Anekant Education Society's

Tuljaram Chaturchand College, Of Arts, Science & Commerce Baramati – 413102

(Autonomous)

Syllabus (CBCS) for M.Sc. Microbiology

w.e.f. June 2022

Anekant Education Society's
TuljaramChaturchand College of Arts, Science and Commerce, Baramati
(Autonomous)

Course Structure for M.Sc. (Microbiology)
(With effect from Academic year 2022-23)

Semester	Paper Code	Title of the Paper	No. of Credits
III	**PSMB231**	Immunology	**4**
	PSMB232	Molecular Biology I	**4**
	PSMB233	Industrial waste water treatment	**4**
	PSMB234 (A)	Biophysical Techniques	**4**
	PSMB234 (B)	Developmental Biology	**4**
	PSMB235	Practical course based on Immunology, Pharmaceutical Microbiology and Industrial waste water treatment	**4**
	PSMB236	Practical course based on Molecular Biology and Microbial Technology	**4**
	SD23	Skill development I	**2**
IV	**PSMB241**	Pharmaceutical Microbiology	**4**
	PSMB242	Molecular Biology II	**4**
	PSMB243	Microbial Technology	**4**
	PSMB244 (A)	Medical Microbiology	**4**
	PSMB244 (B)	Mathematics for Biological Science	**4**
	PSMB245	Dissertation I	**4**
	PSMB246	Dissertation II	**4**
	SD24	Skill development II	**2**

SYLLABUS (CBCS) FOR M.Sc. II. Microbiology
(w. e. from June, 2023)
Academic Year 2023-2024

Class: M. Sc. II (Semester- III)
Paper Code: **PSMB231**
Paper: I
Title of Paper: Immunology
Credit: 4
No. of lectures: 60

Course Objectives:

1. Define cancer and describe the key hallmarks of cancer cells.
2. Explain the role of mutations in the initiation and progression of cancer.
3. Identify the different types of cancer and their prevalence
4. Explain the distinction between the innate and adaptive immune responses.
5. Illustrate how immune cells recognize and respond to cancer cells
6. Analyze strategies to modulate the tumor microenvironment for therapeutic purposes

Course Outcome:

CO1. Explain the mechanisms of immune response regulation to prevent autoimmunity and excessive immune reactions.
CO2. Understand the roles of regulatory T cells and cytokines in immune regulation.
CO3. Describe the role of the immune system in recognizing and eliminating cancer cells.
CO4. Understand immunotherapeutic approaches for cancer treatment
CO5. Develop critical thinking skills to analyze immunological data and solve problems related to immune responses.
CO6. Effectively communicate immunological concepts through written and/or oral presentations

UNIT 1: Cell surface molecules and receptors (15L)

- Structure and function of: G protein coupled receptors, Toll like receptors, Cytokine receptors, T cell receptor, B Cell Receptor, TCRCD3 complex
- Organization of Cytokine receptors and T Cell receptor
- Adhesion molecules in immune activation (Integrin, Selectin, Mucin)
- Signal transduction pathways: IL-2 pathway (JAK/STAT, Ras/MAP Kinase Pathways)

UNIT 2: Regulation of Immune response (15L)

- Negative regulation-Immunological tolerance, Mechanisms of tolerance induction (related experimentation using transgenic animals),
- T cell mediated suppression of immune response
- Regulation of immune responses by antigen, Antigen-antibody complexes, Network theory and its experimental evidence
- Cytokine mediated cross regulation of T_H subsets (T_{H1}&T_{H2})
- Regulation of complement system – Classical, alternative and lectin pathway
- Immunomodulation -Biological Response Modifiers for cancer therapy and autoimmune disorders

UNIT 3: Experimental Immunology **(15L)**

- In vitro systems –Quantification of cytokines (ELISPOT assay), functional assays for phagocytes and cytokines (cytotoxicity and growth assays)
- In vivo systems – Experimental animals in immunology research (Inbred animal strains, Knockout mice, transgenic animals), Animal models for autoimmunity and AIDS

UNIT 4: Tumor Immunology **(15L)**

- Cellular transformations during neoplastic growth,
- Classification of tumors (Sarcoma, Carcinoma, Lukemia, Benign and Malignant tumor)
- Metastasis Process
- Tumors of lymphoid system (lymphoma, myeloma, Hodgkin's disease, Non-Hodgkin's disease)
- Escape mechanisms of tumor from host defence
- Host immune response to tumor – Effecter mechanisms- NK cells, Macrophage, ADCC, Immuno- surveillance theory
- Diagnosis of tumors – biochemical and immunological tumor markers (alphafoetal proteins, carcino embryonic antigen, Cancer therapeutics).
- Approaches in cancer immunotherapy: Immune adjuvant and tumor vaccine therapy

Text / Reference Books:

- Akihiko Yoshimura, Tetsuji Naka and Masato Kubo, (2007), SOCS proteins, cytokine signaling and immune regulation, Nature Reviews, Immunology, 7:454-465.
- Austyn J. M. and Wood K. J. (1993) Principles of Molecular and Cellular Immunology, Oxford University Press,
- Barret James D. (1983) Text Book of Immunology 4th edition, C. V. Mosby & Co. London.
- Boyd William C. (1966) Fundamentals of Immunology, Interscience Publishers, NY.
- Christopher K. Garcia and Erin J. Adams, (2005), How the T Cell Receptor Sees Antigen A Structural View, Cell, Vol. 122: 333– 336, Elsevier Inc.
- David A. Hafler, (2007), Cytokines and interventional immunology, Nature Reviews, Immunology, 7: 423
- GangalSudha and SontakkeShubhangi (2013), Textbook of Basic and Clinical Immunology Paperback, University Press, India
- Kindt, Osborne, Goldsby, (2006), Kuby Immunology, 6th Ed., W. H. Freeman & Co.
- Abbas A. K. and Litchman A. H. (2004), Basic Immunology, Functions and Disorders of Immune System, 2nd Ed., Elsevier Inc
- BhushanPatwardhan, Sham Diwanay and Manish Gautam. (2006). Botanical Immunomodulators and Chemoprotectants in Cancer Therapy.
- In Drug discovery and development Volume I: Drug Discovery. Ed. Chorghade
- Mukund S., (2006), WileyInterscience, John Wiley and Sons Inc. USA. 405-424.
- Michael C Carroll, (2004), The complement system in regulation of adaptive immunity,Nature Immunology 10:981-986.
- Roitt I. M. (1988) Essentials of Immunology, ELBS, London.
- Roitt M. (1984) Essentials of Immunology, P. G. Publishers Pvt. Ltd., New Delhi.

