical considerations.
CO5. Apply varied data collection methods, such as surveys, interviews, experiments, and observations.
CO6. Analyze and interpret both quantitative and qualitative data using suitable statistical and analytical methods.
CO7. Communicate research findings effectively through written reports and oral presentations.
CO8. Demonstrate adherence to guidelines for responsible research practices, exhibiting ethical conduct throughout the research process. Evaluate and critique research studies published in academic journals, identifying their strengths and limitations.
CO9. Cultivate a mindset geared toward research and emphasize the importance of continual learning within the research field.

CO10. Gain an understanding of the philosophy and ethical considerations inherent in research practices.
CO11. Demonstrate the ability to compose research proposals effectively.

1. A dissertation can be carried out by a single student or by group of students where the group should not contain more than four students. The dissertation report will be prepared as per the thesis format. Submission of the dissertation report will be at least three days before the date of examination. One copy of the report will be preserved in the department. If there is more than one student carrying out a single dissertation, a single report can be submitted and these students will be assessed based on single oral presentation. In such case, presentation should be carried out by all the students carrying out the same work; dividing the presentation equally among them.
2. At the time of presentation, the external and internal examiners appointed by the university will be present; the dissertation guide may or may not be present.
3. Presentation should be carried out to an audience comprising of examiners appointed by the university, departmental teaching staff and the postgraduate students of the department. Oral presentation can be carried out using posters, blackboard, transparencies, model or LCD projector. The allotted time for each oral presentation (one project) should be 10 to 12 minutes, followed by question-answer session of 5 to 8 minutes. The audience can participate in this session.
4. The assessment of the dissertation II is for total of 100 marks, out of which the end-semester - will be for 60 marks and the in-semester assessment will be for 40 marks.
5. The assessment of in-semester examination will be carried out by the guide who has supervised the work of the candidate(s) throughout the semester. The assessment will be carried out on the basis of the points, as per the accompanied format. Head of the department should communicate this point wise assessment system to the dissertation supervisor (Guide), well in advance. Guide will give appropriate marks, point-wise and submit it in a sealed envelope to the Head of the respective department, three days prior to examination and project presentation. On the day of examination, Head of the department will hand over these unopened envelopes to the examiners.

Points for Evaluation	**Max. Marks**	**Evaluation**
Intellectual potential – Understanding of the research problem by the student	4	
Research aptitude – 1. Depth of literature survey for the proposed work. 2. Inputs of student in development of plans and protocols for the experimentation 3. Ability to analyze data and formulate a solution 4. Analytical and reasoning abilities of the student for interpretation of data, inputs in discussion	 4 8 4 6	
Motivation – punctuality, meeting dead-lines and seriousness	2	
Ability to work with others	2	
Maturity of scientific thoughts	2	
Communication skill – oral and written	8	
Total	**40**	

6. Assessment of end-semester examination will be carried out (i.e. oral presentation) for

individual student at the time of examination jointly by internal and external examiners. The assessment will be carried out on the basis of the points as per the accompanied format.

Points for Evaluation	**Max. Marks**	**Evaluation**
Proficiency of presentation skills – use of audio-visual aids, preparation of graphs, charts, models, etc., use of scientific language	24	
Quality of the work, results and interpretation, outcome of the study and possible future plans, publication potential of the work	12	
Submission of progress reports, the dissertation report preparation (scientific writing) and its contents	18	
Abilities of satisfactory responses to the queries from the audience	6	
Total	**60**	

7. Students should be made aware of the assessment parameters, on which they will be assessed at the end of the fourth semester.
8. The external and internal examiners by mutual agreement will appropriately settle the marks given by the guide (reconsider, if necessary) and marks of oral presentation.

