Department of Microbiology (PG)

Programme Specific Outcomes (PSOs)

On the successful completion of the Postgraduate programme, the students will be able to

PSO1 **Disciplinary Knowledge**	formulate, articulate, retain and apply specialized terms and knowledge relevant to the core concepts in Microbiology, Biochemistry, Cell and Molecular Biology, Biotechnology, Immunology and Bioinformatics.
PSO2 **Communication Skills**	communicate life science concepts, experimental results and analytical arguments clearly and concisely, both verbally and in writing.
PSO3 **Problem Solving & Analytical Reasoning**	demonstrate competency in laboratory safety and in routine and specialized Microbiological laboratory skills applicable to Microbiological research or clinical methods.
PSO4 **Critical Thinking**	critique how microorganisms are used as model systems to study Microbiology, Genetics, Physiology, Ecology, Biotechnology, Immunology and Bioinformatics.
PSO5 **Research Skills**	demonstrate skills in data collection using statistical techniques and Bioinformatics and documentation of the collected data.
PSO6 **Digital Literacy**	navigate various digital platforms to access biological data and information and be able to critically verify, analyze and use the online information to express scientific ideas coherently
PSO7 **Professional competencies**	explore and venture into the role of microbiologists in various arena of industries, commerce and government organisations by evolving with employability and entrepreneurship
PSO8 **Moral and Ethical Awareness/ Reasoning**	identify the ethical issues governing research in life sciences and apply these principles for making decisions in various aspects of their academic life like report writing, examinations and research projects.
PSO9 **Multicultural Competence**	work with their peers from diverse cultural and economic backgrounds and engage in cultural and academic discourse in a respectful, understanding and sensitive manner, thus preparing them for a diverse and inclusive work environment.
PSO10 **Self-directed & Lifelong Learning**	develop their personal, academic and professional skills through commitment to the pursuit of personal and professional growth.[

Department of Microbiology (PG)

Learning Outcomes-based Curriculum Framework (LOCF)
(w.e.f 2024-2025)

Sem	Category	Course Code	Course Title	Hours/ Wk.	Credits	Marks
1	CC	24MIM4401	General Microbiology and Microbial Diversity	5	4	80
1	CC	24MIM4403	Cell Biology	5	4	80
1	CC	24MIM4405	Biological Chemistry	5	4	80
1	CC	24MIM4201	General Microbiology and Microbial Diversity Lab	3	2	40
1	CC	24MIM4203	Cell Biology and Biological Chemistry Lab	3	2	40
1	DSE	24XXXNNNN	*Discipline Specific Elective – I*	5	4	80
1	GE	24XXXNNNN	*Generic Elective - I*	4	3	60
			Total	**30**	**23**	**460**
2	CC	24MIM4402	Medical Bacteriology and Mycology	5	4	80
2	CC	24MIM4404	Medical Virology and Parasitology	5	4	80
2	CC	24MIM4406	Molecular Biology and Microbial Genetics	5	4	80
2	CC	24MIM4202	Medical Microbiology Lab	3	2	40
2	CC	24MIM4204	Molecular Biology and Microbial Genetics Lab	3	2	40
2	DSE	24XXXNNNN	*Discipline Specific Elective – II*	5	4	80
2	GE	24XXXNNNN	*Generic Elective - II*	4	3	60
			Total	**30**	**23**	**460**
3	CC	24MIM5501	Immunology and Immunomics	6	5	100
3	CC	24MIM5503	Recombinant DNA Technology and Biotechnology	6	5	100
3	CC	24MIM5505	Fermentation Technology and Pharmaceutical Microbiology	5	5	100
3	CC	24MIM5201	Immunology Lab	4	2	40
3	CC	24MIM5203	Recombinant DNA Technology and Biotechnology Lab	4	2	40
3	DSE	24XXXNNNN	*Discipline Specific Elective - III*	5	4	80
3	IS	24MIM5233	Internship*	-	2	40
			Total	**30**	**25**	**500**

4	CC	24MIM5502	Soil and Environmental Microbiology	6	5	100
4	CC	24MIM5504	Food and Dairy Microbiology	6	5	100
4	CC	24MIM5202	Soil and Environmental Microbiology Lab	3	2	40
4	CC	24MIM5204	Food and Dairy Microbiology Lab	3	2	40
4	CC	24MIM5506	Project	8	5	100
4	DSE	24XXXNNNN	*Discipline Specific Elective – IV*	4	4	80
4	SEC	24MIM5244	Professional Competency Skill	-	2	40
			Total	**30**	**25**	**500**
			Grand Total	**120**	**96**	**1920**

* Internship - First Year Vacation (30 Hrs.)

Discipline Specific Elective (DSE)

Sem	Category	Course Code	Course Title	Hours/Wk.	Credits	Marks
1	DSE	24MIM4407	Bioinstrumentation	5	4	80
		24MIM4409	Forensic Science			
2	DSE	24MIM4408	Bioinformatics	5	4	80
		24MIM4410	Basics of Scientific Writing			
3	DSE	24MIM5401	Animal Cell Culture	5	4	80
		24MIM5403	Biosafety, Bioethics and IPR			
4	DSE	24MIM5402	Research Methodology and Biostatistics	4	4	80
		24MIM5404	Vaccinology			

Generic Elective (GE)

Sem	Category	Course Code	Course Title	Hours/Wk.	Credits	Marks
1	GE	24MIM4301	Entrepreneurship in Biobusiness	4	3	60
		24MIM4303	Health and Hygiene			
2	GE	24MIM4302	Epidemiology	4	3	60
		24MIM4304	Vermitechnology			

Mapping with POs

MIM	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
	3	**3**	**2**	**2**	**3**	**2**	**2**	**2**	**3**	**3**

Mapping of courses with PSOs

Courses	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
24MIM4401	3	2	2	3	3	2	2	2	2	3
24MIM4403	3	2	2	3	2	2	2	2	2	3
24MIM4405	3	3	1	2	2	2	2	2	2	2
24MIM4201	3	3	3	3	3	2	3	3	2	3
24MIM4203	3	3	1	1	3	2	2	2	2	3
24MIM4407/ 24MIM4409	3	3	2	2	3	2	2	2	3	3
24MIM4402	3	3	3	3	3	2	2	3	2	3
24MIM4404	3	3	3	3	3	2	2	3	2	3
24MIM4406	3	3	3	3	3	2	3	2	2	3
24MIM4202	3	3	3	3	3	2	3	3	2	3
24MIM4204	3	3	3	3	3	2	3	2	2	3
24MIM4408/ 24MIM4410	3	2	1	2	3	3	2	1	2	3
24MIM5501	3	3	2	2	2	2	2	2	2	3
24MIM5503	3	3	2	2	2	3	2	3	2	3
24MIM5505	3	3	3	2	2	3	3	2	3	3
24MIM5201	3	3	2	2	3	2	2	3	2	3
24MIM5203	3	3	3	2	2	2	3	2	2	3
24MIM5401/ 24MIM5403	3	3	2	2	2	2	2	3	2	3
24MIM5233	3	3	3	3	3	3	3	3	3	3
24MIM5502	3	2	2	2	2	3	3	2	2	3
24MIM5504	3	3	3	2	2	3	2	3	3	3
24MIM5202	3	2	3	3	3	2	3	2	2	3
24MIM5204	3	3	3	3	2	2	3	2	2	3

24MIM5506	3	3	3	3	2	3	3	3	2	3
24MIM5402/ 24MIM5404	3	3	2	2	3	3	2	2	2	3
24MIM5244	3	3	3	3	3	3	3	3	3	3
AVERAGE	**3**	**2.8**	**2.4**	**2.5**	**2.6**	**2.3**	**2.5**	**2.4**	**2.2**	**2.9**

Mapping of courses with POs

Courses	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
24MIM4301/ 24MIM4303	2	2	2	2	2	2	2	2	3	3
24MIM4302/ 24MIM4304	2	2	2	2	2	2	2	2	3	2
AVERAGE	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**2.5**

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIM4401	**General Microbiology and Microbial Diversity**	**Core**	**5**	**4**

This course provides knowledge on the principles of different types of microscopes and their applications. It also facilitates to understand the structure, functions and biosynthesis of cellular components of bacteria. The methods for isolation and cultivation of microalgae will also be dealt. The course deals with pure culture techniques, sterilization methods and microbial biodiversity.

Course Outcomes:

At the end of the course, students will be able to

CO1: recall the principles of different types of microscopes and their applications.
CO2: compare the structure, nutritional requirements and growth of bacteria and fungi.
CO3: illustrate the morphology, classification and cultivation of algae.
CO4: design various pure culture techniques and sterilization methods.
CO5: evaluate the significance of microbial diversity and conservation.

UNIT I: History and scope of microbiology (15 Hours)

Microscopy – Principles and applications. Types of Microscopes - Bright field, Dark-field, Phase-contrast, Fluorescence microscope, Transmission electron microscope (TEM), and Scanning electron microscope (SEM). Sample preparation for SEM & TEM. Atomic force and Confocal microscope's. Micrometry – Stage, Ocular and its applications.

UNIT II: Bacteria (15 Hours)

Structure, properties and biosynthesis of cellular components – Cell wall. Actinomycetes and Fungi - Distribution, morphology, classification, reproduction and economic importance. Sporulation. Growth and nutrition - Nutritional requirements, Growth curve, Kinetics of growth, Batch culture, Synchronous growth, Measurement of growth and factors affecting growth.

UNIT III: Algae (15 Hours)

Distribution, morphology, classification, reproduction, and economic importance. Isolation of algae from soil and water. Media and methods used for culturing algae, Strain selection, and large-scale cultivation. Life cycle - *Chlamydomonas*, *Volvox*,

Spirogyra (Green algae), *Nostoc* (Cyanobacteria) *Ectocarpus*, *Sargassum* (Brown algae), *Polysiphonia*, *Batrachospermum* (Red algae).

UNIT IV: Microbial techniques (15 Hours)

Safety guidelines in Microbiology Laboratories. Sterilization, Disinfection and its validation. Staining methods – Simple, Differential and Special staining. Automated Microbial identification systems - Pure cultures techniques – Cultivation of Anaerobic organisms. Maintenance and preservation of pure cultures. Culture collection centres - National and International.

UNIT V: Microbial biodiversity (15 Hours)

Introduction – Thermophiles - Classification, Thermophilic Archaebacteria and their applications. Methanogens - Classification, Habitats, applications. Alkaliphiles and Acidophiles - Classification, discovery basin, their cell wall and membrane. Barophiles - Classification and their applications. Halophiles - Classification, discovery basin, cell walls and membranes – purple membrane, compatible solutes, Osmoadaptation / halotolerance - Applications of halophiles and Conservation of Biodiversity.

Learning Resources:

Textbooks

1. Bruslin. L (2020). *General Microbiology* - 1st Edition. Oregon State University Publications.
2. Sharma. S. G, Sharma N. R and Sharma M. (2020). *Microbial Diversity, Interventions and Scope*. Springer Singapore. 415p. https://doi.org/10.1007/978-981-15-4099-8.
3. Willey, J., Sandman, K. and Wood, D. (2020). *Prescott's Microbiology*. (11th Edition). McGraw-Hill Company, New York.
4. Kanunga R. (2017). *Ananthanarayanan and Panicker's Textbook of Microbiology*. (10th Edition). Universities Press (India) Pvt. Ltd.
5. Dubey R.C. and Maheshwari D. K. (2009). *Textbook of Microbiology*. S. Chand, Limited.

References

1. Tortora G. J., Funke B. R. and Case C. L. (2015). *Microbiology: An Introduction* (12th Edition). Pearson, London, United Kingdom.
2. Webster J. and Weber R.W.S. (2007). *Introduction to Fungi*. (3rd Edition). Cambridge University Press, Cambridge.
3. Schaechter M. and Leaderberg, J. (2004). *The Desk Encyclopaedia of Microbiology*. Elsevier Academic Press, California.

4. Ingraham, J. L. and Ingraham, C. A. (2000). *Introduction to Microbiology*. (2nd Edition). Books / Cole Thomson Learning, UK.
5. Madigan M. T., Bender K. S., Buckley D. H. Sattley W. M., and Stahl. (2018). *Brock Biology of Microorganisms.* (15th Edition). Pearson.

Websites/ e-Learning Resources

1. http://sciencenetlinks.com/tools/microbeworld
2. https://www.microbes.info/
3. https://www.asmscience.org/VisualLibrary
4. https://open.umn.edu/opentextbooks/BookDetail.aspx?bookId=404
5. https://www.grsmu.by/files/file/university/cafedry//files/essential_microbiology.pdf

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	3	3	2	2	2	2	3
CO2	3	2	2	3	3	2	2	2	3	3
CO3	2	2	3	3	2	3	3	2	3	3
CO4	3	2	3	3	2	2	3	2	2	3
CO5	3	3	2	3	3	3	2	2	2	3
Average	**2.8**	**2.4**	**2.4**	**3**	**2.6**	**2.4**	**2.4**	**2**	**2.4**	**3**

High Correlation - 3; Medium Correlation - 2; Low Correlation - 1

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIM4403	**Cell Biology**	**Core**	**5**	**4**

In this course, the basic structure of prokaryotic and eukaryotic cells, and the tools used to understand them are covered. Structure and composition of biological membranes, transport, intracellular trafficking and cellular organelles are explained thoroughly. Mechanisms of cellular signalling, intercellular junctions and extracellular matrix structure are discussed. The cytoskeleton, cell movement and the integration of cells into tissues are deliberated. Important cellular processes such as cell cycle regulation, apoptosis (programmed cell death), and cancer cell biology will also be dealt in depth.

Course Outcomes:

At the end of the course, students will be able to

CO1: relate the fundamental principles of cell biology
CO2: describe the cell structure and how it relates to cell functions
CO3: evaluate cell signalling and how it regulates cellular functions
CO4: identify the cell movement and how it is accomplished
CO5: appraise the growth, division, and death of cells.

UNIT I: Introduction to cell (**15 Hours)**

Universal principles, properties, origin and evolution of cells, acellular forms- prions, viriods, prokaryotic and eukaryotic cell structure and function, cells as experimental models: *E. coli*, yeasts, vertebrates; tools of cell biology: light and electron microscopy, subcellular fractionation, growth of animal cells and plant cells. Basic types of cells- epithelial cells, muscle cells and nerve cells.

UNIT II: Membranes and transport mechanisms (**15 Hours)**

Membrane structure and function, dynamics, pumps, carriers, channels. Membrane Physiology. Cellular organelles and membrane trafficking, posttranslational targeting of proteins, mitochondria, chloroplasts, peroxisomes, endoplasmic reticulum, nucleus, secretory membrane system and Golgi apparatus, endocytosis and the endosomal membrane, processing and degradation of cellular components.

UNIT III: Cell communication (**15 Hours)**

Signalling mechanisms, plasma membrane receptors, protein hardware for signalling, second messengers, Neural signalling- action potential, synaptic signalling; cellular

adhesion and the extracellular matrix: extracellular matrix molecules, cellular adhesion- integrins, selectins, cadherins, Ig-superfamily CAMs, intercellular junctions- gap junctions, tight junctions, desmosomes, plasmodesmata. Connective tissues.

UNIT IV: Cytoskeleton and cell movement (**15 Hours)**

Cytoskeleton and cellular motility, actin and actin-binding proteins, microtubules and centrosomes, intermediate filaments, motor proteins- kinesin, dynein, myosin, intracellular motility, cellular motility and muscles.

UNIT V: Cell Division, Apoptosis, and Cancer (**15 Hours)**

Cell cycle, phases of the cell cycle, cell cycle *in-vivo*, regulation of the cell cycle, cell cycle checkpoints, mitosis and cytokinesis, meiosis, programmed cell death; Cancer as an example of loss of cell cycle controls.

Learning Resources:

Textbooks

1. Geoffrey, M., Cooper, H., and Robert, E. (2019). *Cell: A Molecular Approach*. Oxford University Press.
2. Pollard, T. D., Earnshaw, W. C., Lippincott-Schwartz, J., and Johnson, G. (2023). *Cell Biology E-Book: Cell Biology E-Book*. Elsevier Health Sciences.

References

1. Plopper, G., Sharp, D., and Sikorski, E. (Eds.). (2013). *Lewin's Cells*. Jones & Bartlett Publishers.
2. Karp, G. (2016). *Cell and Molecular Biology: Concepts and Experiments 8th Edition with Plus Set*. John Wiley & Son.
3. Alberts, B., Bray, D., Hopkin, K., Johnson, A., Lewis, J., Raff, M., ... and Walter, P. (2017). *Molecular Biology of The Cell*. Garland Science.
4. Alberts, B., Bray, D., Hopkin, K., Johnson, A., Lewis, J., Raff, M., ... and Walter, P. (2013). *Essential cell biology*. Garland Science.
5. Lodish, H., Berk, A., Zipursky, S. L., Matsudaira, P., Baltimore, D., and Darnell, J. (2016). *Molecular cell biology* (Vol. 8). New York: WH Freeman.

Websites/e – Learning Resources

1. https://training.seer.cancer.gov/anatomy/cells_tissues_membranes/cells/structure.html
2. https://chem.libretexts.org/Bookshelves/Biological_Chemistry/Supplemental_Modules_(Biological_Chemistry)/Proteins/Case_Studies%3A_Proteins/Membrane_Transport
3. https://rb.gy/ukfr0i

4. https://bio.libretexts.org/Courses/University_of_California_Davis/BIS_2A%3A_Introductory_Biology_(Easlon)/Readings/14%3A_The_Cytoskeleton.
5. https://rb.gy/2772y1

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	2	2	2	2	3	2	2
CO2	3	3	2	2	2	2	2	3	2	2
CO3	3	2	2	3	3	2	3	2	2	3
CO4	2	2	2	3	2	3	2	2	2	3
CO5	2	2	2	3	3	3	3	2	2	3
Average	**2.6**	**2.4**	**2**	**2.6**	**2.4**	**2.4**	**2.4**	**2.4**	**2**	**2.6**

High Correlation - 3; Medium Correlation - 2; Low Correlation - 1

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIM4405	Biological Chemistry	Core	5	4

This course on biological chemistry includes basic structure of atom, chemical bonds and the importance of pH and biological buffers. Composition, structure and functions of carbohydrates, proteins, lipids and vitamins are discussed. Enzymes and enzyme kinetics, and the laws of bioenergetics are explained. Metabolism of carbohydrates, proteins, lipids, nucleotides and vitamins metabolism are explained.

Course Outcomes:

At the end of the course, students will be able to

CO1: explain the fundamental concepts in biochemistry.
CO2: analyse the structures of various biomolecules.
CO3: evaluate the regulation and mechanism of enzyme activity and bioenergetics.
CO4: discuss the metabolic pathways of carbohydrates and vitamins.
CO5: compare the metabolism of amino acids, nucleic acid's and lipids.

UNIT I: Physical and chemical concepts in biology (15 Hours)

Structure of atoms, molecules and chemical bonds; Biomolecule interaction – Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction and covalent bond; Principles of biophysical chemistry- pH, buffer, reaction kinetics and colligative properties.

UNIT II: Biomolecules (15 Hours)

Composition, structure, classification and functions – Carbohydrates, lipids, proteins, nucleic acids and vitamins; Conformation of proteins - Ramachandran plot, primary, secondary, tertiary & quaternary structures, domains, motif and folds.

UNIT III: Enzymes and bioenergetics (15 Hours)

Enzymes and enzyme kinetics - regulation of enzymatic activity - mechanism of enzyme catalysis - Michaelis-Menten equation – isozymes; Bioenergetics – thermodynamics, free energy, coupled reactions, group transfer and biological energy transducers.

UNIT IV: Carbohydrate and vitamin metabolism (15 Hours)

Types of metabolism; Carbohydrate metabolism - glycolysis, TCA cycle, oxidative phosphorylation, gluconeogenesis; glycogen metabolism, - Glycogenesis and

Glycogenolysis, HMP shunt, uronic acid pathway; Vitamin metabolism – Vitamins A, D and C.