- Sham Diwanay, Manish Gautam and BhushanPatwardhan. (2004). Cytoprotection and Imunomodulation in Cancer Therapy. Current Medicinal Chemistry Anti-Cancer Agents, 4: 479-490

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									
CO 2	2									
CO 3				3						
CO 4					2					
CO 5		2							2	
CO 6			2			2			2	

Justification for the mapping

Disciplinary Knowledge:
CO1: Understanding the mechanisms of immune response regulation to prevent autoimmunity and excessive immune reactions contributes to disciplinary knowledge in immunology.
CO2: Grasping the roles of regulatory T cells and cytokines in immune regulation enhances disciplinary knowledge in the field of immunology**.**

Critical Thinking and Problem Solving:
CO5: Developing critical thinking skills to analyze immunological data and solve problems related to immune responses directly aligns with critical thinking and problem-solving abilities.

Social Competence:
CO6: Effectively communicating immunological concepts through written and/or oral presentations demonstrates social competence by facilitating the dissemination of knowledge within the scientific community.

Research-Related Skill:
CO3: Describing the role of the immune system in recognizing and eliminating cancer cells highlights research-related skills, as it involves understanding the complex interplay between the immune system and cancer**.**

Transdisciplinary Knowledge:
CO4: Understanding immunotherapeutic approaches for cancer treatment involves knowledge that spans across immunology and oncology, contributing to transdisciplinary knowledge.

Personal and Professional Competence:
CO7: Emphasizing effective citizenship and ethics in the context of immune responses contributes to personal and professional competence, ensuring responsible and ethical use of immunological knowledge**.**

Effective Citizenship and Ethics:
CO7: Understanding the ethical considerations in immune response regulation and cancer treatment aligns with effective citizenship and ethics, emphasizing responsible conduct in research and clinical practice.

Self-Directed and Lifelong Learning:
CO5: Developing critical thinking skills
CO8:** Effectively communicating immunological concepts contribute to fostering self-directed and lifelong learning by encouraging students to continuously update their knowledge and communication skills in the ever-evolving field of immunology

SYLLABUS (CBCS) FOR M.Sc. II. Microbiology
(w. e. from June, 2023)
Academic Year 2023-2024

Class: M. Sc. II (Semester- III)
Paper Code: **PSMB232**
Paper: II
Title of Paper: Molecular Biology I
Credit: 4
No. of lectures: 60

Course objective:

1. Grasping the concepts behind operons and the mechanisms governing gene regulation within cells.
2. Exploring the function and importance of riboswitches in gene regulation and comprehending the role of sigma factors in response to phage infections across various bacterial hosts.
3. Developing a detailed understanding of the molecular processes involved in mRNA, rRNA, and tRNA processing within cells.
4. Gaining insight into the role and significance of non-coding RNAs, as well as comprehending the mechanisms of RNA interference in gene regulation.
5. Students will comprehend the roles of activators and repressors in regulating gene expression and their mechanisms of action in controlling transcription.
6. Students will gain an understanding of the processes involved in chromatin remodeling, how it impacts gene expression, and its significance in regulating transcription.
7. Students will explore the mechanisms and significance of DNA methylation and imprinting in epigenetic regulation and their roles in altering gene expression.

Course outcome:

- CO1. Students will showcase an extensive grasp of operons and the diverse regulatory mechanisms controlling gene expression in both prokaryotic and eukaryotic systems.
- CO2. Students will understand the functional importance of riboswitches in gene regulation, along with comprehending how sigma factors respond to phage infections across varied bacterial hosts.
- CO3. Students will attain a thorough comprehension of the intricate molecular processes involved in the processing of mRNA, rRNA, and tRNA, encompassing splicing, modifications, and maturation.
- CO4. Students will grasp the functions and mechanisms of non-coding RNAs, including their active involvement in RNA interference pathways and their impact on gene silencing.
- CO5. Students will be able to explain the distinct roles of activators and repressors in controlling gene expression.
- CO6. They will analyze and describe the processes involved in altering chromatin structure and accessibility, leading to changes in gene expression.
- CO7. Students will explain the mechanisms of DNA methylation and genomic imprinting.

UNIT 1: RNA processing (15L)

- mRNA processing: splicing, capping, polyadenylation
- Coordination of mRNA processing

- rRNA processing
- tRNA processing
- Non coding RNAs and their production

UNIT 2: Fine Control of Prokaryotic transcription (15L)

- Lactose operon: - repressor-operator interactions, mechanism of repression, Positive control of lac operon-Mechanism of CAP action, catabolite repression
- The Arabinose operon: - Ara operon repression loop, evidence for repression loop, autoregulation of araC
- The Tryptophan operon: - control of trp operon by attenuation, defeating attenuation
- Riboswitches
- Sigma factor Switching: - Phage infection- T4, T7 infection in *E. coli*, SPO1 infection in *B. subtilis*

UNIT 3: Fine Control of Eukaryotic transcription (15L)

- Activators and Repressors
- Chromatin remodeling
- Histone Acetylation, methylation, phosphorylation
- RNA interference
- Role of SiRNA, micro-RNA in gene silencing

UNIT 4: Epigenetic effects (15L)

- Epigenetic effect sustained by a proteinaceous structure that assembles on DNA: - Heterochromatin, Polycomb group proteins, Condensins
- Epigenetic effect sustained by a covalent modification of DNA: - DNA methylation and imprinting
- Epigenetic effect sustained by a protein aggregate: - Yeast prions, Mammal prions

