Department of Microbiology (UG)

Programme Specific Outcomes (PSOs)

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

PSO1 **Disciplinary Knowledge**	create, express, remember language and knowledge related to the important ideas in Microbiology, Biochemistry, Cell and Molecular Biology, Biotechnology, Immunology and Bioinformatics.
PSO2 **Communication Skills**	convey ideas, lab practical results both in oral and written formats.
PSO3 **Problem Solving**	show the ability to understand lab safety and are skilful in basic Microbiology laboratory skills.
PSO4 **Analytical Reasoning**	understand the array of microbes used as model organisms to study Microbiology, Genetics, Physiology, Ecology, Biotechnology, Immunology and Bioinformatics.
PSO5 **Research Skills**	show their knowledge in different methods of data collection and basic statistical methods.
PSO6 **Digital Literacy**	explain and access different digital platforms for learning core concepts in Biology and use them wisely
PSO7 **Leadership and Teamwork**	acquire the abilities required to lead and collaborate as a team.
PSO8 **Moral and Ethical Awareness/ Reasoning**	identify the ethical and moral issues and apply them in various aspects of their academic life.
PSO9 **Multicultural Competence**	mingle with students of diverse backgrounds and communities in a respectful, understanding and sensitive manner, thus preparing them for an inclusive higher education and work setting.
PSO10 **Self-directed & Lifelong Learning**	develop their academic and professional skills through dedication to the pursuit of continuous personal growth.

Department of Microbiology (UG)

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

Sem	Part	Course Code	Course Title	Hours/ Wk.	Credits	Marks
1	I	24XXXNNNN	Tamil / Hindi / French	3	2	30
1	II	24XXXNNNN	English	3	2	30
1	III CC	24MIC1501	Fundamentals of Microbiology and Microbial Diversity	5	5	75
1	III CC	24MIC1401	Basic and Clinical Biochemistry	4	4	60
1	III CC	24MIC1403	Fundamentals of Microbiology, Microbial Diversity and Biochemistry Lab	4	4	60
1	III S	24MIC1405	Cell Biology	5	4	60
1	IV NME	24XXXNNNN	*Non-Major Elective – I*	3	2	30
1	IV AEC	24MIC1200	Environmental Studies	3	2	30
1	V	24XXXNNNN	*NSS/NCC/PED/SLP/GMP/ GNS/LIB/ACH*	-	-	-
			Total	**30**	**25**	**375**
2	I	24XXXNNNN	Tamil / Hindi / French	3	2	30
2	II	24XXXNNNN	English	3	2	30
2	III CC	24MIC1502	Microbial Physiology and Metabolism	5	5	75
2	III CC	24MIC1402	Bioinstrumentation	4	4	60
2	III CC	24MIC1404	Microbial Physiology and Metabolism Lab	4	4	60
2	III S	24MIC1406	Microbial Ecology	5	4	60
2	IV NME	24XXXNNNN	*Non Major Elective – II*	3	2	30
2	IV AEC	24HVS/ CHR1200	Human Values Development/ Christian Studies	3	2	30
2	V	24XXXNNNN	*NSS/NCC/PED/SLP/GMP/ GNS/LIB/ACH*	-	1	15
			Total	**30**	**25+1**	**375+15**

Sem	Part	Course Code	Course Title	Hours/ Wk.	Credits	Marks
3	I	24XXXNNNN	Tamil / Hindi / French	3	2	30
3	II	24XXXNNNN	English	3	2	30
3	III CC	24MIC2501	Molecular Biology and Microbial Genetics	5	5	75
3	III CC	24MIC2503	Clinical Laboratory Technology	5	5	75
3	III CC	24MIC2301	Molecular Biology and Microbial Genetics Lab	3	3	45
3	III CC	24MIC2303	Clinical Laboratory Technology Lab	3	3	45
3	III S	24XXXNNNN	*Offered by Department of Biochemistry*	5	4	60
3	IV SEC	24XXXNNNN	*Skill Enhancement Course – I*	3	2	30
3	V	24XXXNNNN	*NSS/NCC/PED/SLP/GMP/ GNS/LIB/ACH*	-	-	-
			Total	**30**	**26**	**390**
4	I	24XXXNNNN	Tamil / Hindi / French	3	2	30
4	II	24XXXNNNN	English	3	2	30
4	III CC	24MIC2502	Immunology and Immunotechnology	5	5	75
4	III CC	24MIC2504	Food Processing Technology	5	5	75
4	III CC	24MIC2302	Immunology and Immunotechnology Lab	3	3	45
4	III CC	24MIC2304	Food Processing Technology Lab	3	3	45
4	III S	24XXXNNNN	*Offered by Department of Mathematics*	5	4	60
4	IV SEC	24XXXNNNN	*Skill Enhancement Course – II*	3	2	30
4	V	24XXXNNNN	*NSS/NCC/PED/SLP/GMP/ GNS/LIB/ACH*	-	1	15
			Total	**30**	**26+1**	**390+15**
5	III CC	24MIC3501	Bacteriology and Mycology	5	5	75
5	III CC	24MIC3503	Virology and Parasitology	5	5	75

Sem	Part	Course Code	Course Title	Hours/ Wk.	Credits	Marks
5	III CC	24MIC3401	Medical Microbiology Lab	4	4	60
	III CC	24MIC3403	Recombinant DNA Technology Lab	4	4	60
5	III DSE	24XXXNNNN	*Discipline Specific Elective – I*	5	4	60
5	III GE	24XXXNNNN	*Generic Elective – I*	4	3	45
5	IV IS	24MIC3255	Internship*	-	2	30
5	IV SEC	24XXXNNNN	*Skill Enhancement Course – III*	3	2	30
			Total	**30**	**29**	**435**
6	III CC	24MIC3402	Environmental and Agriculture Microbiology	4	4	60
6	III CC	24MIC3404	Food, Dairy and Probiotic Microbiology	4	4	60
6	III CC	24MIC3302	Environmental and Agriculture Microbiology Lab	3	3	45
	III CC	24MIC3304	Food, Dairy and Probiotic Microbiology Lab	3	3	45
6	III CC	24MIC3406	Project	4	4	60
6	III DSE	24XXXNNNN	*Discipline Specific Elective – II*	5	4	60
6	III GE	24XXXNNNN	*Generic Elective – II*	4	3	45
6	IV SEC	24MIC3266	Professional Competency Skill	3	2	30
			Total	**30**	**27**	**405**
			Grand Total	**180**	**158+2**	**2370+30**

* Internship – Second Year Vacation (30 Hrs.)

Part III

Discipline Specific Elective (DSE)

Sem	Part	Course Code	Course Title	Hours/Wk.	Credits	Marks
5	III	24MIC3405	Recombinant DNA Technology	5	4	60
		24MIC3407	Bioprocess Technology			
6	III	24MIC3408	Pharmaceutical Microbiology	5	4	60
		24MIC3410	Nanobiotechnology			

Supportive (offered to Department of Biochemistry)

Sem	Part	Course Code	Course Title	Hours/Wk.	Credits	Marks
3	III	24MIC2401	Basics of Microbiology (TcL)	5	4	60

Generic Elective (GE)

Sem	Part	Course Code	Course Title	Hours/Wk.	Credits	Marks
5	III	24MIC3301	Biosafety and Bioethics	4	3	45
		24MIC3303	Biocomposting			
6	III	24MIC3306	Entrepreneurship and Biobusiness	4	3	45
		24MIC3308	Scientific Writing			

Part IV

Non-Major Electives (NME)

Sem	Part	Course Code	Course Title	Hours/Wk.	Credits	Marks
1	IV	24MIC1201	Social and Preventive Medicine	3	2	30
2	IV	24MIC1202	Nutrition, Health and Hygiene	3	2	30

Skill Enhancement Courses (SEC)

Sem	Part	Course Code	Course Title	Hours/Wk.	Credits	Marks
3	IV	24MIC2201	Organic Farming and Biofertilizer Technology	3	2	30
4	IV	24MIC2202	Vaccine Technology	3	2	30
5	IV	24MIC3201	Stem Cell Technology	3	2	30

Mapping with POs

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

Mapping of courses with PSOs

Courses	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
24MIC1501	3	1	3	3	3	2	2	3	2	2
24MIC1401	3	1	3	1	2	2	1	2	2	2
24MIC1403	3	1	2	2	2	2	2	2	3	3
24MIC1405	3	1	2	2	1	2	2	2	2	3
24MIC1200	2	1	1	2	2	2	2	3	2	3
24MIC1502	3	1	3	3	3	2	2	2	2	3
24MIC1402	3	1	2	1	2	2	2	2	2	3
24MIC1404	3	1	3	3	2	2	2	1	2	3
24MIC1406	3	1	1	2	2	2	2	2	2	3
24MIC2501	3	2	1	3	1	2	2	2	2	3
24MIC2503	3	2	2	1	1	2	2	3	2	3
24MIC2301	3	2	3	3	2	1	2	2	2	3
24MIC2303	3	2	2	2	2	2	2	3	2	3
24MIC2502	3	2	2	2	2	3	2	3	2	3
24MIC2504	3	2	3	2	2	3	2	2	2	3
24MIC2302	3	2	2	2	3	1	2	3	2	3
24MIC2304	3	2	2	3	3	1	2	2	2	3
24MIC3501	3	3	3	3	3	3	3	3	3	3
24MIC3503	3	3	3	3	3	3	3	3	3	3
24MIC3401	3	3	3	3	3	1	3	2	3	3
24MIC3403	3	3	2	3	3	1	2	2	2	3
24MIC3405/ 24MIC3407	3	3	2	2	2	3	2	2	2	1
24MIC3255	3	3	3	3	3	3	3	3	3	3
24MIC3402	3	3	2	3	3	3	3	2	2	3
24MIC3404	3	3	2	3	3	3	3	2	2	3

24MIC3302	3	3	3	3	3	1	3	3	3	3
24MIC3304	3	3	3	3	2	1	3	3	3	3
24MIC3406	3	3	3	3	2	3	3	3	3	3
24MIC3408/ 24MIC3410	3	2	2	2	2	3	3	2	2	2
24MIC3266	3	3	3	3	3	3	3	3	3	3
AVERAGE	**2.9**	**2.1**	**2.4**	**2.5**	**2.3**	**2.1**	**2.3**	**2.4**	**2.3**	**2.8**

Mapping of courses with POs

Courses	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
24MIC1201	1	1	1	2	1	2	1	1	2	2
22MIC1202	1	1	3	1	1	2	1	1	1	3
24MIC2401	1	2	3	3	3	2	1	1	3	1
24MIC2201	3	2	3	2	3	2	2	2	2	2
24MIC2202	3	2	3	2	3	2	3	3	2	2
24MIC3301/ 24MIC3303	3	3	2	3	2	3	3	2	2	2
24MIC3201	3	2	2	2	2	3	2	3	2	2
24MIC3306/ 24MIC3308	3	2	2	1	3	3	3	3	3	3
AVERAGE	**2.3**	**1.9**	**2.4**	**2**	**2.3**	**2.4**	**2**	**2**	**2.1**	**2.1**

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIC1501	Fundamentals of Microbiology and Microbial Diversity	Core	5	5

This course deals with the fundamental principles, classification and different aspects of Microbiology including recent developments. It also describes the structural organization, morphology and reproduction of microbes and also provides basic methods of cultivation of microbes and measurement of growth. The course deals with the components and functions of various microscopes and other basic laboratory techniques including culturing, disinfection and sterilization.

Course Outcomes:

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

CO1: relate the historical events that led to the discoveries, inventions and the classification of microorganisms.
CO2: explain the detailed structure and functions of prokaryotic cell organelles.
CO3: describe the various pure culture techniques involved in culturing of microorganisms.
CO4: demonstrate the principles and working mechanism of different microscopes, their function and its scope of applications.
CO5: formulate the concept of asepsis, modes of sterilization and disinfectants in controlling microbes.