UNIT V: Amino acid, nucleic acid and lipid metabolism (15 Hours)

Amino acid metabolism – In born errors- phenylketonuria, maple syrup urine disease, albinism, Urea cycle. Nucleotides - Biosynthesis and degradation of purines and pyrimidines; Biosynthesis and β-oxidation of fatty acid, ketone bodies, metabolism of phospholipids, glycolipids, cholesterol and HDL.

Learning Resources:

Textbooks

1. Satyanarayana, U. and Chakrapani, U (2021). *Biochemistry*, 6th Edition, Made Simple Publisher.
2. Jain J. L, Sunjay Jain and Nitin Jain (2016). *Fundamentals of Biochemistry*, 7th Edition, S Chand Company.
3. Shanmugam . A (2016). *Fundamentals of Biochemistry for Medical Students*, 8th Edition. Wolters Kluwer India Pvt Ltd.
4. Vasudevan. D. M., Sreekumari.S, and Vaidyanathan . K (2019). *Textbook of Biochemistry for Medical Students*. Kindle edition, Jaypee Brothers Medical Publishers
5. . Berg, J M Stryer L,. Tymoczko, J. L and Gatto G. J. (2015). *Biochemistry*, 8th edition. WH Freeman publisher.

References

1. Kessel. A and Ben-Tal N (2018). *Introduction to Proteins: structure, function and motion*. 2nd Edition, Chapman and Hall.
2. Nelson D. L and Cox M. M (2017). *Lehninger Principles of Biochemistry*, 7th Edition W.H. Freeman and Co., NY.
3. Styrer L , BergJ. M Tymaczko J. L , Gatto Jr., and Gregory J (2019). *Biochemistry*. 9th Edition, W.H. Freeman & Co. New York.
4. Voet. D, Voet J, and Pratt . C (2016). *Fundamentals of Biochemistry*: Life at the Molecular Level, 5th Edition, Wiley.
5. Joy P. P, Surya S. and Aswathy, C. (2015). *Laboratory Manual of Biochemistry*.

Websites/e – Learning Resources

1. https://www.abebooks.com
2. https://kau.in/document/laboratory-manual-biochemistry
3. https://metacyc.org
4. https://www.medicalnewstoday.com
5. https://journals.indexcopernicus.com

CO – PSO Mapping

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	2	1	2	2	2	3	2	2
CO2	3	2	2	1	2	2	2	3	2	3
CO3	3	3	1	2	2	2	2	2	2	2
CO4	2	3	1	2	3	3	2	2	2	1
CO5	2	3	1	2	3	3	2	1	2	1
Average	**2.6**	**2.8**	**1.4**	**1.6**	**2.4**	**2.4**	**2**	**2.2**	**2**	**1.8**

High Correlation - 3; Medium Correlation - 2; Low Correlation - 1

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIM4201	**General Microbiology and Microbial Diversity Lab**	**Core**	**3**	**2**

The laboratory course provides the basic techniques such as aseptic handling, sterilization techniques, media preparation and isolation of bacteria and fungi from various sources. It also deals with the various staining procedures for bacteria and fungi. It provides hands on experience in various biochemical characterization methods needed for the identification of unknown bacteria.

Course Outcomes:

At the end of the course, students will be able to

CO1: apply aseptic handling techniques and sterilization methods
CO2: demonstrate the pure culture techniques, staining methods and micrometry.
CO3: practice biochemical assays to identify extracellular enzyme production by bacteria.
CO4: analyze the bacterial growth and assess the effect of physical parameters on growth.
CO5: compare the response of the microbes to various antimicrobials.

List of Experiments:

1. Aseptic Handling techniques
2. Methods of sterilization and Preparation of culture media
3. Pure culture isolation and maintenance
    a. Isolation and identification of bacteria and fungi from various samples and study of culture characteristics
    b. Maintenance of pure cultures of bacteria and fungi
4. Staining methods:
    a. Simple staining
    b. Differential staining
    c. Lactophenol cotton blue staining for fungi
5. Motility of bacteria by Hanging drop method
6. Measurement of bacterial cells with micrometer
7. Identification of unknown bacteria by biochemical characterization
    a. IMViC test
    b. Oxidase and catalase tests
    c. Oxidation/fermentation of glucose
8. Determination of bacterial growth curve

9. Effect of physical factors such as temperature and pH on bacterial growth
10. Screening bacteria for the production of extracellular enzymes such as amylase, caseinase, gelatinase, urease, and lipase
11. Determination of antimicrobial susceptibility tests
    a. Minimum inhibitory concentration (MIC)/Minimum Bactericidal Concentration (MBC) Assay
    b. Kirby Bauer method
    c. Agar well diffusion method
    d. Minimum bactericidal concentration

Learning Resources:

Textbooks

1. Sharma S.G., Sharma N.R. and Sharma. M.(2020). *Microbial Diversity, Interventions and Scope*. Springer Singapore. 415p. https://doi.org/10.1007/978-981-15-4099-8.
2. Dubey R.C. and Maheshwari D. K. (2010). *Practical Microbiology*. S. Chand & company, New Delhi.
3. Cullimore D. R. (2010). *Practical Atlas for Bacterial Identification*. (2nd Edition). Taylor & Francis.
4. Cappuccimo, J. and Sherman, N. (2002). *Microbiology: A Laboratory Manual*, (6th Edition) Pearson Education, Publication, New Delhi.
5. Tortora G. J., Funke B. R. and Case C. L. (2015). *Microbiology: An Introduction* (12th Edition). Pearson, London, United Kingdom

References

1. Cappuccino J. G, and Welsh C. T. (2017). *Microbiology: A Laboratory Manual*. Pearson Education.
2. Benson H. J. (2001). *Microbiological Applications: A Laboratory Manual in General Microbiology*. The McGraw− Hill Companies.
3. Webster J. and Weber R. W. S. (2007). *Introduction to Fungi*. (3rd Edition). Cambridge University Press, Cambridge.
4. Gunasekaran P. (1995). *Lab Manual in Microbiology*. New Age International Pvt. Ltd., Madras.

Web Resources

1. http://textbookofbacteriology.net/
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC149666/
3. https://open.umn.edu/opentextbooks/BookDetail.aspx?bookId=404
4. https://www.grsmu.by/files/file/university/cafedry//files/essential_microbiology.pdf
5. https://www.microbes.info/

CO – PSO Mapping

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	3	3	3	2	3	3	2	3
CO2	3	3	3	3	2	2	3	2	2	3
CO3	2	3	3	3	2	2	3	3	3	3
CO4	3	3	3	3	3	2	3	3	2	3
CO5	3	2	3	3	3	2	3	3	3	3
Average	**2.8**	**2.8**	**3**	**3**	**2.6**	**2**	**3**	**2.8**	**2.4**	**3**

High Correlation - 3; Medium Correlation - 2; Low Correlation - 1

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIM4203	**Cell Biology and Biological Chemistry Lab**	**Core**	**3**	**2**

This course includes laboratory experiments involving acidic and alkalimetry, colorimetric estimation of biomolecules, centrifugation and chromatographic separation of amino acids. Estimation and isolation of nucleic acids are also part of this coursework. It deals with the observation of animal and plant cells, their organelles and understanding of cellular physiology.

Course Outcomes:

At the end of the course, students will be able to

CO1: explain the principles of analytical instruments in biochemistry and cell biology
CO2: prepare buffers and analyse biomolecules qualitatively and quantitatively.
CO3: formulate the separation of biomolecules through chromatography and electrophoresis.
CO4: design methods for isolation of nucleic acids from different samples
CO5: compare the structure and physiology of animal and plant cells

List of Experiments:

1. Microscopy – Compound microscope, SEM, TEM
2. Preparative centrifugation
3. Spectrophotometry
4. Preparation of biological buffer and solutions
5. Qualitative analysis of Carbohydrates
6. Qualitative analysis of Proteins
7. Qualitative analysis of Lipids
8. Chromatography– (a) Paper (b) Thin Layer (c) HPLC
9. DNA Isolation and estimation
10. Cell membrane permeability using RBCs, trypan blue exclusion test
11. Identification of Different Stages of Mitosis in Onion Tips
12. Visualization of animal and plant cell
13. Staining and visualisation of mitochondria by Janus green

Learning Resources:

Textbooks

1. Palanivelu P. (2009). *Analytical Biochemistry & Separation Techniques - Lab Manual*. 4th edn. Twenty first Century Publications.
2. Jayaraman J. (1996). *Laboratory Manual in Biochemistry*. 5th ed. New Age International Pub, New Delhi.

References

1. Pandey, S., K Goswami, S., and Jain, B. P. (2020). *Protocols in Biochemistry and Clinical Biochemistry*. Netherlands: Elsevier Science.
2. Geetha K. D. (2010). *Practical Biochemistry*. Jaypee Brothers, Medical Publishers Pvt. Limited
3. Plummer D. T. (1997). *An Introduction to Practical Biochemistry*. Tata McGraw Hill Pub Co, New Delhi.

CO – PSO Mapping

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	2	1	1	2	2	2	2	1	3
CO2	3	2	1	1	2	2	2	2	2	3
CO3	3	3	1	1	3	2	2	2	2	3
CO4	2	3	2	3	3	2	2	1	2	3
CO5	2	3	2	1	3	2	2	1	2	3
Average	**2.6**	**2.6**	**1.4**	**1.4**	**2.6**	**2**	**2**	**1.6**	**1.8**	**3**

High Correlation - 3; Medium Correlation - 2; Low Correlation - 1

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIM4407	Bioinstrumentation	DSE	5	4

This course emphasizes the principles and working mechanisms of laboratory instruments used in Life sciences. The students also learn the theoretical aspects of the techniques like chromatography and molecular biology techniques. This course is intended for enabling the students to illustrate and explain the use of these techniques in biological applications. Acquiring knowledge on spectroscopic techniques and use of radioisotopes in various fields of medicine will enable the students towards their employment in such fields.

Course Outcomes:

At the end of the course, students will be able to

CO1: relate the basics of instrumentation in life sciences.
CO2: describe the separation of macromolecules through chromatography and electrophoresis.
CO3: compare the use of various electrophoretic methods.
CO4: illustrate the principles of spectroscopy.
CO5: examine the role of radioisotopes based techniques in life sciences.

UNIT I: Basic laboratory instruments (15 Hours)

Aerobic and anaerobic incubator – Biosafety Cabinets - Fume Hood, pH meter, Lyophilizer, Flow cytometry. Centrifugation techniques: Basic principles of centrifugation - Standard sedimentation coefficient - measurement of sedimentation co-efficient; Principles, methodology and applications of differential, rate zonal and density gradient centrifugation - Applications in determination of molecular weight.

UNIT II: General principles of chromatography (15 Hours)

Chromatographic Performance parameters; Types- Thin layer chromatography, Paper Chromatography, Liquid chromatography (LPLC &HPLC), Adsorption, ion exchange, Gel filtration, affinity, Gas liquid (GLC). Flash Chromatography and Ultra Performance convergence chromatography. Two-dimensional chromatography and Stimulated moving bed chromatography (SEC).

UNIT III: Electrophoresis (15 Hours)

General principles - moving boundary electrophoresis - electrophoretic mobility – supportive materials – electro endosmosis – types (horizontal, vertical and two-

dimensional electrophoresis) - Principle and applications - paper electrophoresis, Serum electrophoresis, starch gel electrophoresis, Disc gel, Agarose gel, SDS – PAGE, Immunoelectrophoresis. Blotting techniques- Southern, Northern and Western blotting.

UNIT IV: Spectroscopic techniques (15 Hours)

Principle, simple theory of absorption of light by molecules, electromagnetic spectrum, instrumentation and application of UV- visible, Raman, FTIR spectrophotometer, spectrofluorimetry, Atomic Absorption Spectrophotometer, Flame spectrophotometer, NMR, ESR, Emission Flame Photometry and GC-MS. Detection of molecules in living cells - FISH and GISH. Biophysical methods: Analysis of biomolecules by Spectroscopy UV/visible- Circular Dichroism.

UNIT V: Radioisotopic techniques (15 Hours)

Principles and applications of tracer techniques in biology. Radioactive isotopes - radioactive decay; Detection and measurement of radioactivity using ionization chamber, proportional chamber, Geiger- Muller and Scintillation counters, auto radiography and its applications. Commonly used isotopes in biology- labeling procedures and safety aspects.

Learning Resources:

Textbooks

1. Sharma B. K. (2014). *Instrumental Method of Chemical Analysis*. Krishna Prakashan Media (P) Ltd.
2. Chatwal G. R and Anand S. K. (2014.) *Instrumental Methods of Chemical Analysis*. Himalaya Publishing House.
3. Mitchell G. H. (2017). *Gel Electrophoresis: Types, Applications and Research*. Nova Science Publishers Inc.
4. Holme D. and Peck H. (1998). *Analytical Biochemistry*. (3rd Edition). Prentice Hall.
5. Jayaraman, J. (2011). *Laboratory Manual in Biochemistry*. (2nd Edition). Wiley Eastern Ltd., New Delhi.
6. Palanivelu. P. (2016). *Analytical Biochemistry and Separation Techniques* (5th Edition).

References

1. Pavia D. L. (2012). *Spectroscopy* (4th Edition). Cengage.
2. Skoog A. and West M. (2014). *Principles of Instrumental Analysis.* (14th Edition). W. B. Saunders Co., Philadelphia.

3. Miller J. M. (2007). *Chromatography: Concepts and Contrasts* (2nd Edition) Wiley-Blackwell.
4. Gurumani N. (2006). *Research Methodology for Biological Sciences.* (1st Edition) M. J. P Publishers.
5. Ponmurugan P. and Gangathara P. B. (2012). *Biotechniques.* (1st Edition). MJP Publishers.

Websites/ e-Learning Resources

1. https://norcaloa.com/BMIA
2. http://www.biologydiscussion.com/biochemistry/centrifugation/centrifuge-introduction- types-uses-and-other-details-with-diagram/12489
3. https://www.watelectrical.com/biosensors-types-its-working-and-applications.
4. http://www.wikiscales.com/articles/electronic-analytical-balance/
5. https://study.com/academy/lesson/what-is-chromatography-definition-types-uses.

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	2	2	2	3	3	2	2	3	3
CO2	3	3	3	1	3	3	3	2	3	3
CO3	3	2	3	1	2	2	3	2	3	3
CO4	3	3	2	1	3	2	2	2	3	3
CO5	3	3	2	1	3	2	2	3	3	3
Average	**3**	**2.6**	**2.4**	**1.2**	**2.8**	**2.4**	**2.4**	**2.2**	**3**	**3**

High Correlation - 3; Medium Correlation - 2; Low Correlation - 1

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIM4409	**Forensic Science**	**DSE**	**5**	**4**

This course is intended towards imparting basic knowledge about the power of science to support the investigation of crimes and produce scientific substantiation of the evidences and thereby aiding the judicial proceedings. The proof of evidences or the evidences are validated for arriving at certain conclusions during crime investigations. This course presents the diversified applications of various fields of science to be applied for crime investigations.

Course Outcomes:

At the end of the course, students will be able to

CO1: describe the scope, need to use the tools and techniques in forensic science.
CO2: explain the organization of forensic laboratories at national and state levels.
CO3: examine body fluids for identifying the suspects and victims.
CO4: formulate the methods of DNA profiling for investigation.
CO5: judge the medico-legal post-mortem procedures and their importance.

UNIT I: Introduction to forensic science (15 Hours)

Forensic Science - Definition, history and development of forensic science. Scope and need of forensic science in the present scenario. Branches of forensic science. Tools and techniques of forensic science. Duties of a forensic scientist.

UNIT II: Forensic laboratories layout (15 Hours)

Forensic science laboratories - Organizational setup of a forensic science laboratory. Central and State level laboratories in India. Mobile forensic science laboratory and its functions. Forensic microbiology - Types and identification of microbial organisms of forensic significance.

UNIT III: Forensic serological testing (15 Hours)

Forensic serology - Definition, identification and examination of body fluids - Blood, semen, saliva, sweat and urine. Forensic examination and identification of hair and fibre.

UNIT IV: DNA profiling **(15 Hours)**

DNA profiling - Introduction, history of DNA typing. Extraction of DNA from blood and other biological samples- Organic and Inorganic extraction methods. DNA fingerprinting - RFLP, PCR, STR. DNA testing in disputed paternity.

UNIT V: Forensic toxicology **(15 Hours)**

Forensic toxicology - Introduction and concept of forensic toxicology. Medico-legal post-mortem and their examination (Case Studies). Poisons - Types of poisons and their mode of action.

Learning Resources:

Textbooks

1. Nanda B. B. and Tewari R. K. (2001). *Forensic Science in India: A Vision for the Twenty First Century*. Select Publishers, New Delhi. ISBN-10:8190113526 / ISBN-13:9788190113526.
2. James S. H. and Nordby, J. J. (2015) *Forensic Science: An Introduction to Scientific and Investigative Techniques*. (5th Edition). CRC Press. ISBN-10:9781439853832 / ISBN-13:978-1439853832.
3. Li R. (2015) *Forensic Biology*. (2nd Edition). CRC Press, New York. ISBN-13:978-1-4398-8972-5.
4. Sharma B.R (2020). *Forensic Science in Criminal Investigation and Trials*. (6th Edition) Universal Press.
5. Saferstein R (2017). *Criminalistics- An introduction to Forensic Science.* (12th Edition). Pearson Press.

References

1. Nordby J. J. (2000). Dead *Reckoning. The Art of Forensic Detection*- CRC Press, New York. ISBN:0-8493-8122-3.
2. Saferstein R. and Hall A. B. (2020). *Forensic Science Hand book*, Vol. I, (3rd Edition). CRC Press, New York. ISBN-10:1498720196.
3. Lincoln, P.J. and Thomson, J. (1998). *Forensic DNA Profiling Protocols.* (2nd Edition). Vol. 98. Humana Press. ISBN: 978-0-89603-443-3.
4. ValMcDermid (2014). *Forensics.* (2nd Edition). ISBN 9780802125156.
5. Vincent J , DiMaio., and DiMaio.D (2001). *Forensic Pathology* (2nd Edition). CRC Press.

Websites/ e-Learning Resources

1. http://clsjournal.ascls.org/content/25/2/114
2. https://www.ncbi.nlm.nih.gov/books/NBK234877/
3. https://cisac.fsi.stanford.edu/events/microbial forensics

4. https://www.elsevier.com/books/microbial-forensics/budowle/978-0-12-382006-8
5. https://www.researchgate.net/publication/289542469_Methods_in_microbial_forensics

CO – PSO Mapping

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	2	2	2	2	2	2	2	3
CO2	3	2	1	1	2	3	2	2	2	3
CO3	3	2	2	3	2	2	2	3	2	3
CO4	2	3	2	3	3	2	3	3	3	3
CO5	3	3	3	2	2	3	2	2	2	3
Average	**2.8**	**2.6**	**2**	**2.2**	**2.2**	**2.4**	**2.2**	**2.4**	**2.2**	**3**

High Correlation - 3; Medium Correlation - 2; Low Correlation - 1

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIM4301	**Entrepreneurship in Biobusiness**	**GE**	**4**	**3**

This course is intended for enhancing the understanding of basic concepts by students who would be in the many areas of life. This can favour the students to understand the role and importance of entrepreneurship for economic development. Developing personal creativity with an entrepreneurial initiative, by adopting the key steps in the elaboration of business idea will be the results of this course. Understanding the stages of the entrepreneurial process in biotechnology, and create a business plan. This disseminates knowledge about proposal preparation, funding and facing challenges in bio-business.

Course Outcomes:

At the end of the course, students will be able to

CO1: relate several bio-entrepreneurial ideas in practical framework.
CO2: identify entrepreneurial opportunities in agricultural biotechnology sector.
CO3: construct a business plan for waste water treatment and bio-product development.
CO4: propose commercial production of various therapeutic and fermented products.
CO5: interpret the technological management and Start-up Schemes for bio-business.