Text / Reference Books:

- 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.
- Molecular Biology of the Cell, Bruce Albert et. al. , 6th Edn., Garland Sciences.
- Molecular Biology, Loddishet. al., 7th Edn., W. H. Freeman, 2012
- Weaver R., (2007) *Molecular Biology*, 4th Edition, McGrew Hill Science.
- S.B Primrose and R M Twyman 2006 7th edition. Blackwell publishing
- R. Glick, J.J. Pasterneck, Principles and applications of recombinant DNA, 3rd Ed., ASM press.
- 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	2			1				
CO 2	3				2				
CO 3	3				2				
CO 4	3				1				
CO 5	2	3			2				
CO 6	2	2			2				
CO 7	2				2				

Justification for the mapping

PO1: Disciplinary Knowledge

CO1: Strong (3) relation: Students' extensive grasp of operons and regulatory mechanisms demonstrates direct disciplinary knowledge in gene expression control.

CO2: Strong (3) relation: Understanding riboswitches and sigma factors showcases direct disciplinary knowledge in gene regulation across bacterial systems.

CO3: Strong (3) relation: In-depth comprehension of mRNA, rRNA, and tRNA processing signifies direct disciplinary knowledge in molecular processes.

CO4: Strong (3) relation: Understanding non-coding RNAs' roles in RNA interference demonstrates direct disciplinary knowledge in gene silencing.

CO5: Moderate (2) relation: Explaining the roles of activators and repressors in gene expression partially relates to disciplinary knowledge.

CO6: Moderate (2) relation: Analysing chromatin structural changes partially contributes to disciplinary knowledge in gene expression regulation.

CO7: Moderate (2) relation: Explaining DNA methylation mechanisms contributes partially to disciplinary knowledge in epigenetic regulation.

PO2: Critical Thinking and Problem Solving

CO1: Moderate (2) relation: Understanding diverse regulatory mechanisms in gene expression contributes partially to critical thinking.

CO5: Strong (3) relation: Explaining the roles of activators and repressors directly demonstrates critical thinking.

CO6: Moderate (2) relation: Analyzing chromatin structural changes partially requires critical thinking skills.

PO5: Trans-disciplinary knowledge

CO1 - CO7: Knowledge in gene regulation spans multiple disciplines, contributing partially to trans-disciplinary knowledge in biological sciences, reflecting the program outcome.

SYLLABUS (CBCS) FOR M.Sc. II. Microbiology
(w. e. from June, 2023)
Academic Year 2023-2024

Class: M. Sc. II (Semester- III)
Paper Code: **PSMB233**
Paper: III
Title of Paper: Industrial waste water treatment
Credit: 4
No. of lectures: 60

Course Objective:

1. Grasp the significance of treating industrial wastewater for safeguarding both the environment and public health.
2. Outline the origins and classifications of industrial wastewater.
3. Recognize the primary contaminants frequently present in industrial wastewater.
4. Detail the planning and functioning of physical treatment facilities.
5. Introduce the basic principles of biological treatment, encompassing aerobic and anaerobic methodologies.
6. Elucidate the contribution of microorganisms to the breakdown of organic substances through biodegradation.
7. Explore the principles of sustainability within wastewater treatment, emphasizing energy efficiency and reducing the carbon footprint.

Course Outcome:

CO1 : Able to define the key terms and concepts related to industrial wastewater treatment.
CO2 : Summarize the significance of industrial wastewater treatment for environmental protection.
CO3 : Students be able to determine basic wastewater parameters, such as pH, turbidity, and suspended solids.
CO4 : Interpret wastewater characterization data to assess pollution levels and develop treatment strategies.
CO5 : Describe the operating principles of physical treatment processes.
CO6 : Design a preliminary physical treatment system for a specific industrial wastewater.
CO7 : Analyse and interpret data from a biological treatment system, including COD and BOD removal efficiency.

UNIT 1: Principles of Wastewater Treatment (15L)

1. The need for wastewater treatment
2. Laws and regulations of wastewater treatment
3. Measuring pollution load of wastewater
4. Methods for estimating parameters used for determining treatment efficacy
5. Layout of typical wastewater treatment plant

UNIT 2: Pre-treatment & Primary treatment process (15L)

1. Flow equalization – Type, application and design consideration
2. Screening – Screening characteristics and classification of screens
3. Flocculation – Types (Micro & Macro), types of mixers used for flocculation
4. Flotation – Dissolved air and dispersed air flotation system
5. Granular medium filtration

UNIT 3: Secondary and Tertiary Treatment process **(15L)**

1. Aerobic biological processes: Suspended growth biological treatment processes (Activated sludge, Aerated lagoon) & Attached growth biological treatment processes (Trickling filter, Rotating biological reactor)
2. Anaerobic biological processes: Suspended growth biological treatment processes (Anaerobic sequencing batch reactor, Anaerobic sludge blanket process)
   & Attached growth biological treatment processes (Upflow packed bed reactor, Expanded bed reactor and Fluidized bed reactor)
3. Sedimentation and clarification
4. Disinfection – Disinfection with chlorine, ozone, UV radiation
5. Adsorption – Activated carbon treatment

Advanced, Combined and Innovative wastewater treatment processes

Process configuration, treatment process and basic design principles of -

1. Submerged Aerobic Fixed Film reactors (SAFF)
2. Membrane bioreactor (MBR)
3. Mixed Bed Bioreactors (MBBRs)

UNIT 4: Industrial wastewater treatment processes **(15L)**

Characteristics of effluents, processes of treatment

1. Dairy and food processing industry
2. Dye industry
3. Paper manufacture industry
4. Pharmaceutical industry

Text / Reference Books:

- Biotechnology for Water and Wastewater Treatment. Dr.Satya Prakash. Navyug Publishers& Distributors, New Delhi. 2009.
- Industrial Water Pollution Control. 3rd Edition. W. Wesley Eckenfelder Jr. McGraw Hill. 2 000.
- Standard Methods for the Examination of Water & Wastewater. 21st Edition. 2005 APHA.AWWA.WEF
- Wastewater Engineering, Treatment, Disposal and Reuse. 3rd Ed., Metcalf and Eddy (Eds). Tata Mac Graw Hill Publishing Co. Ltd. New Delhi
- Tchobanoglous G. and F. L. Burton. (1991).
- Disposal and Reuse. 3rd Ed., Metcalf and Eddy (Eds). Tata Mac Graw Hill Publishing Co. Ltd. New Delhi
- Biological Wastewater Treatment. Vol. 5. Activated Sludge and Aerobic Biofilm Reactors. Marcos von Sperling. IWA Publishing. London, New York. © 2007 IWA Publishing
- Industrial Wastewater Treatment. A. D. Patwardhan. © Prentice –Hall of India Pvt. Ltd., New Delhi. 2008. ISBN 978-81-203-3350-5.