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

Classification – Three kingdom, five kingdom, six kingdom and eight kingdom. Microbial biodiversity: Introduction to microbial biodiversity- ecological niche. Basic concepts of Eubacteria, Archaebacteria and Eucarya. Conservation of Biodiversity.

UNIT II: General characteristics of cellular microorganisms (15 Hours)

(Bacteria, Algae, Fungi and Protozoa) and acellular microorganisms - (Viruses, Viroids, Prions), Differences between prokaryotic and eukaryotic microorganisms. Structure of Bacterial cell wall, cell membrane, capsule, flagella, pili, mesosomes, chlorosomes, phycobilisomes, spores, and gas vesicles. Structure of fungi (Mold and Yeast), Structure of microalgae.

UNIT III: Pure culture techniques (15 Hours)

Bacterial culture media and pure culture techniques. Mode of cell division, Quantitative measurement of growth. Anaerobic culture techniques.

UNIT IV: Microscopy (15 Hours)

Simple, bright field, dark field, phase contrast, fluorescent, electron microscope – TEM & SEM, Confocal microscopy, and Atomic Force Microscopy. Stains and staining methods.

UNIT V: Sterilization and disinfection (15 Hours)

Sterilization–moist heat - autoclaving, dry heat – Hot air oven, radiation – UV, Ionization, filtration – membrane filter and disinfection, antiseptic; Antimicrobial agents.

Learning Resources:

Textbooks

1. Pelczar. M. J., Chan E.C.S. and Noel. R.K. (2007). *Microbiology*. 7th Edition., McGraw –Hill, New York.
2. Willey J., Kathleen S., and Wood D., (2020). *Prescott's Microbiology*. 1st Edition., McGraw-Hill International edition.
3. Tortora, G.J., Funke, B.R., Case, C. L. (2013). *Microbiology. An Introduction* 11th Edition., A La Carte Pearson.
4. Salle. A.J (1992). *Fundamental Principles of Bacteriology*. 7th Edition., McGraw Hill Inc. New York.
5. Boyd, R.F. (1998). *General Microbiology,* 2nd Edition., Times Mirror, Mosby College, Publishing, St Louis.

References

1. Pommerville, J. C. (2013). *Fundamentals of microbiology*. Jones & Bartlett Publishers.
2. Stanier R.Y, Ingraham J. L., Wheelis M. L., and Painter R. R. (2010). *General Microbiology*, 5th Edition., MacMillan Press Ltd
3. Tortora, G.J., Funke, B.R. and, Case, C.L (2013). *Microbiology-An Introduction*,11th Edition., Benjamin Cummings.
4. Nester E., Anderson D., Roberts C. E., and Nester M. (2006). *Microbiology-A Human Perspective*, 5th Edition., McGraw Hill Publications.
5. Madigan M.T., Martinko J.M., Stahl D.A, and Clark D. P. (2010). *Brock - Biology of Microorganisms,* 13th Edition Benjamin-Cummings Pub Co.

Websites/ e-Learning Resources

1. https://www.cliffsnotes.com/study-guides/biology/microbiology/introduction-to-microbiology/a-brief-history-of-microbiology
2. https://www.keyence.com/ss/products/microscope/bz-x/study/principle/structure.jsp
3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6604941/#
4. https://bio.libretexts.org/@go/page/9188
5. https://courses.lumenlearning.com/boundless-microbiology/chapter/microbial-nutrition/

CO – PSO Mapping

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

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

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIC1401	Basic and Clinical Biochemistry	Core	4	4

This course on biological chemistry includes physical and chemical concepts in biology, composition, structure, functions and metabolism of carbohydrates, proteins and lipids. It describes the disorders in amino acid metabolism and helps to interpret the consequences, biochemical and clinical features, diagnosis and treatment of metabolic diseases of day today life.

Course Outcomes:

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

CO1: compare the structure, classification, biochemical functions and significance of carbohydrates and lipids

CO2: differentiate essential and non-essential amino acids, biologically important modified amino acids and their functions, Illustrate the role, classification of Proteins and recognize the structural level organization of proteins, its functions and denaturation.

CO3: categorize diseases to recognize defective enzymes and in-born errors related to carbohydrate and lipid metabolism.

CO4: discuss the various disorders of amino acid metabolism.

CO5: appraise the imbalances of enzymes in organ function and relate the role of clinical biochemistry in screening and diagnosis.

UNIT I: Biomolecules - Carbohydrate (12 Hours)

Carbohydrate – General properties, function, structure, classification– monosaccharides (Glucose, Fructose, Galactose), Oligosaccharides (Sucrose, Maltose, Lactose) and polysaccharides (Starch, Glycogen,) and biological significance. Lipids – General properties, functions, structure, classification (Simple, Derived and Complex), Cholesterol, LDL, HDL – biological significance.

UNIT II: Biomolecules - Amino acids & Proteins (12 Hours)

General properties, functions, structure, classification and biological significance. Proteins– General structure, Properties, functions, classification and biological significance.

UNIT III: Disorders of carbohydrate metabolism (12 Hours)

Disorders of Metabolism: Disorders of carbohydrate metabolism: diabetes mellitus, ketoacidosis, hypoglycemia, glycogen storage diseases, galactosemia and lactose intolerance. Disorders of lipid metabolism: hyperlipidemia, hyperlipoproteinemia, hypercholesterolemia, hypertriglyceridemia, sphingolipidosis.

UNIT IV: Disorders of amino acid metabolism (12 Hours)

Disorders of Metabolism: Disorders of amino acid metabolism: alkaptonuria, phenylketonuria, phenylalaninemia, homocystineuria, tyrosinemia, aminoacidurias.

UNIT V: Evaluation of organ function tests (12 Hours)

Assessment and clinical manifestations of renal, hepatic, pancreatic, gastric and intestinal functions. Diagnostic enzymes: Principles of diagnostic enzymology. Clinical significance of aspartate aminotransferase, alanine aminotransferase, creatine kinase, aldolase and lactate dehydrogenase.

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, Vaidyanathan K. (2019). *Textbook of Biochemistry for Medical Students.* Kindle edition, Jaypee Brothers Medical Publishers.
5. Jeremy M. Berg, Lubert Stryer, John L. Tymoczko, Gregory J. Gatto. (2015). *Biochemistry,* 8th Edition. WH Freeman publisher.

Reference

1. Amit Kessel and Nir Ben-Tal. (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. Stryer L , Berg J. M , John L. Gatto T , Gregory J. (2019). *Biochemistry.* 9th Edition, W. H. Freeman & Co. New York.
4. Voet D , Voet J, Charlotte Pratt. (2016). *Fundamentals of Biochemistry: Life at the Molecular Level*, 5th Edition, Wiley.

5. Joy PP, Surya S. and Aswathy C. (2015). *Laboratory Manual of Biochemistry*, 1st Edition., Publisher: Kerala Agricultural University.

Websites/ e-Learning Resources

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

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	1	3	2	2	2	1	1	2	2
CO2	3	1	1	1	2	2	1	1	2	2
CO3	3	1	3	1	3	2	1	2	2	2
CO4	3	1	3	1	3	2	1	2	3	2
CO5	3	1	3	1	2	2	1	2	3	2
Average	**3**	**1**	**2.6**	**1.2**	**2.4**	**2**	**1**	**1.6**	**2.4**	**2**

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

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIC1403	**Fundamentals of Microbiology, Microbial Diversity and Biochemistry Lab**	**Core**	**4**	**4**

This lab course provides basic knowledge in good laboratory practices and safety measures. The course will train students in sterilization techniques, preparation of media, isolation of pure cultures from the various samples, staining methods and microscopy. It also deals with pH metry, colorimetry, chromatography and estimation of various biochemical compounds.

Course Outcomes:

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

CO1: practice sterilization methods, media preparation and their quality control.
CO2: demonstrate pure culture isolation techniques and pigment production of microbes.
CO3: differentiate microbes through microscopic methods, staining techniques and motility test.
CO4: analyze the biomolecules using various analytical techniques.
CO5: measure different macro molecules of diverse biological origin.

List of Experiments:

1. Microbiological good laboratory practice and safety.
2. Sterilization and assessment of sterility– Autoclave, hot air oven, and membrane filtration.
3. Media preparation: liquid media, solid media, semi-solid media, agar slants, agar deeps, agar plates.
4. Pure culture techniques: streak plate, pour plate, serial dilution.
5. Staining techniques: smear preparation, simple staining and Gram's staining.
6. Microscopy: light microscopy and bright field microscopy.
7. Lactophenol Cotton Blue and KOH staining.
8. Motility: stabbing and Hanging drop method
9. Microbial Diversity using Hay Infusion Broth-Wet mount.
10. pH metry – preparation of buffer
11. Chromatography methods – Thin Layer and Paper
12. Colorimetry

13. Quantitative analysis of Protein
14. Quantitative analysis of Carbohydrates
15. Quantitative analysis Lipid

Learning Resources:

Textbooks

1. Cappucino J . G and Sherman N. (1996). *A lab manual Benjamin Cummins*, New York 1996.
2. Kannan. N. (1996). *Laboratory manual in General Microbiology*. Palani Publications.
3. Sundararaj T. (2005). *Microbiology Lab Manual* (1st edition) publications.
4. Gunasekaran, P. (1996). *Laboratory manual in Microbiology*. New Age International Ld., Publishers, New Delhi.
5. Plummer D T. (1996) *An Introduction to Practical Biochemistry*, Tata – McGraw – Hill.

References

1. Atlas. R. (1997). *Principles of Microbiology*, 2nd Edition, Wm. C. Brown publishers.
2. Amita J, Jyotsna A and Vimala V. (2018). *Microbiology Practical Manual*. (1st Edition). Elsevier India
3. Talib VH. (2019). *Handbook Medical Laboratory Technology*. (2nd Edition). CBS
4. Wheelis M. (2010). *Principles of Modern Microbiology,* 1st Edition. Jones and Bartlett Publication.
5. Rajan. S and Christry R.S. (2009) *Experimental procedures in Life Sciences*, Anjana Book House Publishers and Distributors, Chennai.

Websites/ e-Learning Resources

1. http://www.biologydiscussion.com/micro-biology/sterilisation-and-disinfection-methods-and principles-microbiology/24403.
2. https://www.grsmu.by/files/file/university/cafedry//files/essential_microbiology.pdf
3. https://microbiologyinfo.com/top-and-best-microbiology-books/
4. https://www.cliffsnotes.com/studyguides/biology/microbiology/introduction-to-microbiology/a-brief-history-of-microbiology
5. https://open.umn.edu/opentextbooks/textbooks/404

CO – PSO Mapping

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

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

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIC1405	Cell Biology	Core	5	4

This course offers students the basic structure of prokaryotic and eukaryotic cells and their organelles. It will help them understand the features common to all cells, from microbes to mammals. Students will learn how cells interact with each other and the outer environment, the importance of cytoskeleton in various cellular processes such as intracellular transport, cell division.

Course Outcomes:

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

CO1: recall various milestones in the discovery of the structure of diverse cells, their basic properties and functions.
CO2: describe the fine structure of the plasma membrane, intercellular junctions and adhesion molecules aiding in cellular organization.
CO3: identify the structure and functions of organelles and the cytoskeleton.
CO4: discuss and compare various cell signalling strategies adapted by cells to convert external signals to various cellular responses.
CO5: evaluate the mechanisms of cell division, growth and death.

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

The discovery of cells- cell theory- basic properties of cells- characteristics that distinguish prokaryotic and eukaryotic cells- cellular organisation - types of prokaryotic cells- types of eukaryotic cells.