UNIT I: Bioentrepreneurship (12 Hours)

Introduction to bio-business, SWOT analysis of bio-business. Development of Entrepreneurship. Stages in entrepreneurial process. Government schemes and funding. Small scale industries - Definition, characteristics, need and rationale.

UNIT II: Entrepreneurship opportunities in agricultural biotechnology (12 Hours)

Business opportunity, Essential requirement, marketing, strategies, schemes, challenges and scope. Case study on Plant cell and tissue culture technique and polyhouse culture. Herbal bulk drug production, nutraceuticals, value added herbal products. Bioethanol production using agricultural waste and algal source. Integration of system biology for agricultural applications. Biosensor development in agri management.

UNIT III: Entrepreneurship opportunities in industrial biotechnology (12 Hours)

Business opportunity, Essential requirement, marketing strategies, schemes, challenges, and scope. Pollution monitoring and Bioremediation for Industrial pollutants. Integrated compost production - microbe enriched compost. Biopesticides. Biofertilizers and Single cell protein.

UNIT IV: Therapeutic and fermented products (12 Hours)

Opportunities in Stem cell production, stem cell bank, production of monoclonal/polyclonal antibodies, secondary metabolite production – antibiotics, probiotics and prebiotics.

UNIT V: Project Management, Technology Management and Start-up Scheme (12 Hours)

Building Biotech business - challenges in Indian context - biotech partners (BIRAC, DBT, Incubation centers. etc.,), operational biotech parks in India. Indian Company act for Biobusiness - schemes and subsidies. Project proposal preparation, Successful start-ups-case study.

Learning Resources:

Textbooks

1. Acton A. Q. (2021). *Biological Pigments - Advances in Research and Application*- (Scholarly Editions). Atlanta, Georgia.ISBN: 978-1-481-68574-0
2. Shimasaki C. (2014). *Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies*- Academic Press. ISBN: 978-0-12-404730-3
3. Stanbury P. F. and Whitaker. A. *Principles of Fermentation Technology*, (3rd Edition). Butterworth-Heinemann. ISBN 10: 0080999530
4. Kumar. A (2020). *Small Business and Entrepreneurship,* Willey Distributions, Dream Tech Press.
5. Redy .A (2015). *An Unfinished Agenda*. ISBN 139780670087808.

References

1. Crueger, W, and Crueger. A. (2017). *Biotechnology: A Text Book of Industrial Microbiology*. (2nd Edition). Medtech. ISBN-10 : 9385998633
2. Teng P. S. (2008). *Bioscience Entrepreneurship in Asia*. World Scientific Publishing Company.
3. Agarwal S., Kumari S. and Khan S. (2021). *Bioentrepreneurship and Transferring Technology into Product Development*. Business Science Reference. ISBN-10 : 1799874125
4. Krishnamurthy A.G. (2017) *Dirubai Ambani Against All Odds*. McGraw Hills.
5. Drucker.P.F. (1985) *Innovation and Entrepreneurship*.

Websites/ e-Learning Resources

1. https://www.profitableventure.com/biotech-business-ideas/
2. https://www.bio-rrad.com/webroot/web/pdf/lse/literature/Biobusiness.pdf
3. https://www.nature.com/articles/s41587-021-01110-3
4. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3003900/
5. https://springhouse.in/government-schemes-every-entrepreneur/

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	2	2	2	2	2	2	2	2	3
CO2	1	2	2	2	2	2	2	2	3	2
CO3	1	2	2	2	2	2	2	2	3	3
CO4	1	2	2	2	2	2	3	3	3	2
CO5	1	2	2	2	2	2	2	2	3	3
Average	**1**	**2**	**2**	**2**	**2**	**2**	**2.2**	**2.2**	**2.8**	**2.6**

High Correlation - 3; Medium Correlation - 2; Low Correlation - 1

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIM4303	**Health and Hygiene**	**GE**	**4**	**3**

This course is designed to address broad spectrum of health-related issues within the industry, community, hospitals and health sector. The content covers up para-medical, administrative, financial, social, informational and occupational aspects around the modern healthcare standards. Studies will include, among others, courses in medical, biological, technological, legal, administrative and social foundations areas. The course provides students with a wider perspective of modern healthcare system and associated health facilities.

Course Outcomes:

At the end of the course, students will be able to

CO1: recall the importance of health determinants and public health standards.
CO2: explain the community health concepts.
CO3: interpret the risk factors for occupational health hazards.
CO4: appraise different health planning systems and educational programmes.
CO5: assess the role of national and international health care agencies in disease control and management.

UNIT I: Health determinants and standards (12 Hours)

Individual health parameters; determinants of health, key health indicators; importance and source of public-health data and health status in India: standards, relevance to social aspects. Future challenges in public health.

UNIT II: Community health concepts (12 Hours)

Determinative factors: Family health history, Physique, Environment, Life-style and Socio cultural aspects. Overview of Healthcare Systems in India; Primary healthcare, hand-washing, immunization, Secondary healthcare, Tertiary healthcare Hospital interventions, intravenous rehydration and surgery.

UNIT III: Occupational health (12 Hours)

Risk factors for disease; Diseases and occupational relevance Drugs, Tobacco and Alcohol: Chemical agents, Effects and Side effects.

UNIT IV: Heath planning and education **(12 Hours)**

Need and Demands, Objectives- Planning Cycle, Management methods, techniques, need and demands – Health Planning and systems in India - History of Public Health in India – role of Union Ministry Health and Family Welfare. Understanding the significance of the environment for human health -Human population pressures and pollution dynamics. Principles and Practices of health education.

UNIT V: Health care agencies **(12 Hours)**

Role of Public, Private and NGOs in Health sector; Expenditure in Health-care Government Plans and Policies in India - UNITAID and Debt2 Health finance schemes; The Global Health Council, The Global Alliance for TB Drug Development, The International AIDS Vaccine Initiative, Malaria Vaccine Initiative, World Health Organization (WHO) and Centre for Disease Control and Prevention (CDC): Organization, Objectives and Role of UN Millennium Development Goals.

Learning Resources

Textbooks

1. Edlin G and Golanty E. (2010). *Health & Wellness.* 10th Ed. Jones & Barlett Publisher.
2. Park, K. (2023). *Parks Textbook Of Preventive And Social Medicine*. India: Bhanot.
3. Skolnik R. (2012). *Global Health 101*. 2nd Ed. Jones & Barlett Learning.
4. Shanmugavel G. (2021). *Text book of public health and hygiene*, Darshan Publishers. ISBN: 9789386739551.
5. Aravind K. (2005). *Health and Hygiene*. Ist Edition, ISBN: 9788189011864.
6. Muir W. A. (1981). *Health and cleanliness*. London: Health and cleanliness council.

References

1. Schneider M. J. (2014). *Introduction to Public Health.* 4th Ed. Jones & Barlett.
2. Talaro K. and Talaro A. (1996). *Foundations in Microbiology*. 2nd Ed. WnC. Brown Publishers, Chicago.
3. Park J. E and Park K. (1989). *Textbook of Preventive and Social Medicine*. 12th Ed. BanarsidasBhanot Publishers, India.
4. Perrin P. (1995). *Handbook on War and Public Health*. International Committee of the Red Cross: Geneva.
5. Kerr C. (1998). *Community Health and Sanitation*. Intermediate Technology Publications. London.

Websites/ e-Learning Resources

1. https://www.unicef.org>wash
2. https://www.chp.gov.hk>health
3. https://www.health.harvard.edu
4. https://www.nia.nih.gov>health
5. https://www.lawinsider.com>health

CO – PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	2	3	2	2	3	3	2	2	3
CO2	2	2	3	2	2	2	2	2	2	2
CO3	2	2	2	2	2	2	2	2	2	3
CO4	2	2	2	2	3	2	3	2	2	2
CO5	2	2	2	2	2	3	2	2	2	3
Average	**2**	**2**	**2.4**	**2**	**2.2**	**2.4**	**2.4**	**2**	**2**	**2.8**

High Correlation - 3; Medium Correlation - 2; Low Correlation - 1

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIM4402	**Medical Bacteriology and Mycology**	**Core**	**5**	**4**

This course helps the learners to acquire knowledge on collection, transportation and processing of various kinds of clinical specimens. It comprehensively explains the morphology, characteristics and pathogenesis of bacteria and fungi. It also discusses the antifungal agents, their importance and various diagnostic methods.

Course Outcomes:

At the end of the course, students will be able to

CO1: relate the collection, transport and processing of different clinical specimens.
CO2: compare the pathogenesis and diagnosis of disease causing Gram-positive bacteria.
CO3: examine the pathogenesis and diagnostic methods to detect disease causing Gram-negative bacteria**.**
CO4: employ various methods to detect superficial fungal infections and apply knowledge on antifungal agents.
CO5: apply various methods to detect systemic and opportunistic fungal infections.

UNIT I: Collection, processing and handling of clinical specimens (15 Hours)

Classification of medically important bacteria, Normal flora of human body, Collection, transport, storage and processing of clinical specimens, Microbiological examination of clinical specimens, antimicrobial susceptibility testing. Handling and maintenance of laboratory animals – Rabbits, guinea pigs and mice.

UNIT II: Bacteriology I (15 Hours)

Morphology, classification, characteristics, pathogenesis, laboratory diagnosis and treatment of diseases caused by species of *Staphylococci, Streptococci, Pneumococci, Neisseriae., Bacillus, Corynebacteria, Mycobacteria* and *Clostridium*.

UNIT III: Bacteriology II (15 Hours)

Morphology, classification, characteristics, pathogenesis, laboratory diagnosis and treatment of diseases caused by Enterobacteriaceae members, *Yersinia, Pseudomonas, Vibrio, Mycoplasma, Helicobacter, Rickettsiae, Chlamydiae, Bordetella, Francisella., Spirochaetes- Leptospira, Treponema* and *Borrelia*. Nosocomial, zoonotic and opportunistic infections -prevention and control.

UNIT IV: Mycology I **(15 Hours)**

Morphology, taxonomy and classification of fungi. Detection and recovery of fungi from clinical specimens. Dermatophytes and agents of superficial mycoses. *Trichophyton, Epidermophyton* and *Microsporum*. Yeasts of medical importance – *Candida* and *Cryptococcus*. Mycotoxins. Antifungal agents, testing methods and quality control.

UNIT V: Mycology II (**15 Hours)**

Dimorphic fungi causing Systemic mycoses, *Histoplasma, Coccidioides, Sporothrix* and *Blastomyces*. Fungi causing Eumycotic Mycetoma, Opportunistic fungi- Fungi causing secondary infections in immunocompromised patients. Immunodiagnostic methods in mycology- Recent advancements in diagnosis. Antifungal agents.

Learning Resources:

Textbooks

1. Sastry, A. S., and Bhat, S. (2021). *Essentials of Medical Microbiology:* (Revised Edition). India: Jaypee Brothers Medical Publishers Pvt. Limited.
2. Kanunga R. (2017). *Ananthanarayanan and Panicker's Text book of Microbiology*. (2017). Orient Longman, Hyderabad.
3. Greenwood, D., Slack, R. B. and Peutherer, J. F. (2012) *Medical Microbiology*, (18th Edition). Churchill Livingstone, London.
4. Finegold, S. M. (2000) *Diagnostic Microbiology,* (10th Edition). C.V. Mosby Company, St. Louis.
5. Alexopoulos C. J., Mims C. W. and Blackwell M. (2007). *Introductory Mycology,* (4th Edition). Wiley Publishers.
6. Chander J. (2018). *Textbook of Medical Mycology*. (4th Edition). Jaypee brothers Medical Publishers.

References

1. Salle A. J. (2007). *Fundamental Principles of Bacteriology*. (4th Edition). Tata McGraw-Hill Publications.
2. Collee J. C. Duguid J. P. Foraser, A. C, and Marimon B. P. (1996). *Mackie & McCartney Practical Medical Microbiology.* 14th edn, Churchill Livingston.
3. Cheesbrough M. (2006). *District Laboratory Practice in Tropical countries*. - Part 22nd edn. Cambridge University Press.
4. Topley and Wilson (1998). *Principles of Bacteriology*. 9th edn. Edward Arnold, London.
5. Murray P. R., Rosenthal K. S. and Michael A. (2013). *Medical Microbiology*. Pfaller. 7th edn. Elsevier, Mosby Saunders.

Websites/ e-Learning Resources

1. http://textbookofbacteriology.net/nd
2. https://microbiologysociety.org/members-outreach-resources/links.html
3. https://www.pathelective.com/micro-resources
4. http://mycology.cornell.edu/fteach.html
5. https://www.adelaide.edu.au/mycology/

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	2	3	2	2	3	2	3
CO2	3	3	3	3	3	3	3	3	2	3
CO3	3	3	3	3	3	3	3	3	2	3
CO4	3	3	3	3	3	2	2	3	2	3
CO5	3	3	3	3	3	2	2	3	2	3
Average	**3**	**3**	**3**	**2.8**	**3**	**2.4**	**2.4**	**3**	**2**	**3**

High Correlation - 3; Medium Correlation - 2; Low Correlation - 1

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIM4404	**Medical Virology and Parasitology**	**Core**	**5**	**4**

This course describes the replication strategy and cultivation methods of viruses. It helps students acquire knowledge about oncogenic virus and human viral infections. It helps to develop diagnostic skills for the identification of viral and parasitic infections.

Course Outcomes:

At the end of the course, students will be able to

CO1: explain the cultivation of viruses by different methods and diagnostic assays.
CO2: compare the symptoms of viral infections and presumptively identify the viral disease.
CO3: interpret the viral biology with host genetics to diagnose and prevent viral diseases.
CO4: analyse the spread, control and prevention of diseases caused by protozoan parasites.
CO5: assess the spread, control and prevention of diseases caused by helminthic parasites.

UNIT I: Introduction to virology (15 Hours)

General properties of viruses - Structure and Classification - viroids, prions, satellite RNAs and virusoids. Cultivation of viruses - embryonated eggs, experimental animals and cell cultures. Purification and Assay of viruses – Physical and Chemical methods (Electron Microscopy, Protein and Nucleic acids studies). Infectivity Assays (Plaque and end-point).

UNIT II: Virology I (15 Hours)

Virus Entry, Host Defenses Against Viral Infections, Epidemiology, pathogenic mechanisms, Pathogenesis, laboratory diagnosis, treatment for the following viruses: DNA Viruses- *Pox* , *Herpes* , *Adeno* , *Papova* and *Hepadna* , RNA Viruses- Picorna, *Orthomyxo*, *Paramyxo*, *Rhabdo*, *Rota*, *HIV* and other *Hepatitis viruses*, *Arbo* – *Dengue virus*, *Ebola virus*, Emerging and reemerging viral infections.

UNIT III: Virology II **(15 Hours)**

Bacterial viruses - ΦX 174, M13, MU, T4, lambda, Pi; Structural organization, life cycle and phage production. Lysogenic cycle- typing and application in bacterial genetics. Diagnosis of viral infections– conventional serological and molecular methods. Antiviral agents and viral vaccines.

UNIT IV: Parasitology I **(15 Hours)**

Introduction to Medical Parasitology – Classification, host-parasite relationships. Epidemiology, life cycle, pathogenic mechanisms, laboratory diagnosis, treatment for the following: Protozoa causing human infections – *Entamoeba,* Aerobic and Anaerobic amoebae, *Giardia, Trichomonas, Balantidium. Toxoplasma, Cryptosporidium, Leishmania,* and *Trypanasoma.*

UNIT V: Parasitology II **(15 Hours)**

Classification, life cycle, pathogenicity, laboratory diagnosis and treatment for parasites – Helminthes - Cestodes – *Taenia solium, T.sSaginata, T. echinococcus*. Trematodes – *Fasciola hepatica, Fasciolopsis buski, Paragonimus, Schistosomes*. Nematodes - *Ascaris, Ankylostoma, Trichuris, Trichinella, Enterobius, Strongyloides* and *Wuchereria*. Other parasites causing infections in immune compromised hosts and AIDS. Cultivation of parasites. Diagnosis of parasitic infections – Serological and molecular diagnosis. Anti-protozoan drugs.

Learning Resources:

Textbooks

1. Sastry, A. S., and Bhat, S. (2021). *Essentials of Medical Microbiology:* (Revised Edition). India: Jaypee Brothers Medical Publishers Pvt. Limited. Kanunga R. (2017). Ananthanarayanan and Panicker's Text book of Microbiology. (10th Edition). Universities Press (India) Pvt. Ltd.
2. Dubey, R. C. and Maheshwari D. K. (2010). *A Text Book of Microbiology*. S. Chand & Co.
3. Rajan S. (2007). *Medical Microbiology*. M. J. P Publisher.
4. Paniker J. (2006). *Textbook of Parasitology*. Jay Pee Brothers, New Delhi.
5. Arora, D. R. and Arora B. B. (2020). *Medical Parasitology*. (5th Edition). CBS Publishers & Distributors Pvt. Ltd. New Delhi.

References

1. Carter J. (2001). *Virology: Principles and Applications* (1st Edition). Wiley Publications.
2. Willey J., Sandman K. and Wood D. (2019) *Prescott's Microbiology*. (11th Edition). McGraw Hill Book.
3. Jawetz E., Melnick J. L. and Adelberg E. A. (2000). *Review of Medical Microbiology*. (19th Edition). Lange Medical Publications, U.S.A.
4. Finegold S. M. (2000). *Diagnostic Microbiology*. (10th Edition). C.V. Mosby Company, St. Louis.

Websites/ e-Learning Resources

1. https://en.wikipedia.org/wiki/Virology
2. https://academic.oup.com/femsre/article/30/3/321/546048
3. https://www.sciencedirect.com/science/article/pii/S0042682215000859
4. https://nptel.ac.in/courses/102/103/102103039/
5. https://www.healthline.com/health/viral-diseases#contagiousness

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	3	3	2	3	3	2	3
CO2	3	3	3	3	3	3	2	3	2	3
CO3	3	3	3	3	3	3	2	3	3	3
CO4	3	3	3	3	3	2	3	3	2	3
CO5	3	3	3	3	3	2	2	3	2	3
Average	**3**	**3**	**3**	**3**	**3**	**2.4**	**2.4**	**3**	**2.2**	**3**

High Correlation - 3; Medium Correlation - 2; Low Correlation - 1

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIM4406	**Molecular Biology and Microbial Genetics**	**Core**	**5**	**4**

This course deals with the essential concepts of molecular biology and microbial genetics. The structure of the genomes, chromosomes, and extrachromosomal inheritance are discussed. It explains the molecular basis of transmission of genetic information from nucleic acids to proteins. It highlights various types of mutations and their repair mechanisms. The course emphasizes the genetics of microbes such as bacteria, phages and yeast.

Course Outcomes:

At the end of the course, students will be able to

CO1: explain the structural organization of nuclear and organelle genome
CO2: describe the mechanism of transcription, translation and gene regulation
CO3: categorize the types of DNA mutation, recombination and DNA repair mechanisms.
CO4: analyse the role of plasmids and phages in microbial genetics.
CO5: appraise the mechanisms of horizontal gene transfer between microbes

UNIT I: Structure of prokaryotic and eukaryotic genome (15 Hours)

Introduction to prokaryotic genomic structure, Extrachromosomal DNA, Eukaryotic Genome - Structure of chromatin, chromosome, centromere, telomere, nucleosome. Modifications- methylation, acetylation, phosphorylation and its effect on structure and function of chromatin, DNA methylation and gene imprinting, organelle genome.

UNIT II: Expression and regulation of genome (15 Hours)

Mechanisms of transcription, RNA splicing, translation, genetic code, transcriptional regulation in prokaryotes and eukaryotes, regulatory RNAs, gene regulation in development and evolution, and systems biology.