Mapping of Program Outcomes with Course

Outcomes

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

Course Outcomes	Programme Outcomes(POs)								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3						2		
CO2	3							2	
CO3	3		2		2	2			1
CO4	3	2		3	2	2		3	2
CO5	3	2	2	2	2	3	2		2
CO6	3	2	2	2		2			2
CO7	3	3	2			2		2	2

Justification for the mapping

PO1: Disciplinary Knowledge

The majority of course outcomes, CO1 to CO7, impart disciplinary knowledge by exploring terms and concepts associated with treating industrial wastewater, emphasizing its significance for environmental protection, and elucidating fundamental wastewater parameters.

PO2: Critical Thinking and Problem Solving

CO4, CO5, CO6, and CO7 foster critical thinking and problem-solving skills by necessitating students to interpret wastewater characterization data for assessing pollution levels and devising treatment strategies. CO6, entailing the creation of an initial physical treatment system for specific industrial wastewater, and CO7, involving the analysis and interpretation of data from a biological treatment system including COD and BOD removal efficiency, promote analytical and solution-oriented thinking.

PO3: Social Competence

CO3, CO5, CO6, and CO7 enhance social competence through collaborative work in interdisciplinary teams addressing environmental concerns. This experience cultivates effective communication, teamwork, and cooperation, enabling students to engage diverse stakeholders and contribute responsibly to solutions for water treatment issues.

PO4: Research-related Skills and Scientific Temper

CO4, CO5, and CO6 instill research-related skills by exposing students to various sampling, isolation, and analysis techniques, preparing them for scientific research. They also foster a scientific temper by emphasizing the critical evaluation of data from a biological treatment system, including COD and BOD removal efficiency.

PO5: Trans-disciplinary Knowledge

CO3, CO4, and CO5 promote trans-disciplinary knowledge by integrating principles from microbiology, environmental science, chemistry, and engineering to address intricate environmental challenges. This approach equips students with a versatile skill set applicable across diverse scientific and engineering fields.

PO6: Personal and Professional Competence

CO3, CO4, CO5, CO6, and CO7 enhance personal and professional competence by providing students with knowledge and practical skills essential for careers in research, environmental monitoring, and water treatment. They instill a sense of responsibility for environmental stewardship, preparing individuals to positively impact society while fostering their professional development in various scientific and environmental fields.

PO7: Effective Citizenship and Ethics
CO1 and CO5 promote effective citizenship and ethical behavior by emphasizing responsible environmental stewardship and ethical conduct in research and water management practices. They equip students with the knowledge and values necessary to make informed decisions concerning environmental conservation and sustainable water use, contributing to the well-being of communities and ecosystems.

PO8: Environment and Sustainability
CO2, CO4, and CO7 address environmental and sustainability concerns by exploring the critical role of microorganisms in maintaining ecosystem balance and investigating the impact of human activities on water quality. They equip students with knowledge and tools to develop sustainable solutions for environmental challenges such as pollution control, wastewater treatment, and the preservation of natural resources.

PO9: Self-directed and Life-long Learning
CO3, CO4, CO5, CO6, and CO7 encourage self-directed and lifelong learning by urging students to explore cutting-edge research, adapt to evolving environmental challenges, and stay updated with advancements in microbiological techniques and technology. This approach fosters curiosity, adaptability, and motivation for continuous expansion of knowledge and expertise to address dynamic issues related to wastewater treatment.

SYLLABUS (CBCS) FOR M.Sc. II. Microbiology
(w. e. from June, 2023)
Academic Year 2023-2024

Class: M. Sc.II (Semester- III)
Paper code: PSMB 234 (A)
Paper: IV (A)
Title of Paper: Biophysical Techniques
Credit: 4
No. of lectures: 60

Course Objective:

1. To gain understanding in diverse biophysics methodology.
2. To gain understanding in various methods for determining molecular structures
3. To understand the principles and operations of biophysical techniques.
4. To gain understanding of different ionization methods.
5. To acquire knowledge in both chromatography and spectroscopy techniques.
6. To ascertain the physical and chemical characteristics of atoms or molecules
7. Demonstrates a solid understanding of biophysical concepts.

Course Outcome:

CO1. Students will develop the capability to comprehend molecular structure determination.
CO2. Students will understand the core principles of biology, chemistry, and physics understanding how these disciplines interconnect with biology systems
CO3. Students will proficiently conduct laboratory procedures while adhering to safe practices
CO4. Students will analyze primary literature critically within the field.
CO5. Students will efficiently use databases, computational tools, and various online resources.
CO6. Students will demonstrate awareness of issues in the practice of science.
CO7. Demonstrates a solid understanding of biophysical concepts.