UNIT II: Membranes and junctions **(15 Hours)**

Structure of plasma membrane- Fluid mosaic model- Functions of plasma membrane. Transport across membrane- channels, pumps, carriers- absorption of glucose from the intestine. Endocytosis- exocytosis- membrane trafficking. Extracellular matrix- cell adhesion- intercellular junctions.

UNIT III: Cellular organelles and the cytoskeleton **(15 Hours)**

Mitochondria, chloroplasts, peroxisomes, endoplasmic reticulum, secretory membrane system and Golgi apparatus, nucleus. Cytoskeleton- major functions of the cytoskeleton. Actin fibres, microtubules, intermediate filaments- Centrioles and centrosomes- mechanism of muscle contraction and the role of cytoskeleton.

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

Cell signalling- local signalling and long-distance signalling-Three stages of cell signalling- a preview of reception, transduction and response. Receptors in the plasma membrane- G protein coupled receptors, Receptor tyrosine kinases- ion channel receptors- intracellular receptors. Signal transduction pathways- Protein phosphorylation and dephosphorylation- second messengers. Responses- cellular and cytoplasmic responses. Mechanism of cholera toxin- stimulation of glycogen breakdown by epinephrine.

UNIT V: Cell cycle **(15 Hours)**

Key roles of cell division- Cell cycle- Phases of the cell cycle- Mitosis- Meiosis. Regulation of cell cycle. Apoptosis, Cancer as an example of loss of cell cycle controls.

Learning Resources:

Textbooks

1. Plopper, G., Ivankovic, D. B. (2020). Principles of Cell Biology. United States: Jones & Bartlett Learning, LLC.
2. Urry, L. A., Cain, M. L., Wasserman, S. A., Minorsky, P. V., Orr, R. B. (2020) . Campbell Biology. United Kingdom: Pearson.

References

1. Karp, G., Iwasa, J., Marshall, W. (2020). Karp's Cell and Molecular Biology. United Kingdom: Wiley.

2. Mason, K. A., Singer, S., Raven, P. H., Losos, J., Johnson, G. B. (2016). Rave n, Biology © 2017, 11e (AP Edition) Student Edition. United States: McGraw-Hill Education.

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://bio.libretexts.org/Bookshelves/Introductory_and_General_Biology/Book%3A_General_Biology_(Boundless)/09%3A_Cell_Communication#:~:text=Cellular%20communication%20ensures%20regulation%20of,single%2Dcelled%20to%20multicellular%20organisms.&text=Receptors%2C%20either%20i

ntracellular%20or%20cell,which%20activate%20numerous%20cellular%20processes.
4. https://bio.libretexts.org/Courses/University_of_California_Davis/BIS_2A%3A_Introductory_Biology_(Easlon)/Readings/14%3A_The_Cytoskeleton.
5. https://bio.libretexts.org/Bookshelves/Introductory_and_General_Biology/General_Biology_2e_(OpenStax)/02%3A_Unit_II-The_Cell/2.07%3A_Cell_Reproduction/2.7.05%3A_Cancer_and_the_Cell_Cycle#:~:text=Uncontrolled%20growth%20of%20the%20mutated,constant%20cell%20number%20in%20homeostasis.

CO – PSO Mapping

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

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

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIC1201	Social and Preventive Medicine	NME	3	2

The course offers the concepts of health- disease and their social determinants. It summarizes the health management systems and highlights various health care services. The framework outlines the goals of preventive medicine and emphasizes the knowledge of alternative medicine.

Course Outcomes:

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

CO1: explain the evolution of health information systems and policies.
CO2: compare various factors associated with health management systems.
CO3: identify the appropriate health care services.
CO4: appraise the role of preventive medicine and diagnosis in community setting.
CO5: recognise the usage of alternative medicine during disease outbreaks.

UNIT I: Introduction to social medicine (9 Hours)

History of social medicine-concepts of health and disease-social determinants of health and disease-Health and quality of life-Health information system- measures of population health-health policies.

UNIT II: Health management (9 Hours)

Applications of behavioral sciences and psychology in health management-nutritional programs for health management-water and sanitation in human health-national programs for communicable and non-communicable diseases- environmental and occupational hazards and their control.

UNIT III: Health care and services (9 Hours)

Health care of the community-information, education, communication and training in health-maternal and child health-school health services- Geriatrics-care and welfare of the aged-mental health-health services through general practitioners.

UNIT IV: Preventive medicine (9 Hours)

Introduction- role of preventive medicine- levels of prevention-Risk assessment in communities and vulnerable population –surveillance, monitoring and reporting of disease outbreaks - forecasting and control measures in community setting – early detection methods.

UNIT V: Prevention through alternate medicine (9 Hours)

Unani, Ayurveda, Homeopathy, Naturopathy systems in epidemic and pandemic outbreaks. International health regulations. Infectious disease outbreak case studies and precautionary response during SARS and MERS coronavirus, Ebola and novel SARS-COV2 outbreaks.

Learning Resources:

Textbooks

1. Park.K (2021). *Textbook of preventive and social medicine*, 26th edition. Banarsidas Bhanot publishers.
2. Mahajan & Gupta (2013). *Text book of preventive and social medicine*, 4thedition. Jaypee Brothers Medical Publishers.
3. Chun-SuYuan, Bieber E. J , Bauer B (2006). *Textbook of Complementary and Alternative Medicine*. Second Edition. Routledge publishers.
4. Jain V, (2020). *Review of Preventive and Social Medicine: Including Biostatics*. 12th edition, Jaypee Brothers Medical Publishers.
5. Sunder L. A. P (2011). *Textbook of Community Medicine: Preventive and Social Medicine*, CBS publisher.

References

1. Waitzkin H, Pérez A, Anderson M (2021). *Social Medicine and the coming Transformation.* First Edition. Routledge publishers.
2. Prabhakara GN (2010). *Short Textbook of Preventive and Social Medicine.* Second Edition. Jaypee publishers.
3. Suls J. M , Davidson K. W , Kaplan R. M. (2010). *Handbook of Health Psychology and Behavioural Medicine*. Guilford Press.
4. Muller M. E , Muller M , Bezuidenhout M, Jooste K (2006). *Health Care Service Management*. Juta and Company Ltd.
5. Rose G (2008). *Rose's Strategy of Preventive Medicine: The Complete*.OUP Oxford.

Websites/ e-Learning Resources

1. https://www.omicsonline.org/scholarly/social--preventive-medicine-journals-articles-pptslist.php
2. https://www.teacheron.com/online-md_preventive_and_social_medicine-tutors
3. https://www.futurelearn.com
4. https://www.healthcare-management-degree.net
5. https://www.conestogac.on.health-care-administration-and-service-management

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	1	1	2	1	2	1	1	3	2
CO2	1	1	1	2	1	2	1	1	3	2
CO3	1	1	1	2	1	2	1	1	2	2
CO4	1	1	1	1	1	2	1	1	2	2
CO5	1	1	1	3	1	2	1	1	2	3
Average	**1**	**1**	**1**	**2**	**1**	**2**	**1**	**1**	**2.4**	**2.2**

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

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIC1200	**Environmental Studies**	**AEC**	**3**	**2**

This course is designed to introduce the importance, knowledge and issues related to the environment. It focuses on the natural resources, energy flow and types of ecosystems. The significance of biodiversity, hotspots, endangered species and conservation are emphasized. It also highlights the social issues and population explosion in the environment.

Course Outcomes:

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

CO1: recognize the significance of renewable and non-renewable resources.
CO2: describe the concept, functions and types of ecosystems.
CO3: discuss the importance of biodiversity and its conservation.
CO4: compare different types of pollution and assess the various waste management strategies
CO5: evaluate the importance of environmental issues, climate change and population explosion.

UNIT I: Introduction to environmental studies (9 Hours)

Definition – scope and importance - Need for public awareness – Role of people and institutions in Environment protection - Natural resources: Renewable and Non-renewable resources - Natural resources and management - Concept of sustainability and sustainable development.

UNIT II: Ecosystems (9 Hours)

Concept, Structure and functions of ecosystem – Producers - consumers and decomposers. Energy flow in an ecosystem - food chain, food web and ecological succession – Types of ecosystems: Forest – Grassland - Desert - Aquatic.

UNIT III: Biodiversity and its conservation (9 Hours)

Introduction- definition - Types of diversity: genetic- species and ecosystem biodiversity - Value of biodiversity: Consumptive use - productive use - social, ethical and aesthetic values- Biodiversity at global, national and local levels. India as a mega diversity nation - Hotspots - Threats to biodiversity: habitat loss, poaching of wildlife, man- wildlife conflicts- Endangered and endemic species of India- Conservation of biodiversity: *In- situ* and *Ex-situ* conservation.

UNIT IV: Environmental pollution (**9 Hours)**

Definition, causes, effects and control measures of air, water, soil, noise and thermal pollution - Nuclear hazards - Global warming: Depletion of ozone layer - greenhouse effect. Solid waste management - Disaster management.

UNIT V: Social issues and the environment **(9 Hours)**

Environmental movements: Chipko - Appiko- Silent valley - Bishnois of Rajasthan. Rain water harvesting - watershed management - Human rights - Rights of animals. Environment protection Act - Wildlife protection Act - Forest conservation Act - Public awareness - use of Environmental Calendar for Activities - Human Population and the Environment: Population explosion - Family welfare programme - urbanization – town planning - environment and human health.

Learning Resources:

Textbooks

1. Batra S. K and Batra K and Kaur H, (2023), *Environmental Studies* 6th Edition, Taxmann Publications.
2. Arumugam N , Kumaresan V (2017), *Environmental studies Based on UGC syllabus*, Sara S Publications, India.
3. Chawla S (2017), *Textbook of Environmental studies*, MC GRAW HILL Education, India.
4. Bharucha E (2013), *Textbook of Environmental studies for Undergraduate courses*, 2nd edition, Universities press (India) Private Ltd.
5. Asthana D K , Chand S & Co Ltd, (2010). *A Textbook of Environmental Studies*, S Chand & Co Ltd.

References

1. Myneni S R (2019) *Environmental Studies*, Asia Law House, Hyderabad**.**
2. Kaushik A and C.P. Kaushik (2014), *Perspectives in Environmental Studies*, 4th multicolour edition, New Age International (P) Limited Publishers.
3. Thatheyus A.J (2011) *Textbook of Environmental Studies*, Narosa Publishing House, New Delhi.

Websites/ e-Learning Resources

1. https://www.ugc.gov.in/oldpdf/modelcurriculum/env.pdf
2. https://alison.com/tag/environmental-education
3. https://vardhaman.org/wp-content/uploads/2021/03/ENVIRONMENTAL-SCIENCE-1.pdf

4. https://mcphs.libguides.com/sustainability_and_environmental_resources/free_online_resources
5. https://www.unep.org/explore-topics/education-environment/what-we-do/massive-open-online-courses

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	1	1	1	2	2	2	2	2	2	2
CO2	2	1	1	2	1	2	2	2	2	2
CO3	2	1	1	2	2	2	2	3	3	3
CO4	2	1	2	2	2	2	3	3	3	3
CO5	2	1	1	2	1	2	2	3	2	3
Average	**1.8**	**1**	**1.2**	**2**	**1.6**	**2**	**2.2**	**2.6**	**2.4**	**2.6**

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

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIC1502	**Microbial Physiology and Metabolism**	**Core**	**5**	**5**

This course provides students the information on physiology and metabolism of microbes. It aims to emphasize on the nutritional diversifications and uptake of nutrients by microbes and their growth. The students are exposed to the basic ideas on nature of energy, concepts of thermodynamics and oxidation reduction reactions. It gives an opportunity to learn the basic principles and pathways in microbial metabolism

Course Outcomes:

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

CO1: describe the concept of microbial growth and identify the factors affecting bacterial growth.
CO2: distinguish microbes based on nutrition and evaluate the methods of nutrient uptake
CO3: analyze the pathways to compare anaerobic and aerobic energy production in microbes.
CO4: compare the process of photosynthesis in bacteria and eukaryotic microbes.
CO5: interpret the modes of reproduction in bacteria, fungi, algae and protozoa

UNIT I: Physiology of microbial growth (15 Hours)

Batch – continuous - synchronous cultures; Growth Curve and measurement method (turbidity, biomass, and cell count). Control of microbial growth.