UNIT III: DNA damage, repair, mutation and recombination (15 Hours)

Genetic nomenclature - Mutagenesis – causes, types, detection. DNA repair mechanisms. Mutants - isolation and characterization - significance - analysis. - Genetic recombination – homologous and site-specific - mapping - complementation

analysis; Extrachromosomal DNA - purification, replication, amplification, gene transfer and Partitioning.

UNIT IV: Phage and yeast biology (15 Hours)

General properties, structure, stages, counting, Host Restriction and Modification, Lysogenic Cycle; Genetics of Phage T4 - Genetic Mapping; Lytic Growth of Phage λ; Lysogeny; Construction of Phage Mutants; Elements of Yeast Genetics - cell cycle, Mating Type Conversion, Expression and Recombination Paradoxes.

UNIT V: Gene transfer mechanisms (15 Hours)

Transformation– Griffith & Avery and McLeod Experiments - Natural Competence and Artificial Transformation, Conjugation and its types. Transduction- Generalized and Specialized, Transposons - Insertion sequences, complex and compound transposons – Tn10, Tn5- Types of Transposition reactions and Retroposon. Mechanism –Transposons of *E. coli*, Bacteriophage and Yeast. Importance of transposable elements in horizontal transfer of genes and evolution.

Learning Resources:

Textbooks

1. Watson, J. D. (2024). *Molecular biology of the gene*. 8th Ed. Garland Science.
2. Snyder, L. Champness, W and Champness W. (2020). *Molecular Genetics of Bacteria*. 5th Ed American Society for Microbiology

References

1. Maloy S. R. Cronan J. E and Freifelder D. (2004). *Microbial Genetics*. 2nd Ed. Jones and Bartlett publication.
2. Clark, D. P., Pazdernik, N. J., and McGehee, M. R. (2018). *Molecular Biology*. 3rd Ed. Netherlands: Elsevier Science.

Websites/ e-Learning Resources

1. https://microbenotes.com/gene-cloning-requirements-principle-steps-applications/
2. https://courses.lumenlearning.com/boundless-biology/chapter/dna-replication/50
3. Molecular Biology Notes - Microbe Notes
4. Molecular Biology Lecture Notes; Study Materials | Easy Biology Class

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	2	2	3	2	2	3	2	2	3
CO2	3	2	2	3	2	3	3	2	2	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	2	3	2	2	3
CO5	3	3	3	3	3	2	3	2	2	3
Average	**3**	**2.6**	**2.6**	**3**	**2.6**	**2.4**	**3**	**2.2**	**2.2**	**3**

High Correlation - 3; Medium Correlation - 2; Low Correlation - 1

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIM4202	**Medical Microbiology Lab**	**Core**	**3**	**2**

This lab course is designed to give students clinical experience in the area of bacteriology and mycology. Test procedures routinely applied are covered with an emphasis on the isolation, identification, and antimicrobial susceptibility testing of pathogenic microorganisms.

Course Outcomes:

At the end of the course, students will be able to

CO1: demonstrate the collection, transport, culture and examination of different clinical samples.
CO2: practice antibiotic sensitivity tests and compare with the standard.
CO3: identify medically important bacteria, fungi and parasites from the clinical samples by staining and biochemical tests.
CO4: interpret laboratory tests in the diagnosis of infectious diseases.
CO5: design experiments to identify the etiological agents like bacteria, fungi and parasites.

List of Experiments:

1. Staining of clinical specimens - Wet mount, Differential and Special staining methods.
2. Isolation and identification of bacterial pathogens from clinical specimens - cultivation in basal, differential, enriched, selective and special media – Biochemical identification tests.
3. Enumeration of bacteria in urine to detect significant bacteriuria.
4. Antimicrobial sensitivity testing – Kirby-Bauer method and Stokes method.
5. Minimum inhibitory concentration (MIC) test.
6. Minimum bactericidal concentration (MBC) test.
7. Examination of different fungi by Lactophenol cotton blue staining and KOH staining.
8. Cultivation of fungi and their identification - *Mucor, Rhizopus, Aspergillus, Penicillium.*
9. Identification of Dermatophytes.
10. Cultivation of viruses –Egg Inoculation methods.
11. Diagnosis of Viral Infections –ELISA –HIA.
12. Spotters of viral inclusions and CPE-stained smears.
13. Examination of parasites in clinical specimens - Ova/cysts in faeces.

14. Concentration: methods – Floatation methods-simple Saturated salt solution method – Zinc sulphate methods - Sedimentation methods- Formal ether method.
15. Blood smear examination for malarial parasites. Thin smear by Leishman's stain – Thick smear by J.B. stain.
16. Identification of common arthropods of medical importance - spotters of *Anopheles, Glossina, Phlebotomus, Aedes,* Ticks and mites.

Learning Resources:

Textbooks

1. Venkatajothi .R (2021) ,*"Practical Textbook of Medical Microbiology for Medical and Dental Students*. (N.P.): Darshan Publishers.
2. Cullimore D. R. (2010). *Practical Atlas for Bacterial Identification*, 2nd Edition. Publisher-Taylor and Francis.
3. Abbott A. C. (2010). *The Principles of Bacteriology*. Nabu Press.
4. Parija S. C. (2012). *Textbook of Practical Microbiology*. Ahuja Publishing House.
5. Cappuccimo, J. and Sherman, N. (2002) *Microbiology: A Laboratory Manual*, (6th Edition). Pearson Education, Publication, New Delhi.
6. Morag C. and Timbury M. C. (1994). *Medical Virology*. 4th edn. Blackwell Scientific Publishers.

References

1. Collee J. G., Fraser A.G. Marmion B. P. and Simmons A. (1996). *Mackie & McCartney Practical Medical Microbiology*. (14th Edition). Elsevier, New Delhi.
2. Chart H. (2018). *Practical Laboratory Bacteriology*. CRC Press.
3. Moore V. A. (2017). *Laboratory Directions for Beginners in Bacteriology*. Triste Publishing Ltd.
4. Cheesbrough M. (2006). *District Laboratory Practice in Tropical countries*.-Part 22ndEdition.Cambridge University Press.
5. Murray P.R., Rosenthal K.S. and Michael A. (2013). *Medical Microbiology*. Pfaller. 7th Edition. Elsevier, Mosby Saunders.

Websites/ e-Learning Resources

1. http://textbookofbacteriology.net/
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7173454/
3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3768729/
4. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC149666/
5. https://www.intechopen.com/books/current-issues-in-molecular-virology-viral-genetics-and-biotechnological-applications/vaccines-and-antiviral-agents

CO – PSO Mapping

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	2	2	3	2	3	3	2	3
CO2	3	3	3	3	3	2	3	3	2	3
CO3	3	3	3	3	3	2	3	3	3	3
CO4	3	3	3	3	3	2	3	3	3	3
CO5	3	3	3	3	3	2	3	3	2	3
Average	**3**	**3**	**2.8**	**2.8**	**3**	**2**	**3**	**3**	**2.4**	**3**

High Correlation - 3; Medium Correlation - 2; Low Correlation - 1

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIM4204	**Molecular Biology and Microbial Genetics Lab**	**Core**	**3**	**2**

This course provides the students with the hands on experience to isolate nucleic acids and proteins from biological samples and analyze their quantity and quality. This course enhances student's ability to screen and isolate various mutant organisms and phages.

Course Outcomes:

At the end of the course, students will be able to

CO1: use different methods for Genomic and Plasmid DNA isolation.
CO2: estimate the concentration of isolated nucleic acids and protein extraction.
CO3: operate the procedures for DNA and protein separation.
CO4: experiment the methods for detection of gene expression and isolation of mutants.
CO5: practice the methods for phage titration and bacterial conjugation

List of Experiments

1. Isolation of genomic DNA from *E.coli* cells.
2. Isolation of plasmid DNA from *E.coli* cells.
3. Estimation of DNA – UV spectrophotometer.
4. Extraction of protein from animal tissue – Homogenization, Solubilization and ammonium sulphate precipitation.
5. Electrophoretic separation of DNA.
6. Electrophoretic separation of protein – PAGE (Demonstration).
7. Detection of *lac z* gene expression - Blue white screening.
8. Bacterial mutagenesis by physical method – UV.
9. Phage titration.
10. Bacterial conjugation.

Learning Resources:

Textbooks

1. Crichton. M. (2014). *Essentials of Biotechnology*. Scientific International Pvt Ltd. New Delhi.

2. Sambrook J. and Russell D. W. (2012). *Molecular Cloning - A Laboratory Manual* – 7th Edition. Cold Spring Harbor, N.Y: Cold Spring Harbor Laboratory Press.
3. Dale J. W., Schantz M. V. and Plant N. (2012). *From Gene to Genomes – Concepts and Applications of DNA Technology*. (3rd Edition). John Wileys and Sons Ltd.
4. Gunasekaran P. (2007). *Laboratory Manual in Microbiology*. New Age International.
5. Cappucino, J. G and Sherman, N. (2016). *Microbiology – A laboratory manual*. (5th Edition). The Benjamin Publishing Company. New York.

References

1. Glick B. R. and Patten C.L. (2018) *Molecular Biotechnology – Principles and Applications of Recombinant DNA*. 5th Edition. ASM Press.
2. Russell P. J. (2010). *iGenetics - A Molecular Approach*, 3rd Edition., Pearson New International edn.
3. Nelson D.L., Cox M.M. and Lehninger A. L (2017). *Principles of Biochemistry*. 7th Edition, W.H. Freeman.
4. Synder L., Peters J. E., Henkin T.M. and Champness W. (2013). *Molecular Genetics of Bacteria*, 4th edition, ASM Press Washington-D.C. ASM Press.
5. Brown T.A. (2016). *Gene Cloning and DNA Analysis*. (7th Edition). John Wiley and Jones, Ltd.

Web Resources / e-Learning resources

1. https://www.molbiotools.com/usefullinks.html
2. (PDF) Molecular Biology Laboratory manual (researchgate.net)
3. https://www.molbiotools.com/usefullinks.html
4. https://geneticgenie.org.
5. https://currentprotocols.onlinelibrary.wiley.com/doi/pdf/10.1002/cpet

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	3	2	2	3	2	2	3
CO2	3	3	3	3	3	2	3	2	2	3
CO3	3	3	3	2	2	2	3	2	2	3
CO4	3	3	3	3	3	2	3	3	3	3
CO5	3	3	3	3	3	2	3	3	3	3
Average	**3**	**3**	**3**	**2.8**	**2.6**	**2**	**3**	**2.4**	**2.4**	**3**

High Correlation - 3; Medium Correlation - 2; Low Correlation - 1

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIM4408	**Bioinformatics**	**DSE**	**5**	**4**

This course discusses the various biological data mining concepts and tools. It helps to understand the principles and applications of sequence alignment methods and tools. It provides knowledge on different phylogenetic tree construction methods and their uses in phylogenetic analysis. It also provides insight into various tools and techniques used in molecular docking, immunoinformatics and subtractive genomics.

Course Outcomes:

At the end of the course, students will be able to

CO1: identify databases that provide information on nucleic acids & proteins and create algorithms for sequence alignment.
CO2: construct phylogenetic tree.
CO3: predict the structure of proteins using various tools.
CO4: analyse the properties of ligands.
CO5: design drugs by predicting drug-ligand interactions and molecular docking.

UNIT I: Data mining and sequence alignment (15 Hours)

Biological Data Mining – Exploration of Data Mining Tools. Cluster Analysis Methods. Data Visualization. Biological Data Management. Biological Algorithms – Biological Primary and Derived Databases. Concept of Alignment, Pairwise Sequence Alignment (PSA), Multiple Sequence Alignment (MSA), BLAST, CLUSTALW, Scoring Matrices, Percent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM).

UNIT II: Phylogenetic analysis (15 Hours)

Phylogenetic Tree Construction - Concept of Dendrograms. Evolutionary Trees - Distance Based Tree Reconstruction - Ultrametric trees and Ultrametric distances – Reconstructing Trees from Additive Matrices - Evolutionary Trees and Hierarchical Clustering - Character Based Tree Reconstruction - Maximum Parsimony Method, Maximum likelihood method - Reliability of Trees – Substitution matrices – Evolutionary models.

UNIT III: Protein structure prediction & visualization (15 Hours)

Computational Protein Structure prediction – Secondary structure – Homology modelling- Fold recognition and ab-initio 3D structure prediction – Structure comparison and alignment – Prediction of function from structure. Geometrical parameters – Potential energy surfaces – Hardware and Software requirements- Molecular graphics – Molecular file formats- Molecular visualization tools.

UNIT IV: Properties of ligands (15 Hours)

Compound databases – Tools to draw compound structures- Comparative Molecular Field Analysis – 4 D QSAR –HYBOT Descriptors – Structure Descriptors – Applications – Linear Free Energy Relationships – Quantity Structure - Property Relationships –Prediction of the Toxicity of Compounds.

UNIT V: Molecular docking simulation (15 Hours)

Molecular Docking- Flexible - Rigid docking-Target- Ligand preparation-Solvent accessibility- Surface volume calculation, Active site prediction- Docking algorithms- Genetic, Lamarckian - Docking analyses- Molecular interactions, bonded and nonbonded - Molecular Docking Software and Working Methods. Genome to drug discovery – Subtractive Genomics – Principles of Immunoinformatics and Vaccine Development.

Learning Resources:

Textbooks

1. Lesk A. M. (2019). *Introduction to Bioinformatics*. (5th Edition). Oxford University Press.
2. Helen, S. G. H. (2021). *Basic Bioinformatics*. India: MJP Publisher.
3. Lengauer T. (2008). *Bioinformatics- from Genomes to Therapies* (Vol-1). Wiley- VCH.
4. Rastogi S. C., Mendiratta N. and Rastogi P. (2022). *Bioinformatics - Methods and Applications* (Genomics, Proteomics and Drug Discovery) (5th Edition). Prentice-Hall of India Pvt. Ltd.
5. Attwood, T.K. and Parry-Smith, D.J. (1999). *Introduction to Bioinformatics.* Addision Wesley Longman Limited, England.
6. Mount D.W., (2013). *Bioinformatics sequence and genome analysis*, 2nd edn.CBS Publishers, New Delhi.

References

1. Baxevanis A. D. and Ouellette F. (2004). *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins.* (2nd Edition). John Wiley and Sons.

2. Bosu O. and Kaur S. (2007). *Bioinformatics - Database, Tools, and Algorithms*. Oxford University Press.
3. David W. M. (2001). *Bioinformatics Sequence and Genome Analysis* (2nd Edition). CBS Publishers and Distributors (Pvt.) Ltd.
4. Xiong J, (2011). *Essential bioinformatics*, First south Indian Edition, Cambridge University Press.
5. Harshawardhan P. Bal (2006). *Bioinformatics Principles and Applications*, Tata McGraw-Hill Publishing Company Limited.

Websites/ e-Learning Resources

1. https://www.hsls.pitt.edu/obrc/
2. https://www.hsls.pitt.edu/obrc/index.php?page=dna
3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1669712/
4. https://www.kegg.jp/kegg/kegg2.html
5. https://www.ebi.ac.uk/

CO – PSO Mapping

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	2	2	1	2	3	3	2	1	3	2
CO2	2	2	1	2	3	3	2	1	3	2
CO3	2	2	1	2	3	3	2	1	3	2
CO4	2	2	1	2	3	3	2	1	2	2
CO5	2	2	1	2	3	3	2	1	2	2
Average	**2**	**2**	**1**	**2**	**3**	**3**	**2**	**1**	**2.6**	**2**

High Correlation - 3; Medium Correlation - 2; Low Correlation - 1

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIM4410	Basics of Scientific Writing	DSE	5	4

This course is intended to empower students with professional academic writing for biological sciences. It emphasizes on the precision, clarity and other technical skills necessary for writing a research related document. It also deals with writing exercises that involves grammar, sentence construction, paragraph writing, components of research paper such as title, abstract, materials and methods, interpretation of results and its discussion. It also can enrich the students with vocabulary and technical terms used in life science research. Students will become familiar with citing references, their formats, as well as the different types of plagiarism. It will also aid the students with professional standards for communication with the use of digital platforms.

Course Outcomes:

At the end of the course, students will be able to

CO1: recall the formation of correct sentences to paragraphs
CO2: prepare a scientific report
CO3: identify reference formats and avoid plagiarism
CO4: recognize and apply diverse scientific terminologies and vocabulary
CO5: construct emails, letters, oral as well as poster presentations

UNIT I: Grammar for academic writing (15 Hours)

Articles, Subject-verb agreement, Prepositions, Sentence construction, Participle clauses, Verb patterns, punctuation.

UNIT II: Organizing a scientific report (15 Hours)

Writing Exercises on Titles, Abstract, Materials and Methods**,** Results and Discussion.

UNIT III: Bibliography and plagiarism (15 Hours)

Reading exercises, Reference Formats, types of plagiarism, Plagiarism checker software.

UNIT IV: Expressions and vocabulary in science (15 Hours)

Exercises on words that are often confused, Unnecessarily complex words, Empty, wordy and redundant expressions.

UNIT V: Presentations, Emails and Cover letters (15 Hours)

Writing exercises on preparing oral and poster presentation, framing email and cover letters.

Learning Resources:

Textbooks

1. Giba, J. (2014). *Developing skills in scientific writing*. Esteve Foundation.

References

1. Viallard, M. L. (2013). *Mastering Scientific and Medical Writing. A Self-Help Guide*. SM Rogers, Springer.
2. Wallwork, A. (2012). *English for Academic Research: Writing Exercises*. Springer Science & Business Media.

CO – PSO Mapping

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	1	1	3	3	2	2	2	3
CO2	3	3	1	1	3	3	2	2	2	3
CO3	3	2	1	1	2	3	2	2	2	3
CO4	3	3	1	1	3	3	2	2	2	3
CO5	3	3	1	1	3	3	2	1	2	3
Average	**3**	**2.8**	**1**	**1**	**2.8**	**3**	**2**	**1.8**	**2**	**3**

High Correlation - 3; Medium Correlation - 2; Low Correlation - 1

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIM4302	**Epidemiology**	**GE**	**4**	**3**

This course discusses the role of epidemiology in public health. It explains the epidemiology tools and disease surveillance methods and helps to analyse various communicable and non-communicable diseases in India. It deals with the mechanism of antimicrobial resistance. It provides an outline on national health programmes that have been designed to address the issues.

Course Outcomes:

At the end of the course, students will be able to

CO1: recall the fundamental concepts of epidemiology.
CO2: explain the various tools of epidemiology.
CO3: compare the epidemiology of communicable and non-communicable diseases.
CO4: analyze the implications of drug resistance and strategies to control.
CO5: assess Nation-wide control programmes related to communicable and non-Communicable diseases

UNIT I: Fundamentals of epidemiology (12 Hours)

Definitions of epidemiology – Epidemiology of infectious diseases in Public Health. Natural history of disease - Historical aspects of epidemiology. Common risk factors - Epidemiologic Triad - Agent factors, host factors and environmental factors. Transmission basics - Chain of infection, portal of entry. Modes of transmission - Direct and indirect. Stages of infectious diseases. Agents and vectors of communicable diseases of public health importance and dynamics of disease transmission. Epidemiology of Zoonosis - Factors, routes of transmission of bacterial, viral, parasitic and fungal zoonotic agents. Control of zoonosis.

UNIT II: Tools of epidemiology (12 Hours)

Measures of Disease - Prevalence, incidence. Index case. Risk rates. Descriptive Epidemiology - Cohort studies, measuring infectivity, survey methodology including census procedures. Surveillance strategies - Disease surveillance, geographical indication system, outbreak investigation in public health and contact investigation.

UNIT III: Epidemiological aspects of diseases of national importance (12 Hours)

Background to communicable and non-communicable diseases. Vector borne diseases in India. Diarrhoeal diseases. Zoonoses. Viral haemorrhagic fevers. Mycobacterial infections. Sexually transmitted diseases. Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome (HIV/AIDS). Emerging disease threats - Severe Acute Respiratory Syndrome (SARS), Covid-19, Ebola, MDR-TB, Malaria, Mucor mycosis, Avian flu. Dengue, Swine Flu, Chikungunya. Epidemiology, prevention, and control of non-communicable diseases - Asthma, Coronary heart disease, Malignancy, diabetes mellitus, respiratory diseases, eye diseases, Dental disorders. Emerging and Re-emerging Diseases.