UNIT 1: Mass spectroscopy **(15L**)

- Principles of operation,
- Ionization and Ion fragmentation- Electron impact ionization, Chemical Ionization, Electro spray Ionization Matrix assisted laser desorption (MALDI)
- Mass Analysers- Quadruple mass spectrometer, Ion trap Mass spectrometer, Time of flight (TOF) mass spectrometer, Fourier Transform Ion Cyclotron Resonance mass spectrometer (FT-ICR), Orbitrap mass spectrometer
- GC-MS,
- MALDI-TOF

UNIT 2: X-ray crystallography **(15L)**

- Crystallization of proteins.
- Instrumentation, acquisition of the diffraction pattern,
- Basic principles of x-ray diffraction
- Crystal Structures (Bravais Lattices)
- Crystal planes and Miller Indices

- Fourier Transform and Inverse Fourier
- Direct Lattice and Reciprocal lattice
- Ewald sphere
- Electron density Maps
- Phase determination, Phase Refinement, Validation

UNIT 3: NMR spectroscopy **(15L)**

- Basic Principles of NMR
- Chemical shift, Intensity, Line width, Relaxation parameters
- Spin coupling
- Nuclear overhauser effect spectroscopy
- Correlation spectroscopy
- Approach to structure determination by 2D-NMR

UNIT 4: Tools of Bioinformatics **(15L)**

- General Introduction of Biological Databases
- Introduction to Sequences
- Sequence alignment, Local and global alignment, pair wise sequence alignment Multiple sequence Alignment
- Dynamic Programming
- Homology Modelling, 3-D protein Model
- Examples of related tools (FASTA, BLAST, BLAT), databases (GENBANK, PDB, OMIM) and software (RASMOL, Ligand Explorer).

Text / Reference Books:

- Wilson Keith and Walker John (2005) Principles and Techniques of Biochemistry and Molecular Biology, 6th Ed. Cambridge University Press, New York.
- Pattabhi, V. and Gautham, N. (2002) Biophysics. Kluwer Academic Publishers, New Yorkand Narosa Publishing House, Delhi.
- Rolf Ekman, Jerzy Silberring, Ann Westman-Brinkmalm, AgnieszkaKraj (2009) Mass spectrometry :instrumentation ,interpretation, and applications, John Wiley & Sons,Inc.,Canada.
- Irwin H. Segel (1976) Biochemical Calculations: How to Solve Mathematical Problems in General Biochemistry, 2nd Edition. John Wiley & Sons.
- Nölting, B. (2006) Methods in modern biophysics. Second Edition. Springer, Germany.
- Cavanagh John et.al. (1995) Proteins NMR Spectroscopy: Principles and Practice, Academic Press.
- Cotterill, R. M. J. (2002) Biophysics: An Introduction. John Wiley & Sons, England.
- Keeler, J. (2002) Understanding NMR Spectroscopy. John Wiley & Sons, England.
- Mount, D. W. (2001) Bioinformatics: sequence and genome analysis. Cold Spring Harbor Laboratory Press, New York.
- David M Webster (2000) Protein Structure Prediction-Methods and Protocols, Methods In Molecular Biology Vol 143 Humana Press.
- Narayanan, P. (2000) Essentials of Biophysics. New Age International Publication, New

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1									3
CO2	3				3	2			
CO3	2	2		3					3
CO4	3	2							
CO5			2		2				
CO6						2			

Justification for the mapping

PO1: Disciplinary Knowledge

CO2: Disciplinary knowledge of biophysical techniques is justified due to its crucial role in advancing scientific understanding of biological systems at the molecular and cellular levels. These techniques, such as X-ray crystallography, nuclear magnetic resonance spectroscopy, and mass spectrometry, enable researchers to investigate the structure, dynamics, and interactions of biomolecules. This information is fundamental for drug discovery, disease understanding, and the development of therapeutic interventions.
CO4: Students will demonstrate awareness of issuues in the practice of science it is bridge between biology and molecules to cells, organisms, and environment.
CO3: The disciplinary knowledge of biophysics is justified as it provides a bridge between the principles of physics and the complexity of biological systems. By applying physical principles to biological phenomena, biophysics enhances our comprehension of the fundamental processes governing life. It plays a crucial role in unraveling the mechanisms of molecular interactions, cellular functions, and the behavior of biological macromolecules. This interdisciplinary approach is essential for advancing fields like medicine, bioengineering, and molecular biology, contributing to innovations in healthcare and technology.

PO2: Critical Thinking and Problem Solving

CO3: A course focused on critical thinking and problem-solving is justified because these skills are essential for navigating the complexities of various professional and personal situations. Developing critical thinking skills allows individuals to analyze information objectively, evaluate evidence, and make informed decisions. Problem-solving skills, on the other hand, enable individuals to address challenges effectively, fostering adaptability and resilience. Both of these skills are highly transferable across disciplines and are crucial for success in academic, professional, and everyday life.
CO4:Students will critically evaluate primary literature in the dicipline develop and use computer modelling methods to see and manipulate the shapes and structures, crucial information needed to develop new drug targets, or understand how proteins mutate and cause tumors to grow course enhances individuals' ability to approach challenges with analytical reasoning, creativity, and a systematic problem-solving mindset.

PO3: Social competence

CO5: The social competence of biophysical techniques is justified as these methods contribute significantly to advancements in various scientific fields. By providing precise and detailed insights into biological processes at the molecular level, biophysical techniques contribute to the understanding and development of medical treatments, pharmaceuticals, and biotechnological applications. This, in turn, has a positive impact on public health, fostering the well-being of society. Additionally, collaborations among scientists and interdisciplinary research teams, often required for biophysical studies, promote knowledge sharing and innovation, further benefiting the broader scientific community and society as a whole.

PO4:Research related skills and scientific temper.

CO3: Research-related skills and a scientific temper within the field of biophysics are justified as they contribute to advancements in our understanding of complex biological systems. The interdisciplinary nature of biophysics requires researchers to cultivate skills such as experimental design, data analysis, and critical interpretation of results. A scientific temper fosters a curiosity-driven approach, encouraging researchers to question, explore, and innovate.

PO5: Trans-disciplinary Knowledge

CO2: The transdisciplinary knowledge of biophysics is justified because it bridges the gap between multiple scientific disciplines, fostering a holistic understanding of biological phenomena. Biophysics integrates principles from physics, chemistry, and biology to unravel the complexities of living systems. This transdisciplinary approach is essential for addressing multifaceted challenges in fields such as medicine, bioengineering, and environmental science.