UNIT II: Microbial nutrition (15 Hours)

Nutrition requirements - Photoautotrophs, Photoorganotrophs, Chemolithotrophs (Ammonia, Nitrite, Sulfur, Hydrogen, Iron oxidizing Bacteria), Chemoorganotrophs. Nutrition transport mechanisms – Passive diffusion and Active transport. Factors affecting microbial growth.

UNIT III: Microbial metabolism (15 Hours)

An overview of Metabolism - Embden Meyerhof Pathway, Entner-Doudoroff Pathway, Pentose Phosphate Pathway, Tricarboxylic Acid Cycle. Electron Transport Chain and Oxidative Phosphorylation. ATP synthesis. Fermentation-Homolactic

Fermentation, Heterolactic Fermentation, Mixed Acid Fermentation, Butanediol Fermentation.

UNIT IV: Photosynthesis (15 Hours)

An Overview of chloroplast structure. Photosynthetic Pigments, Light Reaction-Cyclic and non-cyclic Photophosphorylation. Dark Reaction - Calvin Cycle.

UNIT V: Reproduction in microbes (15 Hours)

Binary fission, Budding, Reproduction through conidia, cyst formation, endospore formation. Fungi asexual and sexual reproduction, Microalgae reproduction. Asexual and sexual reproduction of protozoa.

Learning Resources:

Textbooks

1. Willey J., Kathleen S., and Wood D., (2020). *Prescott's Microbiology*. 1st Edition., McGraw-Hill International edition.
2. Schlegal, H.G. (1993). *General Microbiology*., 7th Edition, Press syndicate of the University of Cambridge.
3. Rajapandian K. (2010). *Microbial Physiology*, Chennai: PBS Book Enterprises India.
4. Kumari. M S. *Microbial Physiology*, Chennai 1st Edition MJP Publishers 2006.
5. Dubey R.C. and Maheswari, S. (2003). *A textbook of Microbiology*, New Delhi: S. Chand & Co.
6. Reddy S R, Reddy S. M (2008). *Microbial Physiology*. Anmol Publications Pvt Ltd.

References

1. Poole R. K (2004). *Advances in Microbial Physiology*, Elsevier Academic Press, New York, Volume 49.
2. Kim B.H., Gadd G.M. (2008). *Bacterial Physiology and Metabolism*. Cambridge University Press, Cambridge.
3. Caldwell D. R. (1995). *Microbial Physiology & Metabolism* Wm.C. Brown Communications, Inc. USA.
4. Moat, A.G and J.W Foaster (1995). *Microbial Physiology*, 3rd edition. Wiley – LISS, A John Wiley & Sons. Inc. Publications.
5. Shrivastava. D (2011). *Microbial Physiology and Metabolism: Study of Microbial Physiology and Metabolism*. Lambert academic Publication.

Websites/ e-Learning Resources

1. https://courses.lumenlearning.com/boundless-microbiology/chapter/microbial-Nutrition
2. https://onlinecourses.swayam2.ac.in/cec20_bt14/preview
3. http://web.iitd.ac.in/~amittal/2007_Addy_Enzymes_Chapter.pdf
4. https://www.frontiersin.org.microbial-physiology-and-metabolism
5. https://sites.google.com/site/microbial physiologyoddsem/teaching-contents

CO – PSO Mapping

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

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

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIC1402	Bioinstrumentation	Core	4	4

This course will help the students understand the analytical instruments and study the basic principles of instruments used in the field of life-sciences. The students can gain knowledge about principles of spectroscopy, chromatography and electrophoresis. It will also enable students to learn various imaging and radiation-based techniques in clinical diagnosis.

Course Outcomes:

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

CO1: relate the basics of instrumentation in biology
CO2: describe the structure of atoms and molecules using the principles of spectroscopy.
CO3: analyze macromolecules through chromatography and electrophoresis.
CO4: demonstrate the need and applications of imaging techniques.
CO5: assess the principles, working mechanisms and applications of fluorescence and radiation based instruments.

UNIT I: Basic instruments (12 Hours)

pH meter, Buffer of biological importance, Centrifuge- Preparative, Analytical and Ultra, Laminar Air Flow, Autoclave**,** Hot Air Oven and Incubator. Biochemical calculations-preparations of Molar solutions - Buffers- Phosphate, Acetate, TE, TAE- calculation of Normality ,PPM- Ammonium sulphate precipitation.

UNIT II: Spectroscopy (12 Hours)

Spectroscopic Techniques: Colorimeter, Ultraviolet and visible, Infra-red and Mass Spectroscopy- Circular Dichroism

UNIT III: Chromatographic and electrophoresis techniques (12 Hours)

Chromatographic Techniques: Paper, Thin Layer, Column, HPLC and GC. Electrophoresis Techniques: Starch Gel, AGE, PAGE.

UNIT IV: Imaging techniques **(12 Hours)**

Principle, Instrumentation and application of ECG, EEG, EMG, MRI, CT and PET scan radioisotopes.

UNIT V: Fluorescence and radiation based techniques **(12 Hours)**

Spectrofluorimeter, Fluorescent and confocal microscopes, Flame photometer, Scintillation counter, Geiger Muller counter, Autoradiography.

Learning Resources:

Textbooks

1. Jayaraman J (2011). *Laboratory Manual in Biochemistry*, 2nd Edition. Wiley Eastern Ltd., New Delhi.
2. Ponmurugan. P and Gangathara PB (2012). *Biotechniques*.1st Edition. MJP publishers.
3. Veerakumari, L (2009). *Bioinstrumentation*- 5 thEdition -.MJP publishers.
4. Upadhyay and Nath (2002). *Biophysical chemistry – Principles and techniques* 3rd Edition. Himalaya publishing home.
5. Chatwal G and Anand (1989). *Instrumental Methods of Chemical Analysis*. S. Himalaya Publishing House, Mumbai.

References

1. Rodney. F. Boyer (2000). *Modern Experimental Biochemistry*, 3rd Edition. Pearson Publication.
2. Skoog A., West M (2014). *Principles of Instrumental Analysis* – 14th Edition W. B. Saunders Co., Philadephia.
3. N. Gurumani. (2006). *Research Methodology for biological sciences*- 1st Edition – MJP Publishers.
4. Wilson K, and Walker J (2010). *Principles and Techniques of Biochemistry and Molecular Biology*. 7th Edition. Cambridge University Press.
5. Webster, J.G. (2004). *Bioinstrumentation*- 4th Edition - John Wiley & Sons (Asia) Pvt. Ltd, Singapore.

Websites/ e-Learning Resources

1. http://www.biologydiscussion.com/biochemistry/centrifugation/centrifugeintroduction-types- uses-and-other-details-with-diagram/12489
2. https://www.watelectrical.com/biosensors-types-its-working-andapplications/
3. http://www.wikiscales.com/articles/electronic-analytical-balance/ Page 24 of 75

4. https://study.com/academy/lesson/what-is-chromatography-definition-typesuses.html
5. http://www.rsc.org/learn-chemistry/collections/spectroscopy/introduction

CO – PSO Mapping

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

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

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIC1404	**Microbial Physiology and Metabolism Lab**	**Core**	**4**	**4**

The laboratory course starts with 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. Different biochemical methods needed for the identification of unknown bacteria will also be dealt with.

Course Outcomes:

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

CO1: experiment the hanging drop, wet mount preparation, semi-solid agar, Craigie's tube method.
CO2: demonstrate smear preparation, permanent specimen preparation, capsular, and acid-fast staining.
CO3: practice antibiotic sensitivity testing: Disc diffusion test- quality control with standard strains.
CO4: measure the size of yeast, fungal filaments and protozoa.
CO5: compare the morphological, physiological, and biochemical features of the bacteria for identification.

List of Experiments:

1. Maintenance of pure culture, paraffin method, stab culture, maintenance of mold culture.
2. Motility demonstration: hanging drop, wet mount preparation, semi-solid agar, Craigie's tube method.
3. Staining techniques: Smear preparation, permanent specimen preparation, Capsular, and Acid-fast staining.
4. Direct counts – Direct cell count (Petroff-Hausser counting chamber), Turbidometry.
5. Viable count - pour plate, spread plate.
6. Bacterial growth curve.
7. Anaerobic culture methods.
8. Antibiotic sensitivity testing: Disc diffusion test- quality control with standard strains.
9. Morphological variations in algae, fungi and protozoa.

10. Micrometry: Demonstration of the size of yeast, fungal filaments and protozoa.
11. Methods of bacterial identification- morphological, physiological, and biochemical methods - IMViC test, H_2S, TSI, Oxidase, catalase, urease test, and carbohydrate fermentation test.

Learning Resources:

Textbooks

1. Cappucino J. G and Sherman. N MB (1996). *A lab manual Benjamin Cummins*, New York.
2. Kannan. N (1996). *Laboratory manual in General Microbiology*. Palani Publications.
3. Sundararaj T (2005). *Microbiology Lab Manual* (1st edition) publications.
4. Gunasekaran. P (2007). *Laboratory manual in Microbiology*. New age international publisher.
5. Cooper E (2018). *Microbial Physiology: A Practical Approach*. Callisto Reference publisher.

References

1. White D , Drummond J, Fuqua C (2012) *Physiology and Biochemistry of Prokaryotes.* 4th Ed. Oxford University Press, New York.
2. Poole R.K (2004). *Advances in Microbial Physiology*, Elsevier Academic Press, New York, Volume 49.
3. Kim B.H., Gadd G.M. (2008). *Bacterial Physiology and Metabolism.* Cambridge University Press, Cambridge.
4. Dawes, I.W and Sutherland L.W (1992). *Microbial Physiology* (2nd edition), Oxford Blackwell Scientific Publications.
5. Moat, A.G and J.W Foaster, (1995). *Microbial Physiology*, 3rd edition. Wiley – LISS, A John Wiley & Sons. Inc. Publications.

Websites/ e-Learning Resources

1. https://sites.google.com/site/microbial physiologyoddsem/teaching-contents
2. https://courses.lumenlearning.com/boundless-microbiology/chapter/microbial-Nutrition
3. https://onlinecourses.swayam2.ac.in/cec20_bt14/preview
4. https://www.studocu.com/microbial-physiology-practicals
5. https://www.agr.hokudai.ac.jp/microbial-physiology

CO – PSO Mapping

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

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

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIC1406	Microbial Ecology	Supportive	5	4

This course provides the basic concepts of microbial diversity in different ecosystems. It deals with the various interactions of microbes with plants, animals and humans. It also enlightens on various microbial communities and their habitats. It provides methods to characterize the microbial diversity in relation to the biogeochemical cycles. It also highlights the application of microbes in ecosystem restoration.

Course Outcomes:

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

CO1: describe the concepts of microbial ecology.
CO2: explain the interactions of microbes with other life forms.
CO3: compare the microbial diversity of natural and engineered habitats.
CO4: analyze the role of microbes in different biogeochemical cycles.
CO5: appraise the applications of microbes in environmental remediation.

UNIT I: Concept of microbial ecology (15 Hours)

Microbial Evolution and Phylogeny - Ecology of microorganisms –Microbial diversity – Community structure of microbes in natural environments - Individuals and populations: productivity, growth, distribution, activity. Communities: colonization, succession, diversity, structure. Microbial functions in ecosystem.

UNIT II: Microbial interactions (15 Hours)

Interactions of microorganisms with their physical and chemical environment – interactions with the biotic environment: symbiosis, competition, parasitism, predation; Interactions within microbial communities: in vivo interactions – microbiome, quorum sensing, syntropy, antibiosis; Interactions of microorganisms with algae and plants; Interactions of microorganisms with animals and humans.