UNIT IV: Mechanisms of antimicrobial resistance (12 Hours)

Multidrug Efflux pumps, Extended Spectrum β-lactamases (ESBL). Hospital acquired infections - Factors, infection sites, mechanisms, Role of Multidrug resistant pathogens. Role of *Pseudomonas, Acinetobacter, Clostridium difficile,* HBV, HCV, Rotavirus, *Cryptosporidium* and *Aspergillus* in Nosocomial infections. Prevention and management of nosocomial infections.

UNIT V: National programmes related to communicable and non-communicable diseases (12 Hours)

National Malaria Eradication Programme, Revised National Tuberculosis Control Programme, Vector-Borne Disease Control Programme, National AIDS Control Programme, National Cancer Control Programme and National Diabetes Control Programme. Biochemical and immunological tools in epidemiology - Biotyping, Serotyping, Phage typing, FAME (Fatty acid methyl ester analysis), Curie Point PyMS (Pyrolysis Mass spectrometry), Protein profiling and Molecular typing methods.

Learning Resources:

Textbooks

1. Dicker R., Coronado F., Koo. D. and Parrish. R. G. (2012). *Principles of Epidemiology in Public Health Practice*. (3rd Edition). CDC.
2. Gerstman B. (2013). *Epidemiology Kept Simple: An Introduction to Classic and Modern Epidemiology*. (3rd Edition). Wiley Blackwell.
3. Greenwood, D., Slack, R. B. and Peutherer, J. F. (2012) *Medical Microbiology*, (18th Edition). Churchill Livingstone, London.
4. Jawetz E., Melnick J. L. and Adelberg E. A. (2000). *Review of Medical Microbiology*. (19th Edition). Lange Medical Publications, U.S.A.
5. Dimmok N. J. and Primrose S. B. (1994). *Introduction to Modern Virology*. 5thedn. Blackwell Scientific Publishers.

6. Bouter.L , Zeergers M, and Tianjing L. (2023) *Text book of Epidemiology*, (2nd edition). Wiley – Blackwell.

References

1. Bhopal R. S. (2016). *Concepts of Epidemiology - An Integrated Introduction to the Ideas, Theories, Principles and Methods of Epidemiology*. (3rd Edition). Oxford University Press, New York.
2. Celentano D. D. and Szklo M. (2018). *Gordis Epidemiology*. (6th Edition). Elsevier, USA.
3. Cheesbrough, M. (2004). *District Laboratory Practice in Tropical Countries - Part 2*, (2nd Edition). Cambridge University Press.
4. Ryan K. J. and Ray C. G. (2004). *Sherris Medical Microbiology*. (4th Edition), McGraw Hill, New York.
5. Topley W.W. C., Wilson, G. S., Parker M. T. and Collier L. H. (1998). *Principles of Bacteriology*. (9th Edition). Edward Arnold, London.

Websites/ e-Learning Resources

1. https://www.scielo.br/j/rbca/a/mjDFGTtfWtBm786ZmR9TG9d/?lang=en
2. https://hal.archives-ouvertes.fr/hal-00902711/document
3. https://www.who.int/csr/resources/publications/whocdscsreph200212.pdf
4. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7187955/
5. https://www.who.int/diseasecontrol_emergencies/publications/idhe_2009_london_out breaks.pdf

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	1	2	2	2	1	2	2	2
CO2	2	2	1	2	2	2	1	2	2	2
CO3	2	2	1	3	2	2	1	2	2	2
CO4	2	2	1	2	2	2	1	2	3	2
CO5	2	2	1	3	2	2	1	2	3	2
Average	**2**	**2**	**1**	**2.4**	**2**	**2**	**1**	**2**	**2.4**	**2**

High Correlation - 3; Medium Correlation - 2; Low Correlation - 1

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIM4304	**Vermitechnology**	**GE**	**4**	**3**

This course discusses the earthworm's life cycle and reproduction. The principles of vermicomposting and the types of organic waste are highlighted. The benefits and applications along with their value added products have been emphasized.

Course Outcomes:

At the end of the course, students will be able to

CO1: discuss the concepts of vermicomposting.
CO2: explain the physiology, anatomy and biology of earthworms.
CO3: practice the production of vermicompost.
CO4: analyze the trouble shooting, harvesting and packaging of vermicompost.
CO5: appraise the applications of vermicompost and their value added products.

UNIT I: Introduction to vermiculture (12 Hours)

Introduction to Vermiculture - Definition, classification, history, economic importance - sustainable agriculture, organic farming, earthworm activities, soil fertility & texture, soil aeration, water impercolation, decomposition and moisture, bait & food and their value in maintenance of soil structure. Its role in the bio-transformation of the residues generated by human activity and production of organic fertilizers. Choosing the right worm. Useful species of earthworms. Local species of earthworms. Exotic species of earthworms. Factors affecting distribution of earthworms in soil.

UNIT II: Earthworm biology (12 Hours)

Earthworm Biology and Rearing - Key to identify the species of earthworms. Biology of *Eisenia fetida*. a) Taxonomy, Anatomy, Physiology and reproduction of Lumbricidae. b) Vital cycle of *Eisenia fetida*: alimentation, fecundity, annual reproducer potential and limiting factors (gases, diet, humidity, temperature, pH, light, and climatic factors). Biology of *Eudrilus eugeniae*. c) Taxonomy, Anatomy, Physiology and reproduction of Eudrilidae. d) Vital cycle of *Eudrilus eugeniae*: alimentation, fecundity, annual reproducer potential and limit factors (gases, diet, humidity, temperature, pH, light, and climatic factors).

UNIT III: Vermicomposting process **(12 Hours)**

Vermicomposting Process - Feeds for Vermitech systems- Animal manures- Kitchen Waste and Urban waste- Paper pulp and card board solids- Compost and waste products- Industrial Wastes. Vermicomposting Basic process- Initial pre-composting phase- Mesophilic phase- Maturing and stabilization phase- Mechanism of Earthworm's action. Methods of vermicomposting- a) windrows system; b) wedge system; c) container system-pits, tanks & cement rings; commercial model; beds or bins-top fed type, stacked type, d) Continuous flow system.

UNIT IV: Harvesting and packaging **(12 Hours)**

Vermicomposting - Trouble Shooting-Temperature-Aeration- Acidity- Pests and Diseases- Ants, rodents, Birds, Centipedes, sour crop, Mite pests. Odour problems. Separation techniques- Light Separation-Sideways Separation-Vertical Separation-Gradual transfer. Harvesting Earthworms- manual method- migration method. Packing & Nutritional analysis of vermicompost.

UNIT V: Applications of vermiculture **(12 Hours)**

Applications of Vermiculture - Vermiculture Bio-technology, use of vermi castings in organic farming/horticulture, as feed/bait for capture/culture fisheries; forest regeneration. Application quantity of vermicompost in Agricultural fields- crops, fruits, vegetables & flowers. By-products and value-added products- Vermi wash-vermicompost, tea-vermi meal-enriched vermicompost-pelleted vermicompost.

Learning Resources:

Textbooks

1. Ismail S. A. (2005). *The Earthworm Book, Second Revised Edition*. Other India Press, Goa, India.
2. Rathoure A. K., Bharati P. K. and Ray J. (2020). *Vermitechnology, Farm and Fertilizer.* Vermitechnology, Farm and Fertilizer Discovery Publishing House Pvt Ltd.
3. Christy M. V. (2008). *Vermitechnology*, (1st Edition), MJP Publishers.
4. *The Complete Technology Book on Vermiculture and Vermicompost with manufacturing Process*, (2004) Machinery Equipment Details and Plant Layout. AB Press.
5. Singh . K (2014). *A Textbook of Vermicompost: Vermiwash and Biopesticide*.

References

1. Roy D. (2018). *Handbook of Vermitechnology*. Lambert Academic Publishing.
2. Kumar A. (2005). *Verms and Vermitechnology*, A.P.H. Publishing Corporation, New Delhi.
3. Lekshmy M. S. and Santhi R. (2012). *Vermitechnology*, Sara Publications, New Delhi, India.
4. Edwards C. A., Arancon N. Q. and Sherman R. L. (2011) *Vermiculture Technology: Earthworms, Organic Wastes, and Environmental Management* 1st edn. CRC Press.
5. Ismail, S.A. (1997). *Vermicology-The Biology of Earthworm*. 1st edn. Orient Longman.

Websites/ e-Learning Resources

1. https://en.wikipedia.org/wiki/Vermicompost
2. http://stjosephs.edu.in/upload/papers/9567411a78c63d4ccfbbe85e6aa22840.pdf
3. https://www.kngac.ac.in/elearning_portal/ec/admin/contents/4_18K4ZEL02_2021012803204629.pdf
4. https://composting.ces.ncsu.edu/vermicomposting-2/
5. https://rodaleinstitute.org/science/articles/vermicomposting-for-beginners/

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	1	2	2	2	2	2	1	2	2
CO2	1	1	2	2	2	2	2	1	2	2
CO3	1	1	2	2	2	2	2	1	3	2
CO4	1	1	2	2	2	2	2	1	3	2
CO5	1	1	2	2	2	2	3	1	3	2
Average	**1**	**1**	**2**	**2**	**2**	**2**	**2.2**	**1**	**2.6**	**2**

High Correlation - 3; Medium Correlation - 2; Low Correlation - 1

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIM5501	**Immunology and Immunomics**	**Core**	**6**	**5**

This course introduces the fundamental concepts of Immunology. Topics covered are the basic elements of immune system including lymphoid tissues/ organs and cells. It also deals with the acquired immune response and Hypersensitivity mediated reactions. It also emphasizes the diagnostic techniques and highlights on the immunomics for vaccine development.

Course Outcomes:

At the end of the course, students will be able to

CO1: underline different immune cells and organs involved in immunity.
CO2: compare the acquired immune response to a variety of antigens.
CO3: interpret the significance of Hypersensitivity reactions & mechanisms of immune regulation.
CO4: analyze samples using immunological assays.
CO5: appraise the concepts of vaccine development and applications of immunomics.

UNIT I: Introduction to the immune system (18 Hours)

Introduction to biology of the immune system – Cells and organs (primary & secondary lymphoid organs) of Immune System. T and B lymphocytes – Origin, development, differentiation, lymphocyte subpopulation in humans. Innate immunity- Complement, Toll-like receptors and other components. Acquired immunity – Active and Passive immunity. Antigens - features associated with antigenicity and immunogenicity. Basis of antigen specificity. MHC genes and products, Structure of MHC molecules, Genetics of HLA Systems – Antigens and HLA typing. Antigen processing and presentation to T- lymphocytes.

UNIT II: Acquired immune response (18 Hours)

Immunoglobulins, Theories of antibody production. Class switching and generation of antibody diversity. Monoclonal and polyclonal antibodies. Complement system – mode of activation- Classical, Alternate and Lectin pathways, biological functions.

Antigen recognition – TCR, Diversity of TCR, T cell surface alloantigens, lymphocyte activation, clonal proliferation and differentiation. Physiology of acquired immune response – various phases of HI, CMI – Cell mediated cytotoxicity.

UNIT III: Hypersensitivity & Immune regulated mechanisms (18 Hours)

Hypersensitivity – Types and mechanisms, Autoimmunity, Tumor Immunity and Transplantation immunology. Immunodeficiency-Primary immunodeficiency and Secondary immunodeficiencies. Genetics of Immunohematology – Genetic basis and significance of ABO and other minor blood groups in humans, Bombay blood group, Secretors and Non-secretors, Rh System and genetic basis of D- antigens.
Immune regulation mechanisms – immuno-induction, immuno- suppression, immuno-tolerance, immuno-potentiation, Immunomodulation. Role of cytokines, lymphokines and chemokines.

UNIT IV: Diagnostic immunology (18 Hours)

Diagnostic Immunology - Precipitation reaction, Immunodiffusion methods - SRID, ODD. Immunoelectrophoresis - Rocket and Counter current electrophoresis. Agglutination - Hemagglutination - Hemagglutination inhibition. Labeled Assay-Immunofluorescence assay, Radio immunoassay, FISH, ELISA. Flow cytometry.

UNIT V: Vaccines & Immunomics (18 Hours)

Introduction to Vaccines and Adjuvants - Types of vaccines. Development of vaccines and antibodies in plants.
Immunomics - Introduction and Applications. Antigen engineering for better immunogenicity and use for vaccine development-multiepitope vaccines. Reverse vaccinology.

Learning Resources:

Textbooks

1. Abbas A. K., Lichtman A. H. and Pillai S. (2021). *Cellular and Molecular Immunology*. (10th Edition). Elsevier.
2. Owen J. A., Punt J and Stranford S. A. (2018). *Kuby Immunology*. 8th Ed. WH Freeman and Company, New York.
3. Coico R., Sunshine G. and Benjamini E. (2015). *Immunology – A Short Course.* (7th Edition). Wiley-Blackwell, New York.
4. Delves P. J., Martin S. J., Burton D. R. and Roitt I. M. (2017). *Essential Immunology*. 13th Ed. Blackwell Pub Ltd, UK
5. Flower DR and Perrie Y (2012). *Immunomic Discovery of Adjuvants and Candidate Subunit Vaccines*. Springer Science & Business Media, New York.

References

1. Travers J. (1997). *Immunobiology - The Immune System in Health and Disease*. (3rd Edition). Current Biology Ltd. New York.
2. Delves P. J., Martin S., Burton D. R. and Roitt I. M. (2006). *Roitt's Essential Immunology*. (11th Edition). Wiley-Blackwell.
3. Hay F. C. and Westwood O. M. R. (2002). *Practical Immunology* (4th Edition). Wiley-Blackwell.
4. Pier G. B., Lyczak J. B and Wetzler L. M. (2004). *Immunology, Infection, and Immunity*. ASM press.
5. Murphy K. and Weaver C. (2017). *Janeway's Immunobiology* (9th edition). Garland Science, New York and London.

Websites/ e-Learning Resources

1. https://www.ncbi.nlm.nih.gov/books/NBK279395/.
2. https://med.stanford.edu/immunol/phd-program/ebook.html.
3. https://ocw.mit.edu/courses/hst-176-cellular-and-molecular-immunology-fall-2005/pages/lecture-notes/.
4. Immunology Overview - Medical Microbiology - NCBI Bookshelf (nih.gov).

CO – PSO Mapping

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PSO 8**	**PSO 9**	**PSO 10**
CO1	3	3	1	1	1	3	2	2	2	3
CO2	3	3	2	3	1	2	3	2	2	3
CO3	3	3	2	2	1	3	2	2	2	3
CO4	3	3	2	3	3	2	2	2	3	3
CO5	3	3	2	3	2	2	3	2	3	3
Average	**3**	**3**	**1.8**	**2.4**	**1.6**	**2.4**	**2.4**	**2**	**2.4**	**3**

High Correlation - 3; Medium Correlation - 2; Low Correlation - 1

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIM5503	Recombinant DNA Technology and Biotechnology	Core	6	5

This course aims to impart principles of rDNA technology and the molecular tools employed in gene cloning. It discusses the importance of various gene transfer methods of importance in biotechnology. The significance of PCR and gene sequencing is emphasized. Basics of animal cell and plant tissue culture methods are explained. The crucial role of rDNA technology in human life is laid out with different examples.

Course Outcomes:

At the end of the course, students will be able to

CO1: list the steps involved in introduction and expression of foreign DNA into bacteria, animal and plants cells and their screening.
CO2: discuss the various cloning vectors and their applications.
CO3: assess the usage and advantages of molecular tools.
CO4: compare plant and animal tissue culture protocols.
CO5: evaluate the applications of genetic engineering and gene therapy.

UNIT I: Tools and methods in gene cloning. (18 Hours)

Restriction endonucleases – nomenclature, classification and characteristics - DNA methylases, DNA polymerases, Ligases. Adapters, linkers and homopolymer tailing. Artificial gene transfer techniques - electroporation, microinjection, protoplast fusion and microparticle bombardment – chemical methods. Screening for recombinants.

UNIT II: Cloning and expression vectors (18 Hours)

Gene cloning vectors for prokaryotes and eukaryotes - cloning properties and types of plasmids vectors (pBR322 and derivatives, pUC vectors and pGEM3Z) - Phage Vectors (M13 and Lambda), cosmids, phasmids, phagemids and BACs - Eukaryotic vectors - Yeast vectors – Animal and plant vectors – expression vectors. Shuttle vectors - Expression of foreign genes in bacteria, animals, plants, algae and fungi – merits and demerits.

UNIT III: Molecular Tools used in rDNA technology (18 Hours)

Genomic DNA and cDNA library- Construction and Screening. Techniques in genetic engineering Characterization of cloned DNA: Hybrid arrested translation (HAT) - Restriction mapping - restriction fragment length polymorphism (RFLP) - Polymerase chain reaction (PCR)- Principles, types and their applications. DNA sequencing - Primer walking, Sanger's method and automated sequencing methods. Pyrosequencing – DNA chips and micro array. Protein engineering and techniques - Site directed mutagenesis - Applications of protein engineering.

UNIT IV: Plant and Animal biotechnology (18 Hours)

Plant biotechnology- constituents and concepts of sterilization - preparation, isolation and selection of explant. Suspension cell culture, callus culture, protoplast isolation, culture & fusion. Anther and pollen culture for production. Animal biotechnology- equipment and media used for animal cell culture technology. Primary and established cell line culture and culture media - Serum and serum free media. Cell viability and cytotoxicity. Applications of animal cell culture.

UNIT V: Applications of genetic engineering (18 Hours)

Applications of Genetic Engineering - transgenic animals, Recombinant Cytokines and their use in the treatment of animal infections. Monoclonal Antibodies in Therapy- Vaccines and their Applications in Animal Infections - Human Gene Therapy- Germline and Somatic Cell Therapy- *Ex-vivo* Gene Therapy. *In-vivo* Gene Therapy. Vectors in Gene Therapy- Viral and Non-Viral Vectors. Transgenic Plants.

Learning Resources:

Textbooks

1. Brown T. A. (2020). *Gene Cloning and DNA Analysis*. 8th Edition. John Wiley and Jones, Ltd.
2. Dale J. W., Schantz M.V. and Plant N. (2012). *From Gene to Genomes – Concepts and Applications of DNA Technology.* 3rd Edition. John Wiley and Sons Ltd.
3. Chaudhuri . K (2013). *Recombinant DNA Technology*. The Energy and Resources Institute.
4. Ijaz . S and Haq I. U (2019). *Recombinant DNA Technology*. Cambridge Scholars Publishing.
5. Jain . M (2012). *Recombinant DNA Techniques: A Textbook*, 1st Edition, Alpha Science International Ltd.
6. Maloy S. R. Cronan J. E. and Freifelder D. (2011). *Microbial Genetics*. (2nd Edition). Narosa Publishing House Pvt. Ltd.
7. Glick, B. R. (2020). *Medical Biotechnology*. United States: Wiley.

8. Freshney I, (2005), *Culture of Animal cells, A manual of Basic Technique*. 5th edition, A. John Wiley & Sons, INC, Publication.

References

1. Maloy S. R., Cronan J. E and Freifelder D. (2011). *Microbial Genetics*. 2nd Edition. Narosa Publishing Home Pvt Ltd.
2. Glick B. R. and Patten C.L. (2018). *Molecular Biotechnology- Principles and Applications of Recombinant DNA.* 5th Edition. ASM Press.
3. Russell P. J. (2010). *iGenetics - A Molecular Approach*, 3rd Edition. Pearson New International Edition.
4. Synder L., Peters J. E., Henkin T. M. and Champness W. (2013). *Molecular Genetics of Bacteria*, 4th Edition. ASM Press Washington-D.C. ASM Press.
5. James D. Watson, Michael Gilman, Jan Witkowski, and Mark Zoller (1992). *Recombinant DNA.* Scientific American Books.
6. Russell P. J. (2010). *Genetics - A Molecular Approach*. (3rd Edition). Pearson New International Edition.
7. Dale J. W., Schantz M.V. and Plant N. (2012). *From Gene to Genomes – Concepts and Applications of DNA Technology*. (3rd Edition). John Wileys and Sons Ltd.
8. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., Losick, R. (2013). *Molecular Biology of the Gene*. (n.p.): Pearson Education.