CO5: By combining diverse perspectives, biophysics provides a more comprehensive view of biological processes, enabling researchers to develop innovative solutions to complex problems. The collaborative nature of transdisciplinary work in biophysics promotes knowledge exchange and the synthesis of ideas, leading to breakthroughs that may not be achievable within the confines of a single discipline. This integrated knowledge is crucial for advancing scientific frontiers and addressing real-world challenges that require a multifaceted understanding.

PO6: Personal and Professional Competence

CO2: The personal and professional competence of individuals trained in biophysical techniques is justified by the unique skill set they acquire. On a personal level, mastering these techniques hones problem-solving abilities, attention to detail, and a deep understanding of complex biological systems. This personal competence fosters a mindset of continuous learning and adaptability.

CO6: Professionally, competence in biophysical techniques is in high demand across various industries. Individuals with expertise in these methods are well-equipped for roles in academic research, pharmaceuticals, biotechnology, and healthcare. Their ability to contribute to understanding molecular interactions, structural biology, and disease mechanisms positions them as valuable assets in advancing scientific knowledge and developing innovative solutions. Overall, the personal and professional competence gained through biophysical techniques is justified by its broad applicability and significant contributions to scientific and technological progress.

PO9: Self-directed and Life-long Learning

CO1: Self-directed and lifelong learning in biophysical techniques is justified due to the dynamic nature of scientific research and technological advancements. Given the rapid progress in biophysics, individuals must engage in ongoing learning to stay abreast of emerging methodologies, technologies, and research findings. This proactive approach ensures that professionals in the field remain adaptive and can contribute to cutting-edge developments.

CO3: Students will able to understand the principle and working of biophysical techniques the methods of mathematical analysis and computer modeling to biophysical systems, with the ultimate goal of understanding at fundamental level the structure, dynamics, interactions.

SYLLABUS (CBCS) FOR M.Sc. II. Microbiology
(w. e. from June, 2023)
Academic Year 2023-2024

Class: M. Sc. II (Semester- III)
Paper Code: **PSMB234 (B)**
Paper: IV (B)
Title of Paper: Developmental Biology
Credit: 4
No. of lectures: 60

Course Objective:

1. To introduce students to the molecular and cellular mechanisms that underlies the early development of organisms.
2. To understand stages of development common to most multicellular organisms.
3. Understanding of Developmental mechanisms and processes in genetic model organisms such as the fruit fly (*D. melanogaster*), the worm (*C. elegans*), vertebrates such as the frog as well as in plants.
4. To identify the cellular behaviours that lead to morphological change during development.
5. To understand gene activation plays a role in differentiation and development.
6. Explore how environmental factors influence embryonic development
7. Address ethical issues related to developmental biology research, including controversies surrounding stem cell research and genetic manipulation.

Course Outcome:

Students who successfully complete the course will be able to

CO1. Name, describe and order the main stages of development common to most multicellular organisms.
CO2. Describe the main anatomical changes that occur during development.
CO3. Identify the cellular behaviours that lead to morphological change during development.
CO4. Describe the hierarchy of gene activation that occurs in early *Drosophila* development.
CO5. Understand how gene activation plays a role in differentiation and development.
CO6. Able to explore how environmental factors influence embryonic development
CO7. Address ethical issues related to developmental biology research, including controversies surrounding stem cell research and genetic manipulation.

Unit I: Fundamentals of Developmental Biology: (15 L)

- **Definition and scope**
- **Concepts in Developmental Biology**: Model organisms in study of developmental biology, Growth, Potency, Commitment, Specification, Induction, Competence, Determination, Differentiation, Morphogenetic gradients, Cell fate and cell lineages, Stem cells, Genomic equivalence and the cytoplasmic determinants, Imprinting, Mutants, Transgenics in analysis of development
- **Theories of Developmental Biology:** Preformation, Pangenesis, Epigenesis, Axial gradient, Germplasm.

Unit II: Reproduction and Development: (15L)

- Basics of gametogenesis: Oogenesis, spermatogenesis and spermiogenesis
- Detailed structure of gametes
- Fertilization process in sea urchin and mammals

- cleavage: Types of eggs, types and patterns of cleavage
- Blastula formation
- Morphogenetic movements
- Gastrulation: Formation of germ layers in animals
- Embryogenesis

Unit III: Morphogenesis and organogenesis in animals: (15 L)

- Cell aggregation and differentiation in *Dictyostelium*
- Axes and pattern formation in: Drosophila, Chick
- Organogenesis: Vulva formation in *Caenorhabditis elegans*, Eye lens induction, Limb development, Regeneration in vertebrates
- Differentiation of neurons
- Post embryonic development: Larval formation, Metamorphosis, Environmental regulation of normal development
- Sex determination

Unit IV: Morphogenesis and organogenesis in plants: (15 L)

- Organization of shoot and root apical meristem
- Shoot and root development
- Leaf development and phyllotaxy
- Transition to flowering
- Floral meristems
- Floral development: *Arabidopsis*

References:

1. Development Biology, 9th edition, (2010), Gilbert S.F. (Sinauer Associates, USA)
2. Principles of Development, 4th edition (2010), Wolpert L and Tickle C, Publisher:Oxford University Press, USA.
3. Bhojwani S.S. and BhatnagarS.P. (2009) – Embryology of Angiosperms (VikasPubl House, New Delhi).
4. Burgess J. (1985) An Introduction to Plant Cell Development (Cambridge Univ Press, UK).
5. Taiz L, Zeiger E (2010) – Plant physiology (Sinauer Associates, USA).
6. Sharma HP (2009) – Plant embryology: Classical and experimental (alpha sci).
7. Steeves TA & Sussex IM (2004) – Patterns in plant development. (Cambridge Univ Press, Cambridge, New York).
8. The molecular life of plants by Jones et al Wiley.
9. Biochemistry and Molecular Biology of Plants, 2nd Edition - Bob Buchanan et al Wiley.
10. Plant Physiology, Taiz and Zeiger Sixth edition Sinaeur

Mapping of Program Outcomes with Course Outcomes

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

Course Outcomes	ProgrammeOutcomes(POs)									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10
CO1	2			4	2					
CO2			2							
CO3	2					2				
CO4		2								
CO5										
CO6						2				
CO7						2	2			

Justification for the mapping

PO1: Disciplinary Knowledge

CO 1:Knowledge of these stages allow for the design of effective educational Strategies tailored to students cognitive abilities and needs

CO 3: Drosophila melanogaster, which has been instrumental in advancing our understanding of genetics, developmental biology, and evolution. It enables students to grasp fundamental principles of organism development.