UNIT III: Ecology of natural and engineered microbial habitats (15 Hours)

Air, water and soil borne microbes – role of microbes in natural and engineered habitats- construction of Winogradsky column; Marine ecosystems; ocean surface , tidal flats, estuaries , deep -sea , methane seeps, anoxic basins ; Freshwater

ecosystems: lakes, rivers and ponds; Terrestrial ecosystems: rocks , soil and forest; Extreme environments: deserts , hot springs glaciers, deep subsurface; Synthetic communities and applied microbial ecology ; Evolving communities; evolutionary ecology and community stability.

UNIT IV: Measurement of microbial diversity- Biogeochemical cycles (15 Hours)

Characterization of microbial communities - Culture – based methods, biomarkers, cell strains, PCR, metagenomics, pyrosequencing – Carbon cycle, decomposition of organic matter, lignin and cellulose, xenobiotics; Nitrogen metabolism (Nitrogen cycle) – Sulfur cycle, Geothermal vents, acids mine drainage and sulfur reduction.

UNIT V: Applications of microbes in ecosystem management (15 Hours)

Bioremediation - concept, methods and microbes involved Waste water treatment - Activated sludge and trickling filter. Microbial degradation - oil spills, heavy metals, microplastics and pesticides. Bioleaching – Mechanism and applications.

Learning Resources:

Textbooks

1. McLean R. J. C, . Barton L. L , 2019 *Environmental Microbiology and Microbial Ecology*, Willy Blackwell Publication.
2. Atlas R.M., and Bartha R 1998. *Microbial Ecology: Fundamentals and Applications*. 4th ed. Addison-Wesley, NY.
3. Kumar P, 2021. *Fundamentals of ecology and environment*. (2nd edition).

References

1. Marshall K.C., 2012. *Advances in Microbial Ecology* - Volume 12, Plenum Press, New York.
2. Barton L.L , Northup D. E, 2011. *Microbial Ecology*, Willy Blackwell Publication.
3. Lynch J.M., and Hobbie J. E. 1988. *Microbial Ecology: A Conceptual Approach.* Blackwell Scientific Publication.

Websites/e – Learning Resources

1. https://www.ncbi.nlm.nih.gov/pubmed/11571135
2. https://science.sciencemag.org/content/348/6237/1261359.full
3. https://doi.org/10.1016/j.ecolmodel.2017.06.020
4. https://www.nature.com/articles/nclimate1951
5. https://www.abdn.ac.uk/staffpages/uploads/mbi010/Nature%20Reviews%20in%20Microbiology%205,%20384-392.pdf

CO – PSO Mapping

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	1	1	3	2	2	1	2	2	3
CO2	3	1	1	2	2	2	1	2	2	3
CO3	3	1	1	2	2	2	2	2	3	3
CO4	3	1	1	2	2	2	2	2	2	3
CO5	3	1	2	3	2	2	2	3	3	3
Average	**3**	**1**	**1.2**	**2.4**	**2**	**2**	**1.6**	**2.2**	**2.4**	**3**

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

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
22MIC1202	Nutrition, Health and Hygiene	NME	3	2

This course will enable the students to learn about nutrition and its importance. It helps the students to understand the need for a balanced diet for a healthy life. It imparts knowledge on different governmental health care programs. It also educates students to know about different health indicators and hygienic practices.

Course Outcomes:

At the end of the course, students will able to

CO1: describe the importance of nutrition for a healthy life.
CO2: explain the importance of balanced diet in different stages of life.
CO3: illustrate the consequences of poor dietary practices.
CO4: manage the health at individual and community levels.
CO5: create awareness on community health and hygiene.

UNIT I: Basics of nutrition (9 Hours)

Definition, importance, Good nutrition, and mal nutrition; Balanced Diet: Basics of Meal Planning. Carbohydrates, Lipids, Proteins and Vitamins –functions, dietary sources, effects of deficiency. Macro and micro minerals – functions, effects of deficiency; food sources of Calcium, Potassium, and Sodium; food sources of Iron, Iodine, and Zinc. Importance of water– functions, sources, requirements and effects of deficiency.

UNIT II: Nutrition for different stages of life (9 Hours)

Balanced diet - Normal, Pregnant, lactating women, Infancy, young children Adolescents, Adults, and the Elderly; Diet Chart; Nutritive value of Indian foods.

UNIT III: Improper diets (9 Hours)

Definition, Identification, Signs and Symptoms - malnutrition, under-nutrition, over-nutrition, Protein Energy Malnutrition, obesity; Nutritional Disease and Disorder - hypertension, diabetes, anemia, osteomalacia, cardiovascular disease.

UNIT IV: Health indicators and health policies (9 Hours)

Determinants of health, Key Health Indicators, Environment health & Public health; Health-Education: Principles and Strategies. Health Policy and Health Organizations: Health Indicators and National Health Policy of Govt. of India; Functioning of various nutrition and health organizations in India.

UNITV: Hygienic practices and sanitation (9 Hours)

Definition; Personal, Community, Medical and Culinary hygiene; WASH (Water, Sanitation and Hygiene) programme. Rural Community Health: Village health sanitation & Nutritional committee. Community and Personal Hygiene: Environmental Sanitation and Sanitation in Public places.

Learning Resources:

Textbooks

1. Bamji, M.S., Krishnaswamy K and Brahmam G. N. V (2009) *Textbook of Human Nutrition* (3rd edition) Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Swaminathan (1995) *Food & Nutrition* (Vol I, Second Edition) The Bangalore Printing & Publishing Co Ltd., Bangalore.
3. Haldar S. K (2022). *Occupational Health and Hygiene in Industry*. CBS Publishers.
4. Acharya, Sankar, Rama Das and Minati Sen (2021). *Health Hygiene and Nutrition Perception and Practices*. Satish Serial Publishing House.
5. Dass (2021). *Public Health and Hygiene*, Notion Press.

References

1. Khader V (2000) *Food, nutrition & health*, Kalyan Publishers, New Delhi.
2. Srilakshmi, B., (2010) *Food Science*, (5th Edition) New Age International Ltd., New Delhi.
3. Goel A. K. (2005). *A College Textbook of Health & Hygiene*, ABD Publishers.
4. Sharma D. (2015). *Textbook on Food Science and Human Nutrition*. Daya Publishing House.
5. Revilla M. K. F., Titchenal A. and Draper J. (2020). *Human Nutrition.* University of Hawaii, Mānoa.

Websites/ e-Learning Resources

1. https://nhm.gov.in/index1.php?lang=1&level=1&sublinkid=969&lid=49

2. https://nhm.gov.in/index1.php?lang=1&level=1&sublinkid=970&lid=137
3. https://nhm.gov.in/index1.php?lang=1&level=1&sublinkid=149&lid=225
4. https://www.nhp.gov.in/healthylivingViewall

CO – PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	1	1	2	1	1	2	1	1	1	3
CO2	1	1	3	1	1	2	1	1	1	3
CO3	1	1	3	1	1	2	1	1	1	3
CO4	1	1	2	1	2	2	1	1	1	3
CO5	1	1	3	2	2	2	1	1	1	3
Average	**1**	**1**	**2.6**	**1.2**	**1.4**	**2**	**1**	**1**	**1**	**3**

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

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIC2501	**Molecular Biology and Microbial Genetics**	**Core**	**5**	**5**

This course deals with the basics 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 phages, yeast and bacteria.

Course Outcomes:

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

CO1: explain the structure and replication of DNA.
CO2: describe the significance and functions of RNA in protein synthesis.
CO3: categorize the types of DNA mutation and DNA repair mechanisms.
CO4: analyse the role of plasmids and phages in microbial genetics.
CO5: appraise the mechanisms of gene transfer between microbes

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

DNA Structure - Salient features of double helix, forms of DNA. Denaturation and renaturation. DNA topology – Supercoiling, linking number, topoisomerases. DNA organization in prokaryotes, viruses and eukaryotes. Replication of DNA in prokaryotes and eukaryotes - Bidirectional and unidirectional replication, semi-conservative and semi-discontinuous replication. Mechanism of DNA replication – enzymes involved – DNA polymerases, DNA ligase, primase. DNA replication modes - rolling circle, D-loop modes.

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

Transcription in Prokaryotes- Concept of transcription. RNA Polymerases, General transcription factors and processes of transcription in prokaryotes and eukaryotes. Translation in prokaryotes and eukaryotes - Translational machinery - ribosome structure, tRNA structure and processing. Inhibitors of protein synthesis. Overview of regulation of gene expression - *lac, trp* and *ara* operons as examples. Regulation of gene expression by DNA methylation.

UNIT III: Mutation and repair mechanisms (15 Hours)

Mutation - Definition and types - base substitutions, frameshifts, deletions, insertions, duplications, inversions. Silent, conditional, and lethal mutations. Physical and chemical mutagens. Reversion and suppression. Uses of mutations. Repair Mechanisms - Photoreactivation, Nucleotide Repair, Base Excision Repair, Methyl Directed Mismatch Repair and SOS Repair.

UNIT IV: Extrachromosomal DNA, Yeast and Phage biology (15 Hours)

Plasmid replication and partitioning, host range, plasmid incompatibility, plasmid amplification, regulation of plasmid copy number, curing of plasmids. Types of plasmids – R Plasmids, F plasmids, colicinogenic plasmids, metal resistance plasmids, Ti plasmid, linear plasmids, yeast 2µ plasmid, Recombinant plasmid – pBR 322. Bacteriophage - T4, Virulent Phage – Structure and lifecycle. Lambda phage- Structure, Lytic and Lysogenic cycle. Applications of Phages in Microbial Genetics.

UNIT V: Gene transfer mechanisms (15 Hours)

Transformation - Natural Competence and Transformation. Conjugation and its uses. Transduction - Generalized and Specialized. Transposable elements - Prokaryotic transposable elements – insertion sequences, composite, and non-composite transposons. Uses of transposons. Mechanism of transposition: Types - Replicative and non- replicative transposition.

Learning Resources:

Textbooks

1. Malacinski G.M. (2008). *Freifelder's Essentials of Molecular Biology*. 4th Edition. Narosa Publishing House, New Delhi.
2. Gardner E. J. Simmons M. J. and Snusted D.P. (2006). *Principles of Genetics*. 8th Edition. Wiley India Pvt. Ltd.
3. Watson, J. D. (2024). *Molecular biology of the gene.*, 8th Ed. Garland Science.
4. Snyder L. Champness W &Champness W. (2020). *Molecular Genetics of Bacteria*. 5th Ed American Society for Microbiology
5. Trun N. and Trempy J. (2009). *Fundamental Bacterial Genetics.* 1st Edition. Blackwell Science Ltd.
6. Brown T. A. (2024). *Gene Cloning and DNA Analysis- An Introduction*. (7th Edition). JohnWiley and Sons, Ltd.
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.

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. and Cox, M.M. Lehninger (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. Primrose S.B. and Twyman R. M. (2006). *Principles of Gene Manipulation and Genomics*. (7th Edition). Blackwell Publishing.

Websites/ e-Learning Resources

1. [PDF] Lehninger Principles of Biochemistry (8th Edition) By David L. Nelson and Michael M. Cox Book Free Download - StudyMaterialz.in
2. https://microbenotes.com/gene-cloning-requirements-principle-steps-applications/
3. https://courses.lumenlearning.com/boundless-biology/chapter/dna-replication/
4. Molecular Biology Notes - Microbe Notes
5. 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	1	3	1	2	2	2	2	3
CO2	3	2	1	3	1	3	2	2	2	3
CO3	3	2	1	3	1	2	2	2	2	3
CO4	3	2	2	3	1	3	2	2	2	3
CO5	3	2	2	3	1	2	2	2	2	3
Average	**3**	**2**	**1.4**	**3**	**1**	**2.4**	**2**	**2**	**2**	**3**

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

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIC2503	Clinical Laboratory Technology	Core	5	5

This course is intended to train the students to learn the opportunities of a biologist in a clinical scenario. The students learn the principles and practices of the clinical laboratory diagnostics. The importance of specimen collection, preservation, handling and reporting will be taught. The students will acquire awareness of automation in clinical laboratories.