Websites/ e-Learning Resources

1. https://microbenotes.com/gene-cloning-requirements-principle-steps-applications/
2. https://geneticeducation.co.in/what-is-transcriptomics
3. https://www.molbiotools.com/usefullinks.html
4. https://geneticeducation.co.in/what-is-transcriptomics
5. https://courses.lumenlearning.com/boundless-biology/chapter/dna-replication/

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	3	2	3	3	3	2	3
CO2	3	3	3	3	2	3	3	3	2	3
CO3	3	3	2	2	2	3	2	3	2	3
CO4	3	3	2	2	2	3	2	3	2	3
CO5	3	3	2	2	3	3	2	3	2	3
Average	**3**	**3**	**2.4**	**2.4**	**2.2**	**3**	**2.4**	**3**	**2**	**3**

*High Correlation = 3; Medium Correlation = 2; Low Correlation = 1

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIM5505	**Fermentation Technology and Pharmaceutical Microbiology**	**Core**	**5**	**5**

This course deals with the concepts in bioprocess, screening, preservation and improvement of industrially important strains. Emphasis will be given on fermenter design, its types and fermentation economics. It also provides knowledge on the recovery and purification of intracellular and extracellular products. Importance is also given to the basic concepts of pharmaceutical microbiology, production of pharmaceutical products and quality assurance.

Course Outcomes:

At the end of the course, students will be able to

CO1: discuss the concepts in bioprocess, screening, preservation and strain improvement
CO2: construct fermenter and its types.
CO3: illustrate the effective recovery and purification of the products.
CO4: analyze the significance of pharmaceutical microbiology.
CO5: formulate methods for the production of pharmaceutical products and their quality assurance

UNIT I: Bioprocesses concepts and design (**15 Hours)**

Bioprocesses - concepts and design. Industrially important microorganisms – Isolation, primary and secondary screening, preservation and improvement of industrially important strains. Upstream processing - Development of inoculum for fermentation process. Media for industrial fermentation - Formulation, optimization – classical and statistical methods, and sterilization. Stages of upstream - fermenter pre-culture and production. Types of fermentation - Batch, continuous, dual or multiple, surface, submerged, aerobic and anaerobic.

UNIT II: Fermenter **(15 Hours)**

Fermenter – Design, types, construction, functioning and control. Productivity and Yield coefficients. Heat production, Aeration and agitation, Gas exchange and mass transfer. Computer Applications in fermentation technology. Fermentation Economics.

UNIT III: Downstream processing **(15 Hours)**

Downstream Processing - Recovery and purification of intracellular and extracellular products. Biomass separation by centrifugation, filtration and flocculation. Cell disintegration - Physical, chemical and enzymatic methods. Extraction - Solvent, two phase, liquid extraction, whole broth and aqueous multiphase extraction. Purification by different methods. Concentration by precipitation, ultra-filtration, reverse osmosis. Drying and crystallization.

UNIT IV: Overview of pharmaceutical microbiology **(15 Hours)**

Overview of pharmaceutical microbiology - Occurrence of microorganisms - Atmosphere, water, skin, respiratory flora of workers, raw materials, packaging, building equipment and their control measures. Design and layout of sterile manufacturing unit. Contamination and Spoilage of Pharmaceutical products - sterile injectable and non-injectable, ophthalmologic preparation and implants.

UNIT V: Production of pharmaceutical products and quality assurance **(15 Hours)**

Production of pharmaceutical products and quality assurance – Vaccines – Live attenuated (small pox), Inactivated (polio), Subunit/Recombinant (hepatitis-B), Toxoid (tetanus) - immunodiagnostics, immuno-sera, anti-immuno-sera, immunoglobulins. Antibiotics - Penicillin, Griseofulvin, Metronidazole. Enzymes - Streptokinase, Streptodornase. Quality assurance and quality management in pharmaceuticals – In-Process, Final-Product Control and sterility tests. Regulatory aspects - BIS (IS), ISI, ISO, WHO and US certification.

Learning Resources:

Textbooks

1. Patel A. H. (2016). *Industrial Microbiology*. (2nd Edition). Laxmi Publications, New Delhi.
2. Casida L. E. J. R. (2019). *Industrial Microbiology*. New Age International Publishers.
3. Sathyanarayana U. (2005). *Biotechnology*. (1st Edition). Books and Allied (P) Ltd.
4. Reed G. (2004). *Prescott and Dunn's Industrial Microbiology.* (4th Edition). CBS Publishers & Distributors.
5. Waites M. J., Morgan N. L., Rockey J. S. and Higton G. (2013). *Industrial Microbiology: An Introduction.* Wiley Blackwell Publishers.

References

1. Stanbury P. T. and Whitaker. (2016). *Principles of Fermentation Technology*. (3rd Edition). Pergamon Press. NY.
2. Handa S. S. and Kapoor V. K. (2022). *Pharamcognosy*, (4th Edition). Vallabh Prakashan Publishers, New Delhi.
3. Kokate C. K., Durohit A. P. and Gokhale S. R. (2002) *Pharmacognosy*. (12th Edition). Nirali Prakasham Publishers, Pune.
4. Hugo W. B. and Russell A. D. (2004). *Pharmaceutical Microbiology*. (7th Edition). Blackwell Scientific Publication, Oxford.
5. Wallis, T. E. (2005). *Textbook of Pharmacognosy*. (5th Edition). CBS publishers and distributors, New Delhi.

Websites/ e-Learning Resources

1. https://ib.bioninja.com.au/options/untitled/b1-microbiologyorganisms/fermenters.html
2. https://www.acs.org/content/acs/en/education/whatischemistry/landmarks/penicillin.html
3. https://www.sciencedirect.com/topics/biochemistry-genetics-andmolecularbiology/ethanol-fermentation
4. https://www.usp.org/sites/default/files/usp/document/harmonization/genmethod/q05b_pf_ira_34_6_2008.pdf
5. http://www.simbhq.org/

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	2	2	3	3	2	3	3
CO2	3	3	3	3	2	3	3	2	3	3
CO3	3	3	3	2	2	3	3	2	3	3
CO4	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	2	3	3	3	3	3	3
Average	**3**	**3**	**2.8**	**2.4**	**2.4**	**3**	**3**	**2.4**	**3**	**3**

High Correlation - 3; Medium Correlation - 2; Low Correlation - 1

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIM5201	**Immunology Lab**	**Core**	**4**	**2**

This laboratory course helps to gain hands-on experience on the identification of blood groups, Serological reactions, Identification and counting of different types of cells. It also deals with the Agglutination and precipitation reactions, Immunoelectrophoresis, Lymphocyte separation and ELISA test for AIDS.

Course Outcomes:

At the end of the course, students will be able to

CO1: identify the blood groups and types.
CO2: examine the different cells and organs of the immune system.
CO3: compare & contrast antigen and antibody reactions.
CO4: demonstrate the methods of lymphocyte separation.
CO5: select suitable techniques to separate and purify immunoglobulin.

List of Experiments:

1. Erythrocyte antigen detection – forward and reverse, Rh Typing
2. Identification of various immune cells by morphology – Leishman staining, Giemsa staining.
3. Virtual lab - demonstration of lymphoid organs of animals.
4. Virtual lab - Routes of administration and repetitive bleeding.
5. Preparation of Antigens – Soluble, insoluble and adjuvant antigens.
6. Agglutination Reactions- Latex Agglutination reactions- RF, ASO, CRP.
7. Detection of HBsAg by ELISA.
8. Precipitation reactions in gels– Ouchterlony double immunodiffusion (ODD) and Mancini's single radial immunodiffusion (SRID).
9. Immuno-electrophoresis and staining of precipitin lines- Rocket immuno electrophoresis and counter current immuno electrophoresis.
10. Serum and plasma separation by native PAGE.
11. Preparation of lymphocytes from peripheral blood by density gradient centrifugation.
12. Purification of immunoglobulin– Ammonium Sulphate Precipitation.
13. Separation of IgG by chromatography using DEAE cellulose or Sephadex.

Learning Resources:

Text Books

1. Royn A. K (2019). *Immunology Theory and Practical***,** Kalyani Publications.
2. Rich R. R., Fleisher T. A., Shearer W. T., Schroeder H, Frew A. J. and Weyand C. M. (2018). *Clinical Immunology: Principles and Practice*. (5th Edition). Elsevier.
3. Coico R., Sunshine G. and Benjamini E. (2015). *Immunology – A Short Course*. (7th Edition). Wiley-Blackwell, New York.
4. Judith A. Owen, Punt J , Sharon A. Stranford, and Kuby J (2013). *Immunology*, 7th Edition. W. H. Freeman and Company, New York.
5. Talwar. (2006). *Hand Book of Practical and Clinical Immunology*, Vol. I, 2nd edition, CBS.
6. Gupta. P.S. (2003). *Clinical Immunology*. Oxford University Press.

References

1. Frank C. Hay, Olwyn M. R. and Westwood. (2008). *Practical Immunology*, 4th Edition, Wiley-Blackwell.
2. Webley .W (2016). *Immunology Lab Manual*, LAD Custom Publishing.
3. Rose. (1992). Manual of Clinical Lab Immunology, ASM.
4. Travers J, (1997). *Immunobiology- the immune system in health and disease.* Current Biology Ltd. London, New York. 3rd Edition.
5. Delves P. J, Martin S, Dennis R. Burton, and Roitt I M , (2006). *Roitt's Essential Immunology*, 11th Edition. Wiley-Blackwell.
6. Gupta P. S. (2003). *Clinical Immunology*. Oxford University Press.

Websites/ e-Learning Resources

1. https://www.researchgate.net/publication/275045725_Practical_Immunology-_A_Laboratory_Manual.
2. https://www.urmc.rochester.edu/MediaLibraries/URMCMedia/labs/frelinger-lab/documents/Immunology-Lab-Manual.pdf
3. https://webstor.srmist.edu.in/web_assets/downloads/2021/18BTC106J-lab-manual.pdf.
4. Immunology Overview - Medical Microbiology - NCBI Bookshelf (nih.gov).
5. Immunology - an overview | ScienceDirect Topics

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	1	3	2	2	3	2	3
CO2	3	3	3	2	3	2	2	3	2	3
CO3	3	3	2	2	3	2	2	3	2	3
CO4	3	3	2	2	3	2	2	3	2	3
CO5	3	3	2	2	3	2	2	2	2	3
Average	**3**	**3**	**2.4**	**1.8**	**3**	**2**	**2**	**2.8**	**2**	**3**

High Correlation - 3; Medium Correlation - 2; Low Correlation - 1

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIM5203	Recombinant DNA Technology and Biotechnology Lab	Core	4	2

This course aims to train students in the basic techniques required for rDNA technology i.e., genomic DNA and plasmid DNA isolation, restriction digestion, selection and isolation of mutants, expression of target DNA and PCR. It also deals with basic animal cell and plant tissue culturing protocols.

Course Outcomes:

At the end of the course, students will be able to

CO1: perform DNA isolation and manipulation using restriction endonucleases.
CO2: schedule the steps involved in introduction and expression of foreign DNA into bacteria and their screening.
CO3: use molecular tools like PCR and site-directed mutagenesis
CO4: experiment the basic plant tissue culture protocols
CO5: design the basic animal cell culture procedures

List of Experiments:

1. Isolation of genomic and Plasmid DNA from plant, animal tissue, bacteria and blood.
2. Restriction Digestion of DNA
3. Competent cell preparation & Transformation by $CaCl_2$ method
4. Selection of mutants by blue-white screening method
5. Detection of Antibiotic resistant mutants
6. Identification of mutants by replica plating method
7. Demonstration of Polymerase chain reaction and Amplification of Gene by PCR (Multiplex PCR)
8. Analysis of amplified gene on Agarose Gel Electrophoresis.
9. Blotting techniques: Western and Southern blotting – Demonstration
10. Site Directed Mutagenesis - Demonstration

Plant tissue culture

11. Preparation of Tissue Culture Media
12. Callus Induction.
13. Shoot and root induction.

14. Isolation of protoplasts.
15. Synthetic seed preparation.
16. Cell suspension culture.

Animal cell culture

17. Preparation and Sterilization of Cell Culture Media.
18. Primary explant culture from chick embryo.
19. Disaggregation of tissue – Physical method and Enzymatic method.
20. Cell viability assay – Trypan blue dye exclusion test.

Learning Resources:

Textbooks

1. Sambrook J and Russell D.W (2001) Molecular Cloning: A Laboratory Manual, Volume 1, CSHL Press.
2. Robertson D. Shore A. S. and Miller D. M (1997) Manipulation and Expression of Recombinant DNA – A Laboratory Manual, Academic Press, San Diego.
3. Scheppler J. A. Cassin P. E and Gambier R. M (2000) Biotechnology Explorations – Applying the fundamentals, ASM Press, Washington DC.
4. Freshney, R. I. (2016). Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications. Wiley-Blackwell.

References

1. Das, S. and Dash, H. R. (2014). *Microbial Biotechnology-A Laboratory Manual for Bacterial Systems*. Springer.
2. Clark, M. S.(2013). *Plant Molecular Biology—A Laboratory Manual*. Springer Science & Business Media.
3. Mather, J. P. and Barnes, D. (1998). *Methods in Cell Biology*. Volume 57: Animal cell culture methods. Academic press.
4. Sinha, B. K. and Kumar, R. (2008). *Principles of Animal Cell Culture: Students Compendium*.
5. Davis, J. M. (2011). *Animal Cell Culture: Essential Methods*. John Wiley & Sons.

Websites/ e-Learning Resources

1. https://www.britannica.com/recombinant-DNA-technology
2. https://www.byjus.com/recombinant-dna-technology
3. https://www..rpi.edu
4. https://www..ncbi.nlm.nih.gov
5. https://www.le.ac.uk/recombinant-dna-and-genetic-techniques

6. https://webstor.srmist.edu.in/web_assets/srm_mainsite/files/files/BT%200502%20-%20M_Tech%20r-DNA%20Technology%20lab%20manual.pdf

CO – PSO Mapping

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	3	3	3	2	3	2	2	3
CO2	3	3	3	3	3	2	3	2	3	3
CO3	3	3	3	2	2	2	3	2	2	3
CO4	3	3	2	2	2	2	2	2	2	3
CO5	3	3	2	2	2	2	2	3	2	3
Average	**3**	**3**	**2.6**	**2.4**	**2.4**	**2**	**2.6**	**2.2**	**2.2**	**3**

High Correlation - 3; Medium Correlation - 2; Low Correlation - 1

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIM5401	**Animal Cell Culture**	**DSE**	**5**	**4**

This course intends to provide students with basic cell culture methods and bioprocessing technology. Students will be taught with various aseptic techniques, culture vessels, media and supplements for cell culture. The disaggregation of tissue, primary cell culture techniques and maintenance of the culture will be given due importance. The cloning and selection of specific cell types with reference to the immune system and their culturing methods will be discussed. Cloned specific cell line induction and techniques employed in animal cell culture will be covered.

Course Outcomes:

At the end of the course, students will be able to

CO1: explain the history, biology of cultured cells, their properties, advantages and disadvantages.
CO2: identify the role of different culture vessels, substrates and media used in cell culture.
CO3: illustrate the techniques of primary explants culture, monolayer culture, and cell line characterization.
CO4: appraise the process of differentiation and transformation in cell lines.
CO5: choose the techniques for the microscopic observation, cell separation and testing the viability of the cultured cells.

UNIT I: Introduction to animal cell culture (15 Hours)

History, Advantages and disadvantages, types of tissue culture; Biology of cultured cells - cell types, adhesion, proliferation, differentiation, signaling, evolution, senescence, transformation; laboratory design; equipment and materials; aseptic technique; safety and bioethics.

UNIT II: Culture vessels and media (15 Hours)

Culture vessels and substrates, specialized systems; Media, supplements, physico-chemical properties - serum and serum free media; preparation and sterilization; Common microbial contaminants in cell culture – sources, types, monitoring, disposal of contaminated cultures, eradication and Cross-contamination.

UNIT III: Primary culture and routine maintenance (15 Hours)

Primary culture – types, initiation and isolation of the tissue; subculture- propagation, choice of cell line, routine maintenance, methods - Cloning – types - dilution cloning, suspension cloning, isolation of clones - methods; isolation of genetic variants, interaction with substrate.

UNIT IV: Induction of differentiation and the transformed phenotype(15 Hours)

Differentiation – *in-vivo* expression, proliferation, commitment and lineage, stem cell plasticity, markers and induction of differentiation, transformation and immortalization – role in cell line characterization –genetic instability– aberrant growth control – tumorgenicity.

UNIT V: Techniques used in cell culture (15 Hours)

Cryopreservation, Quantitation –confocal microscopy, cell counting- cell proliferation – plating efficiency. Cytotoxicity – viability, toxicity and survival – application of cytotoxicity assay – cell separation – antibody based techniques, specialized techniques - lymphocytes preparation – autoradiography.

Learning Resources:

Textbooks

1. Freshney, R. I. (2016). *Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications.* Wiley-Blackwell.
2. Davis J. M (2011). *Animal Cell culture: Essential Methods,* Wiley-Blackwell. ISBN:9780470975633
3. Clynes M (2012). *Animal Cell culture Techniques*. Springer Bertlin Hiedelberg. ISBN:9783642804120,
4. Jayaraman I (2021). *Animal cell culture: Animal Biotechnology*
5. Bhatt S. M. (2011). *Animal Cell Culture – Concepts and Applications*, Narosa Publishing House Private Limited, New Delhi.

References

1. Mather, J. P. and Barnes, D. (1998). *Methods in Cell Biology*. Volume 57: Animal Cell Culture Methods. Academic Press.
2. Sinha, B K. and Kumar, R. (2008). *Principles of Animal Cell Culture: Students Compendium*. IBDC.
3. Butler, M. (2003). *Animal Cell Culture and Technology*. Taylor & Francis.
4. Davis, JM. (2011). *Animal Cell Culture: Essential Methods*. John Wiley & Sons.

5. Freshney, R. I (2010), *Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications*, 6th ed. A. John Wiley & Sons, INC, Publication. 732p.

Websites/ e-Learning Resources

1. https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SBTA1601.pdf
2. https://lib.mzu.edu.in/wp-content/uploads/2020/11/Animal-Cell-Culture.pdf
3. https://www.corning.com/catalog/cls/documents/application-notes/CLS-AN-042.pdf
4. https://www.vanderbilt.edu/viibre/CellCultureBasicsEU.pdf
5. https://www.researchgate.net/publication/229947454_Animal_Cell_Culture_Media

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	1	1	2	2	2	2	2
CO2	3	3	2	2	1	2	2	2	2	2
CO3	3	3	2	1	2	2	2	3	3	2
CO4	3	3	2	1	2	3	2	3	2	2
CO5	3	3	2	--	2	3	2	2	3	2
Average	**3**	**3**	**2**	**1.25**	**1.6**	**2.4**	**2**	**2.4**	**2.4**	**2**

High Correlation - 3; Medium Correlation - 2; Low Correlation - 1

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIM5403	**Biosafety, Bioethics and IPR**	**DSE**	**5**	**4**

This course aims to provide the students with the basic knowledge of ethics and biosafety essential for Life Science Laboratories. Students will gain knowledge on the basic concepts, protection and laws associated with Intellectual Property Rights and patent filing. Emphasis will be given to applications and issues related to bioethics with special reference to medicine and research.