Mapping of Program Outcomes with Course Outcomes

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)								
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1		3		3					
CO 2		3		3					
CO 3		3		3					
CO 4		3		3					
CO 5		3		3					
CO 6		3		3					
CO 7		3		3					
CO 8		3		3			2		
CO 9		3		3					2
CO 10		3		3					
CO 11		3		3					

Justification for the mapping

2. Critical Thinking and Problem solving:
CO1, CO2, CO3, CO4, CO5, CO6, CO7, CO8, CO9, CO10, CO11: Critical thinking and problem-solving skills are vital when undertaking a dissertation. A dissertation is a substantial piece of independent research that demands a high level of critical thinking, analysis, and

problem-solving. These skills not only contribute to the successful completion of the dissertation but also prepare students for future academic and professional endeavors.

4. Research-related skills and Scientific temper:
CO1, CO2, CO3, CO4, CO5, CO6, CO7, CO8, CO9, CO10, CO11: Engaging in dissertation work requires a strong foundation in research-related skills and the cultivation of a scientific temper. These skills and temper are essential for planning, conducting, and completing a rigorous and independent research project like a dissertation.

7. Effective Citizenship and Ethics:
CO8: By demonstrating ethical conduct in their own research and critically evaluating published studies while adhering to ethical guidelines, students contribute to the responsible and ethical practice of research in their academic and professional communities. These principles are essential for maintaining the integrity and trustworthiness of scientific and scholarly work.

9. Self-directed and Life-long learning:
CO9: By fostering a research mindset and embracing the importance of continuous learning, student position themself to make meaningful contributions to their field and adapt to the evolving landscape of research. This approach supports self-directed and lifelong learning while helping them maintain a fresh and innovative perspective in their research endeavors.

SYLLABUS (CBCS) FOR M.Sc. I. Microbiology (2019 Pattern)
(w. e. from June, 2019)
Academic Year 2019-2020

Class : M. Sc. II (Semester- IV)
Paper Code : SD24
Title of Paper : Skill Development: Chromatographic Techniques
Credit : 2
No. of lectures : 30

Course Objective:

1. Understand the basic principles of UV-Visible spectroscopy, including the electromagnetic spectrum, molecular transitions, and the Beer-Lambert Law.
2. Familiarize students with the components of UV-Visible spectrophotometers, their functions, and the operational procedures.
3. Gain practical skills in setting up, calibrating, and operating UV-Visible spectrophotometers.
4. Learn techniques for quantitative analysis using UV-Visible spectroscopy, including the construction of calibration curves and determination of unknown concentrations.
5. Explore various applications of UV-Visible spectroscopy in chemistry, such as analyzing concentration, determining reaction kinetics, and identifying chemical species.
6. Develop the ability to interpret UV-Visible spectra and correlate spectral features with molecular structures and electronic transitions.
7. Understand the components of an AAS instrument, such as the light source, monochromator, and detector, and the role each plays in the analysis process.
8. Learn sample preparation techniques suitable for AAS, and gain proficiency in introducing samples into the AAS instrument.
9. Develop skills in quantitative analysis using AAS, including calibration procedures, standard addition methods, and the determination of elemental concentrations in samples.

Course Outcome:

CO1. Understand the Principles: Students will be able to explain the fundamental principles of UV-Visible spectroscopy, including the interaction of electromagnetic radiation with matter, molecular transitions, and the Beer-Lambert Law.
CO2. Gain proficiency in operating UV-Visible spectrophotometers, understanding the components, and calibrating the instrument for accurate measurements.
CO3. Develop the ability to perform quantitative analysis using UV-Visible spectroscopy, including the determination of concentration and molar absorptivity.
CO4. Interpret UV-Visible spectra to identify functional groups, electronic transitions, and chemical properties of various compounds.
CO5. Acquire skills in developing experimental methods for specific applications using UV-Visible spectroscopy, such as kinetics studies, reaction monitoring, and quality control.
CO6. Learn to troubleshoot common issues associated with UV-Visible spectrophotometers and understand routine maintenance procedures to ensure reliable and accurate results.
CO7. Understand the fundamental principles of Atomic Absorption Spectroscopy, including the theory of atomic absorption, energy levels, and the role of hollow

cathode lamps.