Course Outcomes:

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

CO1: recall the ethical and professional codes of conduct with patients, laboratory and health- care professionals.
CO2: explain how accurate and reliable information might be obtained about proper collection, storage, and handling of laboratory specimens.
CO3: prepare biological specimens for histopathological examinations.
CO4: analyse blood samples for various haematological disorders**.**
CO5: evaluate quality control principles and practices in clinical laboratory.

UNIT I: Introduction to clinical laboratory science (15 Hours)

Basic laboratory principles - Code of conduct for medical laboratory personnel - Organization of clinical laboratory and role of medical laboratory technician - Safety measures. Assessment of a patient and brief history of collection. Maintenance of Hygiene & Infection Control Practices.

UNIT II: Specimen collection and processing (15 Hours)

Blood, urine, stool, sputum CSF, amniotic fluid and bile. Separation of serum and plasma, Handling of specimens for testing, preservation of specimens, transport of specimens and factors affecting the clinical results.

UNIT III: Introduction to histopathology (15 Hours)

Methods of examination of tissues and cells, Fixation of tissues: Classification and properties of fixatives. Tissue processing - Collection of specimens, Labeling and fixation, Dehydration, Clearing, Impregnation, Embedding - Paraffin block making, Section Cutting, Microtomes – types and mounting of sections.

UNIT IV: Introduction to haematology (15 Hours)

Laboratory methods used in the investigation of coagulation disorders - coagulation tests , Routine coagulation tests, (prothrombin time , plasma recalcification time, partial thromboplastin time , activated partial thromboplastin time, thrombin time), Laboratory diagnosis of bleeding disorders. Estimation of fibrinogen, Assay of coagulation factors.

UNIT V: **Quality standards in health-care laboratories** (**15 hours)**

Development and implementation of standards, Accreditation Boards –NABL, ISO, CAP, COLA, Performing quality assessment - pre-analytical, analytical, and post-analytical phases of testing.

Learning Resources:

Textbooks

1. Mukharji, K. L. (2000). *Medical Laboratory Techniques*, Vol - I, II & III, 5th Edition. Tata McGraw Hill, Delhi.
2. Ochei, A., Kolhatkar. A. (2000). *Medical Laboratory Science: Theory and Practice*, McGraw Hill Education.
3. Ramnik Sood (2015). *Concise Book of Medical Laboratory Technology: Methods and Interpretation*, 2nd Edition, Jaypee Brothers Medical Publishers, New Delhi.
4. Ramakrishnan S, Sulochana K. N (2012). *Manual of Medical Laboratory Techniques*, Jaypee Brothers Medical Publishers Pvt. Ltd
5. Talib V.H. (2019). *Handbook Medical Laboratory Technology*, 2nd Edition, Directorate of health services, Government of India.

References

1. Rutherford, B.H., Gradwohl A.C, Jarett S. J , Gradwohls. (2000). *Clinical Laboratory Methods and Diagnosis*, Vol-I, 8th edition, Mosby.
2. Baker, F.J., Silverton, R.E., and Pallister,. J. (1998). *An Introduction to Medical Laboratory Technology*, 7th Edition, CBS Publishers and Distributors Pvt. Ltd.
3. Godkar (2021). *Textbook of Medical Laboratory Technology*, 3rd Edition, Bhalani Publishing House.
4. Chatterjee M. N and Shinde. R (2008). *Textbook of Medical Biochemistry*, 7th Edition, Jaypee Brothers Medical Publishers Pvt. Limited.
5. Cappucino J.G and Sherman N. (2016). *Microbiology – A laboratory manual.* (5th Edition). The Benjamin publishing company. New York.

Web Resources

1. https://www.jaypeedigital.com › book
2. https://www.pdfdrive.com › wintrobes-clinical-hematology
3. https://currentprotocols.onlinelibrary.wiley.com/doi/pdf/10.1002/cpet.5
4. https://vlab.amrita.edu/index.php?sub=3&brch=272
5. https://nptel.ac.in/courses/102105087

CO – PSO Mapping

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

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

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIC2301	**Molecular Biology and Microbial Genetics Lab**	**Core**	**3**	**3**

This course provides basic knowledge on functioning of various equipments in molecular biology laboratory. It equips the students 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: recall the working principles of equipments used in molecular biology laboratory and various structures of nucleic acids.
CO2: use the methods of isolation and estimation of nucleic acids.
CO3: demonstrate the methods of DNA and protein separation.
CO4: experiment the methods of isolation of auxotrophic and antibiotic-resistant mutants.
CO5: formulate the methods for artificial transformation and isolation of phages.

List of experiments:

1. Demonstration of lab equipments such as pH Meter, Electronic balance, use of glass and micropipettes, Autoclave, Deep freezer, Water bath, Centrifuge, Colorimeter and UV spectrophotometer.
2. Micrographs/ Model / schematic representations of different types of DNA and RNA.
3. Isolation of Genomic and Plasmid DNA from *E. coli*.
4. Isolation of RNA by Trizol method.
5. Estimation of DNA using colorimeter (diphenylamine reagent) and UV spectrophotometer (A260 measurement).
6. Qualitative Analysis by Agarose gel electrophoresis.
7. Resolution and visualization of proteins by polyacrylamide gel electrophoresis (SDS-PAGE) – Demonstration.
8. UV induced auxotrophic mutant production and isolation of mutants by replica plating technique – Demonstration.
9. Isolation of antibiotic-resistant mutants by gradient plate method. - Demonstration
10. Artificial Transformation in *E. coli*.
11. Screening and isolation of phages from sewage.

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. James G Cappucino. and Natalie Sherman. (2016). *Microbiology – A laboratory manual*. (5th Edition). The Benjamin publishing company. New York.

References

1. Glick B. R. and Patten C.L. *Molecular Biotechnology – Principles and Applications of Recombinant DNA*. 5th Edition. ASM Press. 2018.
2. Russell P.J. (2010). *Genetics - A Molecular Approach*, 3rd Edition., Pearson New International edn.
3. Nelson, D.L. and Cox, M.M. Lehninger (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. (2024). *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.org3.
5. https://currentprotocols.onlinelibrary.wiley.com/doi/pdf/10.1002/cpet.5

CO – PSO Mapping

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

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

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIC2303	**Clinical Laboratory Technology Lab**	**Core**	**3**	**3**

This lab course is intended to impart knowledge and training to be employed in clinical laboratory. The students will be trained in essential assays of clinical or diagnostic laboratory. The course highlights the evolving technology that has led to the automation of diagnostic systems in the present clinical care settings.

Course Outcomes:

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

CO1: record the required patient details for collection and proper handling of clinical specimens.
CO2: collect and process blood samples for diagnosis.
CO3: interpret blood grouping, ESR and haematological parameters.
CO4: prepare biological specimens like urine and tissue for clinical examination.
CO5: setup and process samples for molecular diagnosis.

List of experiments:

1. Basic laboratory principles, safety and practices for maintenance of a clinical laboratory
2. Medical Record maintenance, preservation of samples and follow-up methods
3. Venipuncturing and collection of blood
4. Separation of serum/ plasma from whole blood
5. Differential staining of the cells of the blood
6. Total Count/ Differential count of the cells in a smear of blood and by hemocytometry.
7. Erythrocyte sedimentation rate
8. Determination of clotting time and bleeding time
9. Blood grouping (ABO blood groups)
10. Widal's test to test for *Salmonella typhi*
11. VDRL test and ELISA
12. Collection of urine for physical, chemical and microscopic examination.
13. Collection of tissue specimen for histopathology
14. Isolation of DNA/RNA from blood sample for PCR.
15. Automated systems for sampling, processing and reporting (Visit to Clinical Laboratory)

Learning Resources:

Textbooks

1. Mukharji, K. L. (2000). *Medical Laboratory Techniques*, Vol - I, II & III, 5th Edition. Tata McGrawHill, Delhi.
2. Ochei, A., Kolhatkar. A. (2000). *Medical Laboratory Science: Theory and Practice*, McGraw Hill Education.
3. Sood R (2015). *Concise Book of Medical Laboratory Technology: Methods and Interpretation*, 2nd Edition, Jaypee Brothers Medical Publishers, New Delhi.
4. Ramakrishnan S, Sulochana K. N (2012). *Manual of Medical Laboratory Techniques*, Jaypee Brothers Medical Publishers Pvt. Ltd
5. Talib V.H. (2019). *Handbook Medical Laboratory Technology*, 2nd Edition, Directorate of health services, Government of India.

References

1. Rutherford, B.H. Gradwohl, A.C. Sonnenwirth L. Jarett. Gradwohls. (2000). *Clinical Laboratory Methods and Diagnosis*, Vol-I, 8th edition, Mosby.
2. Baker, F.J., Silverton, R.E., and Pallister,.J. (1998). *An Introduction to Medical Laboratory Technology*, 7th Edition, CBS Publishers and Distributors Pvt. Ltd.
3. Godkar (2021). *Textbook of Medical Laboratory Technology*, 3rd Edition, Bhalani Publishing House.
4. Chatterjee M. N and Shinde R. (2008). *Textbook of Medical Biochemistry*, 7th Edition, Jaypee Brothers Medical Publishers Pvt. Limited.
5. Cappucino J. G . and Sherman N. (2016). *Microbiology – A laboratory manual*. (5th Edition). The Benjamin publishing company. New York.

Web Resources

1. https://www.jaypeedigital.com › book
2. https://www.pdfdrive.com › wintrobes-clinical-hematology
3. https://currentprotocols.onlinelibrary.wiley.com/doi/pdf/10.1002/cpet.5
4. https://vlab.amrita.edu/index.php?sub=3&brch=272
5. https://nptel.ac.in/courses/102105087

CO – PSO Mapping

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	2	2	2	2	2	3	3	2	3
CO2	3	2	2	2	2	3	2	3	2	3
CO3	3	2	2	2	2	2	2	3	2	3
CO4	3	2	3	3	2	2	3	3	3	3
CO5	3	2	2	2	2	3	2	3	3	3
Average	**3**	**2**	**2.2**	**2.2**	**2**	**2.4**	**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
24MIC2401	**Basics of Microbiology (TcL)**	**Supportive**	**5**	**4**

This course provides insight into the theories of microbial evolution, scope, microbial taxonomy and orientation to the laboratory: rules of conduct and general safety. It also deals with the basics of microscopy and their applications in identifying microbes. Emphasizes will be given in culturing and control of microorganisms both in theory and practice. The course will enlighten the students to categorize the microorganisms based on their structure, taxonomy and properties along with practical exposure.

Course Outcomes:

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

CO1: describe theories on discovery of microorganisms and rules and general safety measures to be followed inside the laboratory.
CO2: use microscope to identify bacteria based on staining procedures
CO3: prepare different types of media for culturing and control of microorganisms.
CO4: categorize microorganisms based on their structure and properties.
CO5: analyze fungi and protists based on their structure and characteristics features along with isolation and identification of fungi.

UNIT I: Introduction to microbiology (15 Hours)

Discovery of microorganisms – Koch's postulates – Germ theory of disease - Golden era of Microbiology; Microbial evolution – classification. Scope of microbiology.

Lab component:

- Orientation to the laboratory: rules and general safety measures

UNIT II: Basics of microscopy (15 Hours)

Principle and working mechanism of bright-field and dark-field, phase contrast, fluorescence and electron microscopy. Smear preparation and staining of microorganisms. Microbial size and shape.