Course Outcomes:

At the end of the course, students will be able to

CO1: recall the safety measures in handling and disposal of infectious wastes with biosafety guidelines and regulations.
CO2: discuss the various aspects of Intellectual property rights, agreements and treaties.
CO3: categorize the fundamental and legislative aspects of patents.
CO4: analyze the significance of bioethics, biodiversity, Genetically modified foods and food crops
CO5: evaluate the need for bioethics in the field of medicine and research

UNIT I: Introduction to biosafety and guidelines (15 Hours)

Introduction, Historical Background, biosafety issues; Biological Safety Cabinets & their types; Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms. Biosafety Guidelines: Biosafety guidelines and regulations (National and International); GMOs/LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees (IBSC), RCGM, GEAC etc. for GMO applications in food and agriculture;

UNIT II: Intellectual Property Rights, Agreements and Treaties (15 Hours)

Different forms of Intellectual Property Rights – their relevance, importance to industry, Academia. Role of IPR's in Biotechnology, Patent Terminology - Patents, trademarks, copyrights, industrial designs, geographical indications, geotag, trade secrets, non-disclosure agreements. Patent life and geographical boundaries. International organizations and IPR - Overview of WTO, TRIPS, WIPO, GATT, International conventions, Trade agreements, Implication of TRIPS for developing countries.

UNIT III: Patents and patentability of biotechnology inventions (15 Hours)

Process involved in patenting. Patent Search - Procedural steps in patenting, process of filing, PCT application, pre-grant & post-grant opposition, PCT and patent harmonization including Sui-generis system, patent search methods, patent databases and libraries, online tools, Country-wise patent searches (USPTO, EPO, India etc. Patentability of biotechnology inventions in India, Patent Laws in Indian and International Perspective: statutory provisions regarding biotechnological inventions under the current Patent Act 1970 (as Amended 2005). Patent Case study: Basmati Case, Neem Controversy, Turmeric Case.

UNIT IV: Need and scope of bioethics (15 Hours)

Introduction to bioethics - need of bioethics, applications and issues related to bioethics, social and cultural issues. Bioethics and biodiversity - conserving natural biodiversity, convention on protecting biodiversity, protocols in exchanging biological material across borders, Benefit Sharing and Informed Consent, Biopiracy. Bioethics & GMO's - issues and concerns pertaining to genetically modified foods and food crops, organisms and their possible health implications and mixing up with the gene-pool.

UNIT V: Bioethics in medicine and research (15 Hours)

Bioethics in medicine - Protocols of ethical concerns related to prenatal diagnosis, gene therapy, organ transplantation, xeno transplantation, ethics in patient care, informed consent. bioethics and cloning - permissions and procedures in animal cloning, human cloning, risks and hopes. Bioethics in research: stem cell research, human genome project, animal models in research, human volunteers for clinical research, studies on ethnic races. The Nuremberg Code.

Learning Resources:

Text Books

1. Usharani B., Anbazhagi S. and Vidya C. K. (2019). *Biosafety in Microbiological Laboratories*. (1st Edition). Notion Press. ISBN-101645878856.
2. Satheesh M. K. (2009). *Bioethics and Biosafety*. (1st Edition). J. K International Publishing House Pvt. Ltd: Delhi. ISBN: 9788190675703.
3. Goel D. and Parashar S. (2013). *IPR, Biosaftey and Bioethics*. (1st Edition). Pearson Education: Chennai. ISBN-13: 978-8131774700.
4. Joshi. R. M (2006) *Biosafety and Bioethics*. Wiley Publications.
5. Sibi. G (2021). *Intellectual, Property Rights, Bioethics, Biosafety and Entrepreneurship in biotechnology*. Wiley Publications.

References

1. Nithyananda K. V. (2019). *Intellectual Property Rights: Protection and Management*, India, IN: Cengage Learning India Private Limited.
2. Neeraj, P. and Khusdeep, D. (2014). *Intellectual Property Rights*, India, IN: PHI learning Private Limited.
3. Ahuja, V K. (2017). *Law relating to Intellectual Property Rights*, India, IN: Lexis Nexis.
4. Hope T (2004). *Medical Ethics: A very Short introduction*,. Oxford Publication.
5. Parashar. G(2013). *IPR, Biosafety and Bioethics*. Pearson Publications.

Websites/ e-Learning Resources

1. http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf.
2. https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub _489.pdf.
3. https://www.cdc.gov/training/quicklearns/biosafety/
4. https://bioethics.msu.edu/what-is-bioethics
5. https://www.wto.org/english/tratop_e/trips_e/intel1e.htm

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	2	2	2	2	2	2	2	3	2	3
CO2	2	2	2	2	2	2	2	3	2	3
CO3	2	2	2	2	2	2	2	3	3	3
CO4	2	2	2	3	2	3	3	3	3	3
CO5	2	2	2	2	2	2	3	3	2	3
Average	**2**	**2**	**2**	**2.2**	**2**	**2.2**	**2.4**	**3**	**2.4**	**3**

High Correlation - 3; Medium Correlation - 2; Low Correlation - 1

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIM5233	**Internship**	**IS**	**-**	**2**

This paper mainly focuses on enabling students to look for opportunities related to their employment. The students will be trained to look for industries or research institutions that offer experiential learning to relate their academic knowledge with its practical application. The major objective is to impart confidence to the students by hands-on experience to translate them into employable and competent individuals in public/ private sectors.

Course Outcomes:

At the end of the course, students will be able to

CO1: list the possibilities of employment at various institutes/ organizations.
CO2: restate their practical knowledge for research work.
CO3: employ their cognitive abilities and skills to win apprenticeships.
CO4: experiment with scientific research methods to contribute for individual and holistic growth.
CO5: create a professional network to increase their employment opportunities.

The students will be doing their internship in various organizations/ industries/institutes to present their experiences in the form of a report. The students will be given marks based on their performance in viva voce.

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	3	-	3	3	-	3	3
CO2	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	-	3	3	-	3	3
Average	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

High Correlation - 3; Medium Correlation - 2; Low Correlation - 1

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIM5502	**Soil and Environmental Microbiology**	**Core**	**6**	**5**

This course deals with the basics of soil formation, properties and the role of microbes in soil fertility. Emphasis will be given to benefits of interactions among soil microbes and the benefits of microbes as biofertilizers and biocontrol agents. It also provides awareness on the components of environment, environmental pollution, and detection methods. The course provides in-depth knowledge on solid and liquid waste treatments. Highlight will be given on organic matter degradation, bioremediation, and environment impact assessment.

Course Outcomes:

At the end of the course, students will be able to

CO1: explain the role of microorganisms in soil fertility.
CO2: discuss the benefits and impacts of microbial interactions.
CO3: interpret the components of environment, environmental pollution and detection methods.
CO4: analyze the methods involved in the treatment of solid and liquid wastes.
CO5: appraise the organic matter degradation, bioremediation, and environment impact assessment.

UNIT I: Introduction to soil microbiology (**18 Hours)**

Soil Microbiology– Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity, and distribution of major groups of microorganisms in soil. Quantification of soil microflora, role of microorganisms in soil fertility. Mineralization of Organic & Inorganic Matter in Soil. Biological Nitrogen fixation-Chemistry and Genetics of BNF. Phytopathology and Disease cycle of Plant pathogens - Tikka and Citrus canker, Types of disease symptoms, Structural and Inducible biochemical defenses - Systemic Acquired Resistance (SAR), pathogenesis related (PR) proteins, Plantibodies, Phenolics and Phytoalexins.

UNIT II: Microbial interactions **(18 Hours)**

Microbial Interactions - Mutualism, Commensalism, Amensalism, Synergism, Competition, Rhizosphere- Rhizosphere effect, Mycorrhizae – Types, Endophytes, PGPR- Plant growth promoting bacteria– symbiotic (*Bradyrhizobium, Rhizobium, Frankia*), Non-Symbiotic (*Azospirillum*, *Azotobacter*, Mycorrhizae, MHBs,

Phosphate solubilizers, algae), Novel combination of microbes as biofertilizers, PGPRs. Biofertilizers and Biocontrol agents – Types, benefits and application. Advantages, social and environmental aspects - Bt crops and golden rice.

UNIT III: Components of environment (18 Hours)

Components of Environment: Hydrosphere, lithosphere, atmosphere, and biosphere – definitions with examples; Energy flow in the ecosystem- Carbon, Nitrogen, Sulfur and Phosphorous cycles. Physical factors affecting distribution of microorganisms in various environments. Predisposing factors for Environmental diseases – infectious (water-cholera and air borne-influenza) and pollution related, spread and control of these diseases. Treatment and safety of drinking (potable) water, methods to detect potability of water samples. Space microbiology - Microbiological research in space environment.

UNIT IV: Waste management (18 Hours)

Waste management – Solid waste - Types - management - Factors affecting solid waste generation rates. Industrial effluent treatment, primary, secondary, tertiary, and advanced treatment process. Quality assessment of decontaminated matters and other biological effluents. Biological reference standards. Utilization of Solid Waste as Food, Feed and Fuel- Composting, Vermicomposting, Biomanure and Biogas production. E-waste management.

UNIT V: Degradation of organic matter (18 Hours)

Degradation of organic matter - lignin, cellulose, hemicellulose, pectin, common pesticides- herbicides (2,4-D) and pesticides (DDT), heavy metals. Biodegradation of Xenobiotics - Recalcitrant Halocarbons, Recalcitrant TNTs, PCBs and Synthetic polymers. Biodegradation of Hydrocarbons. Biodeterioration of Textiles and Leather. Oreleaching bacteria. Pollution Control Bodies and Environmental laws in India. Environmental impact assessment, EIA guidelines, US Environment protection Agency norms.

Learning Resources:

Textbooks

1. SubbaRao. N. S. (2017). *Soil Microbiology*. (5th Edition). MedTech Publishers.
2. Daniel. C. J. (2006). *Environmental Aspects of Microbiology*. (2nd Edition). Bright Sun Publications.
3. Rangaswami. G. and Mahadevan. A. (2006). *Diseases of Crop Plants in India*. (4th Edition). Prentice–Hall of India Pvt. Ltd.
4. Doyle M. P., and Buchanan R. L. (2012). *Food Microbiology: Fundamentals and Frontiers*. (4th Edition). American Society for Microbiology Press.
5. SubbaRao. N.S. (2005). *Soil microorganisms and Plant Growth*. (4th Edition). Oxford and IBH Publishing Pvt. Ltd.

References

1. Pepper I. L., Gerba C. P. and Gentry T. J. (2014). *Environmental Microbiology* (1st Edition). Academic Press, Elsevier.
2. Bitton, G. (2011). *Wastewater Microbiology*. (4th Edition). Wiley-Blackwell
3. Bridgewater L. (2012). *Standard Methods for the Examination of Water and Wastewater*. American Public Health Association.
4. Shrivastava A. K. (2003). *Environment Auditing*. A. P. H. Publishing Corporation.
5. Tinsley, S. and Pillai, I. (2012). *Environmental Management Systems – Understanding Organizational Drivers and Barriers*. Earthscan.

Websites/ e-Learning Resources

1. https://academic.oup.com/femsec/article/93/5/fix044/3098413
2. http://www.fao.org/3/t0551e/t0551e05.htm
3. www.environmentshumail.blogspot.in/
4. https://www.frontiersin.org/articles/10.3389/fpls.2017.01617/full
5. https://serc.carleton.edu/microbelife/index.html

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	2	2	1	3	3	3	2	2	3
CO2	3	3	2	3	2	3	3	2	2	3
CO3	3	2	2	3	2	3	3	2	3	3
CO4	3	2	3	3	2	3	3	2	3	3
CO5	3	2	3	1	3	3	3	2	2	3
Average	**3**	**2.2**	**2.4**	**2.2**	**2.4**	**3**	**3**	**2**	**2.4**	**3**

High Correlation - 3; Medium Correlation - 2; Low Correlation - 1

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIM5504	**Food and Dairy Microbiology**	**Core**	**6**	**5**

This course deals with the basics of food, associated microbes and the factors influencing spoilage and preservation. It provides information about food-borne infection and intoxication. The course also highlights the food safety and quality assessment. It also facilitates the understanding of spoilage and processing of milk. Students will also gain knowledge on fermented dairy products, food sanitation and regulatory standards.

Course Outcomes:

At the end of the course, students will be able to

CO1: discuss the role of microorganisms involved in food spoilage and food preservation methods.
CO2: illustrate food-borne infections and illnesses.
CO3: compare the national and international standards of food safety and quality assessment.
CO4: assess the spoilage, grades and processing methods of milk.
CO5: appraise the different fermented dairy products, quality control and waste disposal.

UNIT I: Introduction and scope of food microbiology (18 Hours)

Scope of food Microbiology. Microorganisms associated with food. Contamination and spoilage of food –vegetables, fruits, poultry, fish, eggs, meat, meat products and canned foods. Food Preservation - Temperature (low and high), drying, radiation and chemicals.

UNIT II: Food -borne illnesses (18 Hours)

Food microbiology and public health. Food hazards. Food borne diseases - *Bacillus cereus, Vibrio parahaemolyticus, Escherichia coli, Salmonella, Shigella, Yersinia enterocolitica, Listeria monocytogenes* and *Campylobacter jejuni*. Nonbacterial food-borne illness – Helminths (*Giardia*), nematodes (*Trichinella*), protozoa (*Toxoplasma*), toxigenic fungi (*Aspergillus*) and food-borne virus (HAV).

UNIT III: Food safety and quality assessment (18 Hours)

Quality assurance of food - International aspects of Quality and safety assessment of foods. Microbiological quality standards for food. Government regulatory practices and policies - FDA, HACCP, BIS (IS), FSSAI-2014. Food adulteration and common food additives.

UNIT IV: Dairy microbiology (18 Hours)

Introduction to Dairy microbiology – Milk production and hygiene. Microorganisms associated with milk. Microbial metabolites and their role in spoilages- souring, curdling, gassiness, ropiness, proteolysis, lipolysis, abnormal flavour and colour. Antimicrobial systems in raw milk. Microbiological grading of raw milk. Milk-borne diseases and their control. Bacteriological aspects of milk processing – Thermization, pasteurization, boiling, sterilization, UHT, bactofugation, and membrane filtration.

UNIT V: Fermented dairy products (18 Hours)

Composition and chemistry of cream, butter, ghee, ice cream, cheese, kefir, koumiss, rennin, condensed and dried milks, infant food. Spoilage of ghee and use of antioxidants. Chemistry of milk fermentation. Chemistry of rennin coagulation of milk and changes occurring during ripening of cheese, physico-chemical changes in the manufacture and storage of milk powder, lactose, crystallization and its significance. Dairy plant hygiene and sanitation. Disposal of dairy waste. Microbiological standards for Milk and Milk products- PFA BIS, Codex/ ISO standards. Probiotics and prebiotics.

Learning Resources:

Textbooks

1. Canon B, (2022). *Introduction to Dairy Microbiology*. Oxford Book Company. 280p.
2. Ray B. and Bhunia A. (2013). *Fundamentals of Food Microbiology*. (5th Edition). CRC Press
3. Frazier W.C., Westhoff. D. C. and Vanitha K.N. (2013). *Food Microbiology*. (6th Edition). McGraw Hill Education.
4. Doyle M. P., and Buchanan R. L. (2012). *Food Microbiology: Fundamentals and Frontiers*. (4th Edition). American Society for Microbiology Press.
5. Jay J. M., Loessner M. J. and Golden D.A. (2006). *Modern Food Microbiology*. (7th Edition). Springer.

References

1. Robinson R. K. (2000). *Dairy Microbiology* 3rd edn, Elsevier Applied Science, London.

2. Adams M. R, and Moss M. D. (2005). *Food Microbiology*. 4th edition, New Age International Pvt. Ltd., Publishers. First edition.
3. Banwarst, G. J. (2003). *Basic Food Microbiology* 2nd edition, CBS Publishers and Distributors.
4. Hobbs, B. C. and Roberts, D. (1968), *Food Poisoning and Food Hygiene* 7th edn. Edward Arnold: London.
5. Vijaya R. K. (2004). *Food Microbiology* 1st edition. MJP Publishers, Chennai.

Websites/ e-Learning Resources

1. https://www.fssai.gov.in
2. https://www.who.int/news-room/fact-sheets/detail/food-safety
3. https://www.fda.gov/food/hazard-analysis-critical-control-point-haccp/haccp-principles-application-guidelines

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	2	2	3	3	3	3	3
CO2	3	3	3	3	2	3	2	2	3	3
CO3	2	3	3	1	2	3	2	3	3	3
CO4	3	3	2	3	3	3	2	3	3	3
CO5	3	2	2	3	3	3	2	3	3	3
Average	**2.8**	**2.8**	**2.6**	**2.4**	**2.4**	**3**	**2.2**	**2.8**	**3**	**3**

High Correlation - 3; Medium Correlation - 2; Low Correlation - 1

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIM5202	**Soil and Environmental Microbiology Lab**	**Core**	**3**	**2**

The objective of this course is to give practical experience in techniques involved in soil and environmental microbiology. This course demonstrates the associative activities of bacteria and soil biofilm, determination of physico-chemical properties and isolation of industrially important microbes from soil. It also deals with the analysis of water quality and estimation of BOD, COD and DO. Agricultural microbiology experiments are designed to enrich students with isolation, identification and mass production of biofertilizers and biopesticides.

Course Outcomes:

At the end of the course, students will be able to

CO1: demonstrate microbial interactions.
CO2: analyze physico-chemical properties of soil and to isolate industrially important microbes from soil.
CO3: assess the quality of Water: BOD, COD and DO.
CO4: evaluate the microflora and Index of Microbial contamination of air
CO5: plan the isolation and identification of agriculturally important microbes.

List of Experiments:

1. Microbial Ecology
    a. Demonstration of associative activities of bacteria: Competition and antagonism
    b. Soil biofilm

2. Soil Microbiology
    a. Winogradsky Column
    b. Determination of the soil pH and soil water content by dry-weight analysis
    c. Enumeration and examination of soil microorganisms via dilution plating and contact slide assay
    d. Isolation of saccharolytic, proteolytic and lipolytic bacteria from soil
    e. Enrichment and isolation of bacteria that decolorize dyes
    f. Adaptation of soil bacteria to metals and pesticides

3. Water Microbiology
    a. Determination of dissolved oxygen (DO), Chemical oxygen demand (COD) and Biochemical oxygen demand (BOD) of water
    b. Quantitative Analysis of Water: Coliform, MPN Test and Membrane Filter Method
    c. Isolation of *Escherichia coli* bacteriophages from sewage and determining bacteriophage titers

4. Aero-Microbiology
    a. Determination of air microflora and Index of Microbial contamination of air (IMA)

5. Agricultural Microbiology
    a. Isolation and identification of *Rhizobium*, *Azospirillum*, phosphobacteria and *Azotobacter* from soil
    b. Observation of mycorrhizal fungi
    c. Screening for plant growth promoting traits

Learning Resources:

1. Gerba, C. P., Josephson, K., and Pepper, I. L. (2011). *Environmental Microbiology: A Laboratory Manual*. Elsevier.

References

1. Pollack, R. A. (2011). *Laboratory Exercises in Microbiology*. Wiley Global Education.
2. Aneja, K. R. (2003). *Experiments in Microbiology, Plant Pathology and Biotechnology*. New Age International.
3. Tiwari, R. P., Hoondal, G. S., and Tewari, R. (2008). *Laboratory Techniques in Microbiology and Biotechnology*. Global Media.

CO – PSO Mapping

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	2	2	2	3	2	3	2	2	3
CO2	3	3	3	3	3	2	3	2	3	3
CO3	3	2	3	3	2	2	3	2	2	3
CO4	3	2	3	3	3	2	3	2	2	3
CO5	3	2	3	2	3	2	3	2	3	3
Average	**3**	**2.2**	**2.8**	**2.6**	**2.8**	**2**	**3**	**2**	**2.4**	**3**

High Correlation - 3; Medium Correlation - 2; Low Correlation - 1

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIM5204	**Food and Dairy Microbiology Lab**	**Core**	**3**	**2**

This laboratory course includes microbial analyses and grading of various foods such as bakery products, beverages, soft drinks, pickles, confectioneries, eggs and milk products. This course will train students to survey fruits and vegetables for spoilage. Preparation of wine and immobilization techniques will also be covered.