PO2: Critical Thinking and Problem Solving

CO 4: Analyzing and interpreting data from Drosophila experiments can enhance critical thinking skills. Students learn to formulate hypotheses, design experiments, and draw conclusions from their findings, which are key skills in scientific research.

PO3: Social Competence

CO2: anthropology benefit from an understanding of development to examine cultural and societal influences on individuals at various life stages.

PO4: Research-related Skills and Scientific Temper

CO 1: For students interested in pursuing a career in biology or research, a Drosophila development course can serve as a stepping stone. It may lead to opportunities for independent research projects and exposure to scientific research environments.

PO5: Trans-disciplinary Knowledge

CO1: Drosophila research often involves a combination of genetics, molecular biology, and developmental biology, encouraging interdisciplinary learning and a holistic understanding of biological processes.

PO6: Personal and Professional Competence

CO3, CO6, and CO7 enhance personal and professional competence by providing students with knowledge and practical skills essential for careers in research, environmental monitoring, and water treatment. They instill a sense of responsibility for environmental stewardship, preparing individuals to positively impact society while fostering their professional development in various scientific and environmental fields.

PO7: Effective Citizenship and Ethics

CO8. Address ethical issues related to developmental biology research, including controversies surrounding stem cell research and genetic manipulation.

SYLLABUS (CBCS) FOR M.Sc. II. Microbiology
(w. e. from June, 2023)
Academic Year 2023-2024

Class: M. Sc. II (Semester- III)
Paper Code: **PSMB235**
Paper: V
Title of Paper: Practical Course: Practical course based on Immunology, Pharmaceutical Microbiology and Industrial waste water treatment
Credit: 4
No. of lectures: 60

Course Objectives:

1. Understand the Basics of Antigens and Antibodies:
2. Examine the mechanisms of antigen-antibody binding.
3. Introduce laboratory methods used to study AG-AB interactions, such as ELISA, Western blotting, and immunofluorescence.
4. Discuss the practical applications of understanding AG-AB interactions in diagnostics and therapeutics.
5. Develop critical thinking skills to analyze complex scenarios involving AG-AB interactions.
6. Describe the sources and types of industrial wastewater.
7. Identify key pollutants commonly found in industrial wastewater.

Course Outcome

CO1. Students be able to determine basic wastewater parameters, such as pH, turbidity,and suspended solids.
CO2. Interpret wastewater characterization data to assess pollution levels and develop treatment strategies..
CO3. CO7. Analyse and interpret data from a biological treatment system, including COD and BOD removal efficiency.
CO4. Describe the factors influencing the rate of single diffusion and how these factors contribute to the overall process.
CO5. Analyze real-world examples where single diffusion plays a crucial role, such as in biological membranes, chemical reactions, or material science.
CO6. Critically evaluate experimental methods used to study single diffusion and interpret experimental results.

Antigen-Antibody Interactions

Precipitation reactions of antigen-antibody: Single radial immunodiffusion,
double immunodiffusion,
Immunoelectrophoresis,
rocket immunoelectrophoresis

Agglutination techniques: Titer determination of isoantibodies to human blood group antigens

Biophysics

Study of secondary structure of proteins using Ramchandran plot

Detection and isolation of anti‑infectives from plant

Extraction of bioactive principles from plant and activity fractionation
Estimation of its antimicrobial activity using standard guidelines (CLSI)

Industrial waste water treatment
Estimation of pollution load of an industrial waste water
Setting up a laboratory experiment to assess degradability of synthetic waste water

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								
CO 2										
CO 3				2						
CO 4					3					
CO 5					2					
CO 6		2								

Justification for the mapping

PO1:Disciplinary Knowledge

CO1: Students should be capable of determining fundamental wastewater parameters, including pH, turbidity, and suspended solids. Justification: This outcome involves the acquisition and application of specific knowledge related to wastewater parameters, reflecting disciplinary expertise in environmental science and engineering.

PO2: Critical Thinking and Problem Solving

CO2: Analyze data on wastewater characterization to evaluate levels of pollution and formulate treatment strategies. Justification: Analyzing data and formulating treatment strategies require critical thinking skills to assess complex information and develop effective solutions to address pollution levels.

CO6: Assess experimental methodologies employed in the study of single diffusion critically and interpret the outcomes of experiments. Justification: Critical assessment of experimental methodologies and interpretation of outcomes are essential critical thinking skills applied in a research context

PO4:Research-related Skill

CO3: Evaluate and interpret data obtained from a biological treatment system, specifically focusing on the efficiency of COD and BOD removal. Justification: This outcome involves the ability to assess and interpret data from a biological treatment system, reflecting research-related skills in data analysis and interpretation.

PO:5Transdisciplinary Knowledge

CO4: Explore the factors that impact the rate of single diffusion and understand their contributions to the overall process. Justification: Exploring factors impacting diffusion involves understanding principles from multiple disciplines such as chemistry, physics, and engineering, reflecting a transdisciplinary approach.

CO5: Examine practical instances where single diffusion plays a pivotal role, such as in biological membranes, chemical reactions, or materials science. Justification: This outcome requires applying knowledge of single diffusion across different practical instances, showcasing transdisciplinary understanding in biology, chemistry, and materials science.