Lab components:

- Smear preparation and simple staining

- Gram staining

UNIT III: Culturing, Counting and Control of microbes (15 Hours)

Culturing microorganisms – Media - composition, types; techniques of pure culture isolation and preservation; Counting of bacteria; methods of microbial control-physical and chemical.

Lab components:

- Preparation of solid and liquid media, Preparation of agar slant, and agar plate
- Serial dilution
- Pure culture techniques: pour, spread, streak methods

UNIT IV: Bacteria and Virus (15 Hours)

Bacteria – cell structure, Growth curve- factors affecting growth; Archaea – diversity and general characteristics; Virus – properties.

Lab components:

- Observation of bacterial motility by Hanging drop method
- Negative staining

UNIT V: Fungi and Protists (15 Hours)

Structure and characteristics of fungi. Distribution and characteristic of protists.

Lab components:

- Isolation of fungi by Warcup method
- Lactophenol cotton blue staining for fungi

Learning Resources:

Textbooks

1. Prescott L.M, Harley J. P and Klein D.A. (2016). *Microbiology*. 10 edn, McGraw Hill Book Co, New Delhi.
2. Tortora, G. J., Funke, B. R., Case, C. L., & Johnson, T. R. (2018). *Microbiology: an introduction* (Vol. 13). San Francisco, CA: Benjamin Cummings.
3. Pelczar JM., Chan ECS., and Krieg NR. (1998). *Microbiology*. India: McGraw-Hill Education.
4. Atlas. R (1997). *Principles of Microbiology*, 2nd Edition, Wm. C. Brown publishers.

5. Amita J, Jyotsna A and Vimala V (2018). *Microbiology Practical Manual*. (1st Edition). Elsevier India

References

1. Jacquelyn G. Black (2018), *Microbiology*, 8th edn, John Wiley & Sons International Publication.
2. Slonczewski, J. L., & Foster, J. W. (2013). *Microbiology: An evolving science: Third international student edition*. WW Norton & Company.
3. Pommerville, J. C., & Alcamo, I. E. (2012). *Alcamo's Fundamentals of Microbiology: Body systems edition*. Jones & Bartlett Publishers.

Websites/ e-Learning Resources

1. https://www.cliffsnotes.com/study-guides/biology/microbiology/introduction-to-microbiology/a-brief-history-of-microbiology
2. https://www.keyence.com/ss/products/microscope/bz-x/study/principle/structure.jsp
3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6604941/#
4. https://bio.libretexts.org/@go/page/9188
5. https://courses.lumenlearning.com/boundless-microbiology/chapter/microbial-nutrition/
6. http://www.biologydiscussion.com/micro-biology/sterilisation-and-disinfection-methods-and principles-microbiology/24403
7. https://www.ebooks.cambridge.org/ebook.jsf?bid=CBO9781139170635

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	2	2	2	3	3	1	1	3	1
CO2	1	2	3	3	3	3	1	1	3	1
CO3	1	2	3	3	2	2	1	1	3	1
CO4	1	2	3	3	3	2	1	1	3	1
CO5	1	2	3	2	3	2	1	1	3	1
Average	**1**	**2**	**2.8**	**2.6**	**2.8**	**2.4**	**1**	**1**	**3**	**1**

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

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIC2201	**Organic Farming and Biofertiliser Technology**	**SEC**	**3**	**2**

This course imparts knowledge about the significance of organic farming strategies to increase the yield and to conserve environment. It emphasizes on the importance of organic farming in areas and comprehensive knowledge about bacterial bio fertilizers. It highlights the applications of cyanobacterial and fungal biofertilizer. It enhances the knowledge and skill to produce, analyze the quality of packaging, storage and understand the efficacy of biofertilizers.

Course Outcomes:

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

CO1: recall the principles of organic farming for sustainability.
CO2: describe the importance of organic farming in urban areas.
CO3: compare the bacterial biofertilizers and its advantages.
CO4: plan the appropriate use of Cyanobacterial and fungal bio fertilizers.
CO5: evaluate the methods of production and quality control.

UNIT I: Principles of organic farming (9 Hours)

Principles of health, fairness, ecological balance, and care. Environmental benefits of organic farming: sustainability- reduces non- renewable energy by decreasing agrochemical need. Biodiversity- crop rotation, inter-cropping. Ecological services – biological control, soil formation and nutrient cycling.

UNIT II: Organic farming for urban space (9 Hours)

Create a Sustainable Organic Garden (Backyard- Square Foot Gardening, Small Space Gardening, Mini Farming) Composting, Vermicomposting.

UNIT III: Bacterial biofertilizers (9 Hours)

Introduction, advantages and future perspective. Structure and characteristic features of bacterial biofertilizers- *Azospirillum, Azotobacter, Bacillus, Pseudomonas, Rhizobium* and *Frankia.*

UNIT IV: Algal and fungal Biofertilizers (9 Hours)

Structure and characteristic features of Cyanobacterial biofertilizers- *Anabaena, Nostoc;* Structure and characteristic features of fungal biofertilizers- AM mycorrhiza.

UNIT V: Production and quality analysis (9 Hours)

Production of *Rhizobium, Azotobacter, Anabaena*; Biofertilizers -Storage, shelf life, quality control and marketing.

Learning Resources:

Textbooks

1. Sharma A.K. (2006). *Hand book of Organic Farming*.
2. Gaur A.C. (2017). *Hand book of Organic Farming and Biofertilizers*.
3. Subbarao N.S. (2017). *Bio-fertilizers in Agriculture and Forestry* (4th Edition) Med tech publisher
4. Rao S, N. S. (2002). *Soil Microbiology. Soil Microorganisms and Plant Growth*. (4th Edition), Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
5. Dubey, R. C. (2008). *A Textbook of Biotechnology*. S. Chand & Co., New Delhi.

References

1. Fukuoka M, LappeF M , Berry W (2009). The One-Straw Revolution: An Introduction to Natural Farming, 1st edition, YRB Classics.
2. Chakrabarty S (2018). Organic Home Gardening Made Easy, 1st Edition,
3. Singh and Purohit (2008). Biofertilizer technology. Agrobios, India.
4. Bansal M (2019). Basics of Organic Farming CBS Publisher.
5. Hurst, C.J., Crawford R.L., Garland J.L., Lipson D.A., Mills A.L. and Stetzenbach L.D. (2007). Manual of Environmental Microbiology. (3rd Edition). American Society for Microbiology.

Websites/ e – Learning Resources

1. https://agritech.tnau.ac.in/org_farm/orgfarm_introduction.html
2. https://www.fao.org/organicag/oa-faq/oa-faq6/en/
3. https://www.india.gov.in/topics/agriculture/organic-farming
4. https://agriculture.nagaland.gov.in/bio-fertilizer/

CO – PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	2	2	3	3	3	2	2	3	1
CO2	3	2	2	2	3	3	3	2	3	1
CO3	3	2	3	3	3	3	2	2	2	3
CO4	3	2	3	2	3	3	3	2	2	3
CO5	3	2	3	2	2	3	2	2	2	3
Average	**3**	**2**	**2.6**	**2.4**	**2.8**	**3**	**2.4**	**2**	**2.4**	**2.2**

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

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIC2502	**Immunology and Immunotechnology**	**Core**	**5**	**5**

This course aims to give a basic understanding of immunology and its various applications. It covers topics such as complement, antigens, antibody structures and its isotypes, antigen-antibody interactions along with cell- mediated immune responses. Autoimmunity, hypersensitivity reactions, and immunodeficiency disorders are also covered. Additionally, it highlights the principles, procedures and applications of advanced immunological tools and techniques.

Course Outcomes:

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

CO1: underline the fundamental concepts of immunity, contributions of the organs and cells in immune responses.
CO2: describe the significance of antigen, antibodies and vaccines
CO3: use immunological assays and techniques in sample analysis.
CO4: explain the immunologic processes in transplantation and tumour immunology.
CO5: analyze the immune system disorders like hypersensitivity, autoimmunity and AIDS.

UNIT I: Organs and cells of the immune system (15 Hours)

Organs and Cells of the Immune System and Immune Response: Primary lymphoid organs, secondary lymphoid organs, and lymphoid tissues; T – cell and B –cell membrane bound receptors – apoptosis; T - cell processing, presentation and regulation; T –cell subpopulation, properties, functions and T – cell suppression; Physiology of immune response- innate, humoral and cell mediated immunity; Immunohematology.

UNIT II: Antigen and Antibody (15 Hours)

Antigen and Antibody: Antigens – Types - Properties of haptens, epitopes, adjuvants, and cross reactivity; Antibodies- structure, properties, classes; Antigen and Antibody Reactions: precipitation, agglutination, complement fixation, opsonization, neutralization; Vaccines – active and passive immunization; Classification of vaccines; Other approaches to new vaccines; Types of vaccine - antibacterial, antiviral; Vaccination schedule.

UNIT III: Immunoassay and Immunotechniques (15 Hours)

Immunoassay and Immunotechniques - Preparation and standardization of bacterial antigens; Raising of monoclonal and polyclonal antibodies; Purification of antibodies. Immunotechniques - RIA, RAST, ELISA, Immuno fluorescence techniques and Flow cytometry, Agglutination reactions.

UNIT IV: Transplantation and tumor immunology (15 Hours)

Transplantation and Tumor Immunology - MHC Antigens - structure and function; HLA system - Regulation and response to immune system; Transplantation immunology - tissue transplantation and grafting; Mechanism of graft acceptance and rejection; HLA typing; Tumor specific antigens; Immune response to tumors; Immune diagnosis; cancer immune therapy.

UNIT V: Immunological disorders and diseases (15 Hours)

Immunological disorders and diseases - Hypersensitivity reactions (Type I, II, III and IV); acquired immunodeficiency syndrome; Auto immune disorders and diseases: organ specific and systemic.

Learning Resources:

Textbooks

1. Abbas A. K., Lichtman A. H. and Pillai S. (2021). *Cellular and Molecular Immunology*. (10th Edition). Elsevier.
2. Owen JA., Punt J and Stranford SA. (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. Rich R. R, Thomas A. Fleisher, William T. Shearer, Harry Schroeder, Anthony J. Frew, Cornelia M. Weyand. (2018). *Clinical Immunology: Principles and Practice*, 5th Edition. Elsevier.
5. Gupta P.S . (2003). *Clinical Immunology*. Oxford University Press.

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. Clark W. R . (1991). *The Experimental Foundations of Modern Immunology*. 3rdEdition. John Wiley and Sons Inc. New York.
5. Rose N.R, Friedman H, Fahey J. L . (1986). *Manual of Clinical Laboratory Immunology*. ASM.3rd Edition.

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. https://www.ncbi.nlm.nih.gov/books/NBK7795/
5. https://www.sciencedirect.com/topics/immunology-and-microbiology/immunology

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	2	1	1	1	3	1	3	2	3
CO2	3	2	3	3	3	3	3	3	2	3
CO3	3	2	3	3	3	3	3	3	3	3
CO4	3	2	1	1	3	3	2	3	2	3
CO5	3	2	1	1	1	3	3	3	3	3
Average	**3**	**2**	**1.8**	**1.8**	**2.2**	**3**	**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
24MIC2504	Food Processing Technology	Core	5	5

This course aims to introduce the fundamental concepts of food preservation techniques and food quality assessment. This will enable the students to effectively understand the basic principles of food processing techniques to improvise the shelf-life. It aims to impart students with basic knowledge relating to conceptual principles of food processing and its various methods. It focuses on food safety and regulations.

Course Outcomes:

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

CO1: recall the fundamental concepts of food preservation.
CO2: interpret the quality assessment of meat and fish.
CO3: design the processing of milk and milk quality assessment parameters.
CO4: explain the importance of fats and oil processing.
CO5: assess the food safety and adulteration.