Course Outcomes:

At the end of the course, students will be able to

CO1: identify food products for microbial contaminants.
CO2: categorise the quality of milk and eggs.
CO3: examine organisms found in spoiled food.
CO4: prepare wine by anaerobic fermentation.
CO5: assess immobilization of yeast and bacteria.

List of Experiments:

1. Microbial analyses of bakery products.
2. Microbial analyses of carbonated beverages and soft drinks.
3. Microbial analyses of pickles
4. Microbial analyses of confectioneries
5. Microbial examination of eggs
6. Microbial analyses of milk and milk products.
7. Grading of milk quality using the Methylene Blue Reduction Test
8. Analysis of fruits and vegetable spoilage by survey method
9. Examination of microorganisms from spoiled foods
10. Production of wine by anaerobic fermentation
11. Immobilization of yeast and bacteria
12. Visit to food industries

Learning Resources:

Textbooks

1. Cappucino R. (2017). *Microbiology – A Laboratory Manual*, 6th Ed. Benjamin/ Cumming Publication Co, California

2. Frazier W. C. and D. C. Westhoff. (2013). *Food Microbiology*. 4th Ed. Tata McGraw Hill, New Delhi.
3. Doyle M. P., Beuchat L. R. and T. J Montville. (2012). *Food Microbiology: Fundamentals and Frontiers*. 4th Ed. ASM Press, Washington DC.
4. Patel A. H. (2012). *Industrial Microbiology*. 2nd Ed. Macmillan India Limited.

References

1. Marcus K and Lund D.B (2003). *Physical Principles of Food Preservation*. Rutledge.
2. VanGarde, S. J. and Woodburn. M. (2001). *Food Preservation and Safety Principles and Practice.* Surbhi Publications.
3. Sivasankar, B. (2002). *Food Processing and Preservation*, Prentice Hall of India.
4. Khetarpaul and Neelam (2005). *Food Processing and Preservation*, Daya Publications.
5. Barbosa-Cánovas, Gustavo V., María S., Tapia, and Cano M. P (2004). *Novel food processing technologies*. CRC press.

Websites/ e-Learning Resources

1. https://www.fssai.gov.in
2. https://www.who.int/news-room/fact-sheets/detail/food-safety
3. https://www.fda.gov/food/hazard-analysis-critical-control-point-haccp/haccp-principles-application-guidelines

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	3	3	2	3	2	2	3
CO2	3	3	3	2	3	2	3	2	3	3
CO3	2	3	3	2	3	2	3	3	2	3
CO4	3	3	2	3	1	2	3	2	3	3
CO5	3	2	2	3	1	2	3	2	2	3
Average	**2.8**	**2.8**	**2.6**	**2.6**	**2.2**	**2**	**3**	**2.2**	**2.4**	**3**

High Correlation - 3; Medium Correlation - 2; Low Correlation - 1

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIM5506	**Project**	**Core**	**8**	**5**

The project focuses on developing critical thinking ability and opportunities for comprehensive experiential learning for students to relate their academic knowledge with research. The major objective is to equip the students with analytical reasoning, insights, hands-on experience and skills of documentation, data analysis and presentation to translate themselves to be employable and competent individuals for research.

Course Outcomes:

At the end of the course, students will be able to

CO1: identify the research problems and frame a hypothesis.
CO2: sketch the outline of their research work.
CO3: test the hypothesis using appropriate scientific research methods.
CO4: interpret results with the acquired theoretical understanding and earlier reports.
CO5: create a new concept/solution for the identified research problems.

Students will do their project work and present their findings in the form of a dissertation and a oral presentation. The students will be given marks based on their performance in the project and viva voce.

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	3	2	3	3	2	2	3
CO2	3	3	3	3	2	3	3	3	2	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	2	3	3	3	2	3
Average	**3**	**3**	**2.8**	**3**	**2.4**	**3**	**3**	**2.8**	**2.4**	**3**

High Correlation - 3; Medium Correlation - 2; Low Correlation - 1

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIM5402	Research Methodology and Biostatistics	DSE	4	4

This course deals with the objectives of research, research problem, hypothesis, design, sampling, data collection, significance of review, report writing and plagiarism. It also covers biostatistical analysis such as descriptive statistics, Correlation, Regression, Probability theory, ANOVA, statistical software and Computer oriented statistical techniques.

Course Outcomes:

At the end of the course, students will be able to

CO1: explain research design and the methods of data collection.
CO2: describe sampling methods and write research reports.
CO3: discuss the basic concepts of biostatistics.
CO4: apply statistical tools for interpretation of biological data.
CO5: interpret the tests of significance.

UNIT I: Introduction to research methodology (12 Hours)

Introduction to Research Methodology - Meaning and importance. Statement, Constraints. Review of literature - Review and synopsis presentation. Types of research, Research tools. Methods and techniques of data collection - types of data, methods of primary data collection (observation/ experimentation/ questionnaire/ interviewing/ case/pilot study, methods), methods of secondary data collection.

UNIT II: Sampling and sampling distributions (12 Hours)

Sampling and sampling distributions. Sampling frame, importance of probability sampling, sampling - simple random, systematic, stratified random and cluster. Variables - nominal, ordinal, discontinuous, continuous and derived. Research process, designs and Report writing - types of research reports, guidelines for writing an article and report, report format, appendices, Ethical issues related to publishing, Plagiarism and Self-Plagiarism.

UNIT III: Introduction to biostatistics (12 Hours)

Introduction to Biostatistics - Basic concepts, Measurement and measurement scales, Sampling and data collection, Data presentation. Measures of central tendency: Mean, Median, Mode. Measures of variability - Standard deviation, standard error, range,

mean deviation and coefficient of variation. Frequency table of single discrete variable, bubble spot, computation of mean, variance and standard Deviations, t test and correlation coefficient.

UNIT IV: Correlation and regression (12 Hours)

Correlation and regression - Positive, negative, calculation of Karl-Pearson's co-efficient of correlation. Linear regression and multiple linear regression, ANOVA, one and two way classification. Calculation of an unknown variable using regression equation. Tests of significance - Tests of significance: Small sample test (Chi-square t test, F test), large sample test (Z test) and standard error.

UNIT V: Probability and distributions (12 Hours)

Probability and distributions - Introduction to probability theory and distributions, (concept without deviation) binomial, poisson and normal (only definitions and problems) Computer oriented statistical techniques. RSM: methods for process optimization set up CCD, Box Behnken, optimal RSM design, regression models FDS curves, surface contours, multi linear constraints and categoric factors to optimal design.

Learning Resources:

Textbooks

1. Kumar P , Mishra R, and Patel D. (2023) *Biostatistics and Research Methodology*. DR P K Education, India. (ISBN: 978-93-94919-20-4).
2. Shah I and Paul B(2020). *Essentials of Biostatistics and Research Methodology*, 3/e 2021. Academic Publishers, India.
3. Sharma K. R. (2002) *Research methodology*. National Publishing House, New Delhi.
4. Daniel W.W. (2005). *Biostatistics; A foundation for analysis in the health sciences*. (7th Edition). Jhon Wiley & sons Inc, New York.
5. Rao P. S. S. and Richard J. (2006). *Introduction to Biostatistics & Research methods*. Prentice-Hall, New Delhi.
6. Veerakumari L. (2015) *Bioinstrumentation* 1st edn. MJP Publishers.
7. Ahuja V.K. (2017) *Laws Relating to Intellectual Property Rights*. Lexis Nexis.

References

1. Zar J. H. (2006). *Biostatistical Analysis.* (4th Edition). Pearson Education Inc. New Jersey.9385998633.
2. Beins B. C. and McCarthy M.A. (2011). *Research Methods and Statistics*. Pearson Education Inc. New Jersey.

3. Adams K. A. and Lawrence E. M. K. (2014). Research *Methods, Statistics, and Applications*. SAGE Publications, Inc., New Delhi.
4. Anderson J.B. and Poole M. (2011). *Assignment and Thesis Writing*. 4th edn. Wiley India Private Limited.
5. Kothari C.R. and Garg G (2004) *Research Methodology: Methods and Techniques*. 2nd Edition. New Age International Publishers.

Websites/ e-Learning Resources

1. https://www.studocu.com/en-ca/document/mount-royal-university/quantitative-research-methods-and-data-analysis/lecture-notes-all-lectures/344093.
2. https://www.khanacademy.org/math/statistics-probability/sampling-distributions-library
3. https://testbook.com/learn/maths-mean-median-mode/
4. https://rcub.ac.in/econtent/ug/bcom/sem4/Business%20Statistics%20Unit%204%20Correlation%20and%20Regression.pdf
5. https://www.cse.iitk.ac.in/users/piyush/courses/pml_fall17/material/probabilty_tutorial.pdf

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	1	2	3	3	1	2	2	3
CO2	3	3	1	2	3	3	1	2	2	3
CO3	3	3	--	2	3	3	2	1	3	3
CO4	3	3	1	2	3	3	2	2	3	3
CO5	3	3	1	2	3	3	2	2	2	3
Average	**3**	**3**	**1**	**2**	**3**	**3**	**1.6**	**1.8**	**2.4**	**3**

High Correlation - 3; Medium Correlation - 2; Low Correlation - 1

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIM5404	**Vaccinology**	**DSE**	**4**	**4**

The course deals with the concept of vaccines and their types. It also deals with the whole and non-whole cell vaccine preparation. This course gives a comprehensive idea on modern vaccines and challenges of developing anti-fertility vaccines. It also emphasises the different vaccine development strategies in the present scenario.

Course Outcomes:

At the end of the course, students will be able to

CO1: identify the basic concepts of passive immunization and the characteristics of an ideal vaccine.
CO2: explain the evolution of diverse types of vaccines.
CO3: discuss the vaccine development strategies against AIDS, malaria & leprosy
CO4: evaluate the challenges and safety of anti-fertility vaccine.
CO5: compare the strategies for vaccine development.

UNIT I: Introduction to vaccines (12 Hours)

Principles and purpose of vaccination, history, types of immunization, characteristics of an ideal vaccine, vaccine development. Factors affecting efficacy of vaccines, vaccine delivery systems – microbial- and material- based. Passive immunization – natural and artificial immunization – contra-indication.

UNIT II: Whole and Non whole cell vaccines (12 Hours)

Killed vaccines - heat, formaldehyde, radiation; live attenuated vaccines - types – Bacteria (BCG), Virus (Sabin); relative merits of killed and attenuated vaccines. Macromolecules as vaccines - polysaccharides, toxoids, recombinant proteins; recombinant vector vaccines - viral and synthetic peptide vaccines and anti-idiotypic vaccines - methods of development, multivalent sub unit vaccines - micelle, liposome and ISCOM.

UNIT III: Modern vaccines (12 Hours)

Recombinant vector vaccines - viral, bacterial vectors; DNA vaccines - advantages, issues; edible vaccine - advantages - selection of plant (criteria). Vaccines against AIDS, leprosy, tuberculosis, malaria and CoViD – problems and challenges in development of vaccines. Veterinary vaccines- Vaccines against viral, bacterial and

parasitic infections in cattle, dogs and poultry; fish vaccines - vaccination methods and their relative merits.

UNIT IV: Vaccines for control of fertility (12 Hours)

Target antigen – hCG, LH, Mechanism of action – types of anti-fertility vaccines – natural and synthetic – (ZP and Sperm antigen vaccines), reversibility, delivery methods – safety and side effects –ethical and social considerations.

UNIT V: Vaccine development strategies (12 Hours)

Stages of vaccine developments – preclinical research, clinical trials, pre and post licensure practices. Vaccine design and formulation – antigen choice, delivery systems, production and manufacturing – cell culture based, purification and formulation, storage. Emerging technologies and delivery systems. Vaccine regulatory aspects.

Learning Resources:

Textbooks

1. Stanley A P., et al. (2021). *Plotkin's Vaccines*. Elsevier.
2. Milligan, G. N. and Barrett, A. D. (2014). *Vaccinology: An essential guide*. John Wiley & Sons.
3. Talwar G. P, Rao K. V. S and Chauhan V. S. (1994). *Recombinant and synthetic vaccines*, Narosa, New Delhi.

References

1. Benjamini E, Coico R and Sunshine G (2000). *Immunology a short course*. 4th Ed. Wiley-Liss Publication, NY.
2. Owen J. A., Punt J. and Stranford S. A. (2013). *Kuby Immunology*. 7th Ed. WH Freeman and Company, New York.
3. Outteridge P. M. (1985). *Veterinary Immunology*. Academic Press, London.
4. Morrow, W. J. W., Sheikh, N. A., Schmidt, C. S., and Davies, D. H. (2012). *Vaccinology: Principles and Practice*. John Wiley & Sons.

CO – PSO Mapping

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	2	2	2	3	3	2	2	3
CO2	3	3	2	2	2	3	3	2	2	3
CO3	3	3	3	3	2	3	3	3	2	3
CO4	3	3	2	2	2	3	3	3	2	3
CO5	3	3	2	3	3	3	3	2	3	3
Average	**3**	**3**	**2.2**	**2.4**	**2.2**	**3**	**3**	**2.4**	**2.2**	**3**

High Correlation - 3; Medium Correlation - 2; Low Correlation - 1

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIM5244	Professional Competency Skill	SEC	-	2

Microbiology is a branch of life science that evolves in a day to day manner with its application extending in medicine, food industry, agriculture and environment and so on. A diligent scientific approach will be used to examine the role of microorganisms to ensure a sustainable future. During the postgraduate program the students are trained to be technically proficient and competent. The research projects will enable them to identify scientific problems and solve those using scientific approaches with data collection, analysis and statistics. The modes of academic evaluation prepare the students to face competitive examinations with confidence. The theoretical and practical knowledge gained will enable the students to become competent and employable in public and the private sectors.

Course Outcomes:

At the end of the course, students will be able to

CO1: translate their technical expertise into research plans.
CO2: formulate innovative ideas for bio-business.
CO3: prepare for competitive examinations with confidence.
CO4: assess the opportunities for employment in public and the private sectors.
CO5: develop as a holistic individual with social responsibility and integrity.

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3
Average	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

High Correlation - 3; Medium Correlation - 2; Low Correlation - 1

Department of Microbiology (PG)

Value Added Courses

Sem	Course Code	Course Title	Hours/Wk	Credits
2	24MIM422V	Biocomposting	2	2
3	24MIM521V	Molecular Diagnostics	2	2

Course Code	Name of the Course	Category	Hours/Wk	Credits
24MIM422V	**Biocomposting**	**VAC**	**2**	**2**

This course is designed to provides basics of composting, its various methods and applications. This course aims to infuse knowledge about the maximum utilization waste in to useful products by means of composting. By visiting industries students will be enlighten and acquire information to become an entrepreneur.

Course Outcomes:

At the end of the course, students will be able to

CO1: discuses various eco-friendly methods for waste management.
CO2: explain the energy production potential of natural wastes
CO3: illustrate the utilization and nutritive value of agro-wastes.
CO4: explain the production of alternative energy and their importance.
CO5: enlighten the students with field exposure

UNIT I: Composting **(6 Hours)**

Definition - History - fundamentals - microorganisms involved - phases of composting - methods - materials used - applications.

UNIT II: **Vermicomposting** **(6 Hours)**

Definition - collection - characterization - composting methods - factors involved - methods of vermicompost - maintenance - harvesting.

UNIT III: Agro-waste **(6 Hours)**

Collection - role of microbes - fermentation - product recovery of products such as organic acids, vitamin and amino acids.

UNIT IV: Biofuels **(6 Hours)**

Biogas - Screening of waste (ligno-cellulose) - types of digester - factors - production of biogas; Bioethanol - raw materials - microbes involved - fermentation - product recovery.

UNIT V: Composting Management **(6 Hours)**

Emission sources - Offsite movement - Control and treatment - weather conditions - Material handling - Optimize Key Process variables – Treatments.

Learning Resources:

Textbooks

1. Campbell S , Adams N, (1998) The Gardener's Guide to Composting, 3rd edition, by Massachusetts: Storey Publishing.

References

1. Grover P. D. and Mishra, S. K. (1996). Biomass Briquetting: Technology and Practices. Published by FAO Regional Wood Energy Development Programme in Asia, Bangkok, Thailand.
2. Muradin M and Foltynowicz Z (2014). Potential for Producing Biogas from Agricultural Waste in Rural Plants in Poland. Sustainability, 6, 5065-5074.

CO – PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	2	2	1	3	2	3	3	3
CO2	3	3	2	2	1	3	2	3	3	3
CO3	3	3	2	2	1	3	1	3	3	3
CO4	3	3	2	2	2	3	1	3	3	3
CO5	3	3	2	2	2	3	2	3	3	3
Average	**3**	**3**	**2**	**2**	**1.4**	**3**	**1.6**	**3**	**3**	**3**

High Correlation - 3; Medium Correlation - 2; Low Correlation - 1

Course Code	Name of the Course	Category	Hours/Wk	Credits
24MIM521V	**Molecular Diagnostics**	**VAC**	**2**	**2**

This course offers insight into polymerase chain reaction as a tool for diagnosis of infections in a clinical setting. This will help students the various steps involved in the detection of genetic markers for accurate identification of infectious agents. It will equip students to set up and maintain a molecular biology laboratory.

Course Outcomes:

At the end of the course, students will be able to

CO1: discuss the importance of practical applications of a molecular diagnostics in clinical laboratory.
CO2: explain the significance of obtaining good quality nucleic acid samples for PCR reaction.
CO3: analyze and prepare for PCR reaction mixture and storage of PCR products.
CO4: assess PCR products by agarose gel electrophoresis.
CO5: demonstrate the detection of genetic markers by PCR.

UNIT I: Introduction to molecular diagnostics (6 Hours)

Molecular diagnostics lab layout- Setting up a PCR laboratory- Biosafety practices- practices to minimize contamination- good work practices- Practical applications of a molecular diagnostics in clinical laboratory medicine

UNIT II: Nucleic acid extraction (6 Hours)

Extraction method selection- Preparation of reagents- basic extraction steps- Nucleic acid quantity and purity analysis by spectrophotometry and gel electrophoresis

UNIT III: Polymerase chain reaction (PCR) (6 Hours)

Introduction to PCR- Basic steps involved in PCR- Components of PCR- Preparation of PCR reaction mix- Running a PCR reaction- Importance of negative controls and positive controls- Storage of PCR products. RT-PCR

UNIT IV: Analysis of PCR amplicons by gel electrophoresis (6 Hours)

Introduction to agarose gel electrophoresis- Reagent preparation- Separation of PCR products by AGE- Viewing of the amplicons by gel documentation- interpretation of results- troubleshooting

UNIT V: Demonstration of PCR **(6 Hours)**

Preparation of template DNA- preparation of PCR reaction mix- Performing PCR- Agarose gel electrophoresis- gel documentation.

Learning Resources:

Textbook

1. Stoddard, R. (2013). PCR Detection of Microbial Pathogens. Springer Protocols. Springer.

References

1. WHO (2004). Laboratory Biosafety Manual. World Health Organization.
2. Hayashi, K., Mullis, K. B., Ferré, F., and Gibbs, R. A. (1994). The Polymerase Chain Reaction Birkhäuser Basel.

CO – PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	2	2	2	2	3	3	3	3
CO2	3	3	2	3	3	3	2	3	3	3
CO3	3	3	2	3	3	2	2	3	3	3
CO4	3	3	2	3	3	3	2	3	3	3
CO5	3	3	2	3	3	2	2	3	3	3
Average	**3**	**3**	**2**	**3**	**3**	**2**	**2**	**3**	**3**	**3**

High Correlation - 3; Medium Correlation - 2; Low Correlation - 1