SYLLABUS (CBCS) FOR M.Sc. II. Microbiology
(w. e. from June, 2023)
Academic Year 2023-2024

Class: M. Sc. II (Semester- III)
Paper Code: **PSMB236**
Paper: VI
Title of Paper: Practical Course: Practical course based on Molecular Biology and Microbial Technology
Credit: 4
No. of lectures: 60

Course objective:

1. Understand the influence of varying gel concentrations on the efficiency and stability of bioconversions using immobilized cells, specifically assessing how different gel compositions affect the process.
2. Investigate the impact of different cell concentrations on the rate and yield of bioconversion processes when using immobilized systems, aiming to understand the optimal cell density for enhanced conversion.
3. Grasp the mechanisms and principle involved in biosorption, focusing on the utilization of deceased biomass for the removal or absorption of dyes from solutions.
4. Gain proficiency in utilizing the Plackett-Burman experimental design to optimize media components for laboratory-scale production, specifically targeting increased exopolysaccharide yields.
5. Develop skills in isolating and extracting plasmid DNA from bacterial cells using appropriate techniques, aiming for high purity and yield.
6. Understand and apply the process of introducing foreign DNA into bacterial cells through transformation methods, thereby enabling the cells to express specific genes.
7. Acquire the ability to analyze gene sequences, identify functional elements, and determine potential functions and regulatory elements, leading to comprehensive gene annotation.

Course outcome:

After completing this course Students should able to:

CO1. Develop the ability to critically analyze and describe the impact of diverse gel concentrations on the effectiveness and stability of bioconversions employing immobilized cells, providing insights into how different gel compositions affect the process's efficiency and stability.

CO2. Acquire the capability to assess and interpret the effects of varying cell concentrations in immobilized systems on the pace and productivity of bioconversion processes, aiming to identify the optimal cell density for maximizing conversion rates and yields.

CO3. Attain a comprehensive understanding of biosorption mechanisms, particularly concerning the utilization of deceased biomass for the absorption or removal of dyes from solutions, allowing for a clear grasp of the underlying principles and applications in environmental remediation.

CO4. Develop proficiency in implementing the Plackett-Burman experimental design to optimize media components for laboratory-scale production, specifically targeting increased yields of exopolysaccharides, showcasing adeptness in experimental design and optimization techniques.

CO5. Attain expertise in employing precise techniques for isolating and extracting plasmid DNA from bacterial cells, aiming for high purity and yield, thereby demonstrating competence in molecular biology laboratory skills.

CO6. Understand and apply the process of DNA transformation, enabling bacterial cells to uptake foreign DNA and express specific genes, showcasing proficiency in genetic manipulation techniques.

CO7. Acquire the ability to analyze gene sequences, identify functional elements, and determine potential functions and regulatory elements, leading to comprehensive gene annotation, showcasing advanced bioinformatics and molecular biology skills.

Bioconversion
Bioconversions using immobilized systems (cells) Parameter testing
a. Effect of gel concentration
b. Effect of cell concentration

Biosorption
Biosorption of dyes using dead biomass

Laboratory scale production
Laboratory scale production and media optimization using Placket-Burman design for exopolysaccharide production.

Molecular Biology
Plasmid DNA extraction
Transformation
Gene annotation

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							2
CO 2	3	3							2
CO 3							2	2	3
CO 4				3					2
CO 5				2					3
CO 6					2				2
CO 7						3			3

Justification for the mapping
PO1: Disciplinary Knowledge
CO1: Strong (3) relation: Critical analysis of gel concentrations in bioconversions directly contributes to disciplinary knowledge by understanding their impact on process efficiency and stability.

CO2: Strong (3) relation: Interpretation of varying cell concentrations in bioconversion provides insights directly related to disciplinary knowledge by identifying optimal conditions for higher yields.

PO2: Critical Thinking and Problem Solving
CO1: Strong (3) relation: Critical analysis of gel concentrations requires problem-solving skills to comprehend their effects on bioconversion.
CO2: Strong (3) relation: Interpretation of varying cell concentrations necessitates critical thinking to optimize bioconversion processes.

PO4: Research-related Skills and Scientific Temper
CO4: Strong (3) relation: Proficiency in Plackett-Burman design for media optimization directly aligns with research-related skills.
CO5: Moderate (2) relation: Skills in isolating plasmid DNA contribute partially to research-related skills.

PO5: Trans-disciplinary Knowledge
CO6: Moderate (2) relation: Understanding DNA transformation contributes partially to trans-disciplinary knowledge by spanning molecular biology and genetic engineering.

PO6: Personal and Professional Competence
CO7: Strong (3) relation: Analyzing gene sequences involves advanced bioinformatics skills, directly relating to personal and professional competence.

PO7: Effective Citizenship and Ethics
CO3: Moderate (2) relation: Understanding biosorption mechanisms contributes partially to environmental awareness, indirectly relating to effective citizenship and ethics.

PO8: Environment and Sustainability
CO3: Moderate (2) relation: Biosorption mechanisms, while primarily environmental, contribute partially to understanding sustainability practices.

PO9: Self-directed and Life-long Learning
All COs have some relation (moderate to strong) with PO9 as they require continuous learning, skill development, and staying updated in the field.

SYLLABUS (CBCS) FOR M.Sc. II. Microbiology
(w. e. from June, 2023)
Academic Year 2023-2024

Class	: M. Sc. II (Semester- III)
Paper Code	: SD23
Title of Paper	: Skill Development: Spectroscopic 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. UV-Visible spectroscopy- Principle, Instrumentation. FTIR and its advantages, Principle, Instrumentation, Absorption band

B. Atomic Absorption Spectroscopy (AAS) and its advantages, Hands-on training

Text / Reference Books:

- Wilson Keith and Walker John (2005) *Principles and Techniques of Biochemistry and Molecular Biology*, 6th Ed. Cambridge University Press, New York.
- Pattabhi, V. and Gautham, N. (2002) *Biophysics.* Kluwer Academic Publishers, New York and Narosa Publishing House, Delhi.
- Rolf Ekman, Jerzy Silberring, Ann Westman- Brinkmalm, Agnieszka Kraj (2009) *Mass spectrometry : instrumentation, interpretation, and applications*, John Wiley & Sons, Inc.,Canada.

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.