CO8. Gain proficiency in operating AAS instruments, handling sample introduction systems, and optimizing instrumental parameters for different elements.

A. High Performance Liquid Chromatography (HPLC)

Fundamentals and Principles of High Performance Liquid Chromatography (HPLC), Instrumentation, Types of HPLC–Normal phase HPLC, Reverse Phase HPLC, Ion Exchange Chromatography (IEC), Size exclusion chromatography, Mobile phases, Sample preparation, Hands on training

B. Gas Chromatography (GC)

Fundamentals and Principles of Gas Chromatography (GC), Instrumentation, Sample preparation, Mobile phases, Injectors, GC columns, GC detectors

Hands-on training

Text / Reference Books:

- Nelson D. L. and Cox M. M. (2005) *Lehninger's Principles of Biochemistry*, Fourth edition, W. H. Freeman & Co. New York
- Wilson Keith and Walker John (2005) *Principles and Techniques of Biochemistry and Molecular Biology*, 6th Ed. Cambridge University Press, New York.
- Palmer Trevor (2001) *Enzymes: Biochemistry, Biotechnology and Clinical chemistry*, Horwood Pub. Co. Chinchester, England.
- Segel Irvin H. (1997) *Biochemical Calculations* 2nd Ed., John Wiley and Sons, New York

Mapping of Program Outcomes with Course Outcomes

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)									
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2		2		2		2			
CO 2						2	2		2	
CO 3							2		2	
CO 4	2						2			
CO 5				2					2	
CO 6										
CO 7										
CO8										

Justification for the mapping

PO1: Disciplinary Knowledge:

CO1 and CO4 contribute significantly to disciplinary knowledge as they require students to understand the fundamental principles of UV-Visible spectroscopy, molecular transitions, and the interpretation of spectra to identify functional groups and chemical properties. This knowledge forms the basis for expertise in the field of spectroscopy.

Critical Thinking and Problem Solving:

CO3 challenges students to perform quantitative analysis using UV-Visible spectroscopy, necessitating critical thinking skills to determine concentrations and molar absorptivity.

CO5 also promotes critical thinking by requiring students to develop experimental methods for specific applications, such as kinetics studies and quality control.

Social Competence:

While UV-Visible spectroscopy may not directly relate to social competence, the skills developed in operating and applying spectroscopic techniques (CO2, CO5) can be used in collaborative research efforts or in industries with social implications, promoting social competence through effective teamwork.

PO4: Research-related Skill:

CO5, focusing on developing experimental methods for specific applications, aligns with research-related skills. It requires students to apply their knowledge to design experiments, contributing to the development of research skills necessary for scientific inquiry.

PO5: Transdisciplinary Knowledge:

The principles and skills gained from UV-Visible spectroscopy (CO1-CO6) can be applied across various scientific disciplines, showcasing transdisciplinary knowledge. The ability to troubleshoot and perform routine maintenance (CO6) is valuable in maintaining instrumentation across different fields.

PO6: Personal and Professional Competence:

CO2 emphasizes proficiency in operating instruments, and CO6 focuses on troubleshooting and maintenance. These aspects contribute to personal and professional competence by ensuring that students are adept at using and maintaining equipment commonly found in professional settings

PO7: Effective Citizenship and Ethics:

While UV-Visible spectroscopy itself may not directly address citizenship, the ethical use of scientific methods and data interpretation (implicit in CO1-CO4) is crucial. Adhering to principles like the Beer-Lambert Law promotes ethical scientific practices.

Environment and Sustainability:

CO6, involving routine maintenance procedures, indirectly aligns with environmental sustainability. Proper maintenance ensures the longevity of equipment, reducing the need for frequent replacements and minimizing the environmental impact associated with manufacturing and disposal.

PO9: Self-directed and Lifelong Learning:

CO2, CO5, and CO6 collectively contribute to self-directed and lifelong learning. Operating instruments, developing experimental methods, and troubleshooting issues require continuous learning and adaptation to new challenges in the field of spectroscopy.