UNIT I: Fundamentals of food preservation (15 Hours)

Introduction to food preservation –objectives and techniques of food preservation. Preservation: principles of high temperature, low temperature, radiation, chemical preservatives and bio preservatives.

UNIT II: Food quality assessment (15 Hours)

Freshness criteria and quality assessment of meat and fish –spoilage and methods of preservation. Production of byproducts after processing waste and their utilization. Role of packaging material, types of packaging material.

UNIT III: Milk processing and fermented products (15 Hours)

Composition of milk; assessment of milk, thermal processing of fluid milk-pasteurization (LTH, HTST & UHT techniques). Fermented milk products-cheese, Butter milk, Yogurt, Kumis, Kefir and Acidophilus milk. Hygiene and sanitation requirement in food processing and fermentation industries.

UNIT IV: Fat and oil processing **(15 Hours)**

Importance of fats and oils in Food - Extraction of fats and Oils - Rendering, pressing, solvent extraction, pressing of oil- degumming, refining, bleaching, deodorization, fractionation, pyrolysis of fats, toxicity of frying oil.

UNIT V: Food safety and regulations **(15 Hours)**

Methods for the microbiological examination of foods. Food-borne illness and diseases. Microbial cultures for food fermentation. Indian Factories Act on safety, HACCP, Safety from adulteration of food.

Learning Resources:

Textbooks

1. Sangeeta, Kiran P R , Mishra N , Kaur R , Suneetha T.B., Gupta S, Hasan.W , 2024. *Food Processing and Technology*. Nipa Genx Electronic Resources & Solutions Pvt Ltd. 266p.
2. Warris, D.S. 2020. *Food Processing and Preservation* 2nd Vol. CBS Publishers and Distributors Pvt LTD. 952 p
3. Adams M.R. and Moss M. O (2007). *Food Microbiology*. New Age International.
4. Sharma A. (2006). *Text Book of Food Science and Technology*, International Book Distributing Co, Lucknow, UP.
5. Sivasankar. (2005). *Food Processing and Preservation*, 3rd Edition., Prentice Hall of India Pvt Ltd, New Delhi.

References

1. Fellos PJ. (2005). *Food Processing Technology: Principle & Practice* 2nd Edition. CRC.
2. Zeuthen P and Bogh-Sorenson L . (2005). *Food Preservation Techniques*, Woodland Publishing Ltd, Cambridge, England.1
3. Gustavo V, Barbosa-Canovas, Maria S. Tapia and Cano M. P. (2004). *Novel Food Processing Technologies*, CRC.
4. Bhatti S, Varma U. (1995). *Fruit and vegetable processing organizations and institutions*, 1st Edition., CBS Publishing, New Delhi.
5. Mirajkar M, Menon S. (2002). *Food Science and Processing Technology* Vol-2, Commercial processing and packaging, Kanishka Publishers, New Delhi.

Websites/ e-Learning Resources

1. https://sites.google.com/a/uasd.in/ecourse/food-processing-technology
2. https://nptel.ac.in/courses/126105015
3. https://engineeringinterviewquestions.com/biology-notes-on-food-adulteration/
4. https://www.foodprocessing-technology.com/
5. https://www.britannica.com/technology/food-processing

CO – PSO Mapping

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

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

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIC2302	**Immunology and Immunotechnology Lab**	**Core**	**3**	**3**

This laboratory course helps to gain hands-on experience on blood grouping and typing, agglutination and precipitation reactions, electrophoresis, lymphocyte separation and ELISA test for AIDS.

Course Outcomes:

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

CO1: identify the erythrocyte antigens, types and innate and adaptive immune cells
CO2: examine the different cells and organs of the immune system.
CO3: compare and contrast antigen and antibody reactions.
CO4: demonstrate the methods of lymphocyte separation.
CO5: evaluate the concept of ELISA.

List of Experiments:

1. Identification of erythrocyte antigens and typing.
2. Enumeration of innate and adaptive immune cells
3. Virtual lab – Identification of lymphoid organs of fish or chick or mice
4. Latex Agglutination reactions- RF, ASO, CRP
5. Coomb's test.
6. VDRL test.
7. Ouchterlony's Double Immunodiffusion Method (antigen pattern).
8. Single Radial Immunodiffusion Method.
9. Serum, Counter and Immunoelectrophoresis.
10. Separation of Lymphocytes by density gradient centrifugation method.
11. T cell identification (Demonstration)- E-rosette test
12. ELISA: Hepatitis/ HIV

Learning Resources:

Textbooks

1. Roy 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, Kuby J. (2013). *Immunology*, 7thEdition., 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. 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. Janeway Travers. (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, Ivan M. Roitt. (2006). Roitt's *Essential Immunology*, 11thEdition., Wiley-Blackwell.

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. https://www.ncbi.nlm.nih.gov/books/NBK7795/
5. https://www.sciencedirect.com/topics/immunology-and-microbiology/immunology

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	2	2	1	1	1	2	3	2	3
CO2	3	2	2	1	3	1	2	3	2	3
CO3	3	2	3	3	3	1	3	3	3	3
CO4	3	2	2	1	3	1	2	3	2	3
CO5	3	2	3	3	3	1	3	3	3	3
Average	**3**	**2**	**2.4**	**1.8**	**2.6**	**1**	**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
24MIC2304	Food Processing Technology Lab	Core	3	3

This course aims to introduce the laboratory practices for food processing and proximate analysis of food samples. These experiments demonstrate scientific principles of food safety. This course demonstrates the principles of butter making, cheese production and processed meat production.

Course Outcomes:

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

CO1: record the basic knowledge on various properties of foods
CO2: practice food processing techniques
CO3: measure the parameters of food quality
CO4: assess the various parameters of food materials
CO5: appraise the functioning of food processing and dairy industries.

List of Experiments:

1. Determination of cooking properties of parboiled and raw rice.
2. Estimation of microbial load in food materials.
3. Determination of rehydration ratio of dehydrated foods.
4. Experiment on osmotic dehydration of foods.
6. Experiment of food extruder.
7. Experiment on properties of food through microwave oven heating.
8. Determination of properties of milk.
9. Experiments on cream separator to determine the separation efficiency.
10. Experiments on construction and operation of butter churn and butter working accessories.
11. Experiments on detection of Food Adulteration.
12. Experiments on estimation of protein in food.
13. Experiment on expansion and Oil absorption characteristic of snacks on frying.
14. Visit to food processing and dairy industries.

Learning Resources:

Textbooks

1. Subbulakshmi, G , Shobha A, UdipiPadmini S Ghurge. 2021. *Food Processing and Preservation.* 2nd edition, New Age International Private Limited. 328p.
2. Warris, D.S. 2020. *Food Processing and Preservation* 2nd Vol. CBS Publishers and Distributors Pvt LTD. 952 p
3. Adams M.R. and Moss M. O (2007). *Food Microbiology*. New Age International.
4. Sharma A. (2006). *Text Book of Food Science and Technology*, International Book Distributing Co, Lucknow, UP.
5. NIIR Board of Food and Technologists. (2005). *Modern Technology of Food Processing and Agrobased Industries*, National Institute of Industrial Research, Delhi.

References

1. Fellos PJ. (2005). *Food Processing Technology: Principle & Practice* 2ndEdition. CRC.
2. Zeuthen P and Bogh-Sorenson L. (2005). *Food Preservation Techniques*, Woodland Publishing Ltd, Cambridge, England.1
3. Barbosa-Canovas G. V, Maria S. Tapia, M. Pilar Cano. (2004). *Novel Food Processing Technologies*, CRC.
4. Bhatti S , Varma U. (1995). *Fruit and vegetable processing organizations and institutions*, 1st Edition., CBS Publishing, New Delhi.
5. Mirajkar M, Sreelatha Menon. (2002). *Food Science and Processing Technology* Vol-2, Commercial processing and packaging, Kanishka Publishers, New Delhi.

Websites/ e-Learning Resources

1. https://sites.google.com/a/uasd.in/ecourse/food-processing-technology
2. https://nptel.ac.in/courses/126105015
3. https://engineeringinterviewquestions.com/biology-notes-on-food-adulteration/
4. https://www.foodprocessing-technology.com/
5. https://www.britannica.com/technology/food-processing

CO – PSO Mapping

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	2	2	3	3	1	2	2	2	3
CO2	3	2	2	2	2	1	2	2	2	3
CO3	2	2	3	3	2	1	3	2	3	3
CO4	3	2	2	3	3	1	3	2	2	3
CO5	3	2	2	3	3	1	2	2	3	3
Average	**2.8**	**2**	**2.2**	**2.8**	**2.6**	**1**	**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
24MIC2202	Vaccine Technology	SEC	3	2

This course comprehensively explains the milestones, purpose and factors affecting the vaccine efficacy. It also deals with various types of whole and non whole cell vaccines and their preparations. Vaccine design and applications of modern vaccines in the present scenario is emphasized. It also highlights the ethical and legal regulations in clinical trials of vaccine development and commercialization.

Course Outcomes:

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

CO1: recall the historical milestones and factors responsible for immunogenicity.
CO2: describe the different types of Vaccine preparation
CO3: demonstrate the role of rDNA in vaccine technology.
CO4: formulate various vaccine development strategies.
CO5: interpret the ethics and regulation in vaccine production

UNIT I: History of vaccination (**9 Hours)**

Active and passive immunization; requirements for induction of immunity, Epitopes, linear and conformational epitopes, characterization and location of APC, MHC and immunogenicity.

UNIT II: Vaccine preparation **(9 Hours)**

Viral/bacterial/parasite vaccine differences, methods of vaccine preparation – Live, killed, attenuated, sub unit vaccines; Licensed vaccines, Viral Vaccine - Poliovirus vaccine-inactivated & Live, Rabies vaccines, Hepatitis A & B vaccines, COVID, Bacterial Vaccine - Anthrax vaccines, Cholera vaccines, Diphtheria toxoid, Tetanus toxoid, Parasitic vaccine - Malaria Vaccine.

UNIT III: Vaccine technology **(9 Hours)**

Vaccine technology- Role and properties of adjuvants, recombinant DNA and protein-based vaccines, plant-based vaccines, reverse vaccinology; Peptide vaccines, conjugate vaccines. Challenges in Malaria, Tuberculosis, HIV vaccine production.

UNIT IV: Vaccine design (9 Hours)

Fundamental research to rational vaccine design. Antigen identification and delivery, T-Cell expression cloning for identification of vaccine targets for intracellular pathogens, Rationale vaccine design based on clinical requirements: Scope of future vaccine strategies.

UNIT V Vaccine-ethics and regulations (9 Hours)

Vaccine additives and manufacturing residuals, Regulation and testing of vaccines, Regulation of vaccines in developing countries, Quality control and regulations in vaccine research, Animal testing, Rational design to clinical trials, Large scale production, Commercialization. Storage of vaccines. Vaccine safety ethics and Legal issues.

Learning Resources:

Textbooks

1. Ellis R. W (2001). New Vaccine Technologies. Landes Bioscience.
2. Barton C (2009). Advances in Vaccine Technology and Delivery. Espicom Business Intelligence.
3. Male, David (2007). Immunology. 7th Edition. Mosby Publication.
4. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne. (2002). Immunology. 6th Edition, Freeman.
5. Brostoff J, Seaddin JK, Male D, Roitt IM. (2002). Clinical Immunology. 6th Edition, Gower Medical Publishing.

References

1. Plotkin S. K , Orenstein W and Paul Offit A (2013). *Vaccines*, 6th Edition. BMA Medical Book Awards Highly Commended in Public Health. Elsevier Publication.
2. Coico, R. (2003). *Immunology: A Short Course*. 5th Edition, Wiley – Liss.
3. Banwarst. G.J. (2003). *Basic Food Microbiology* 2ndedition, CBS Publishers and Distributors. Parham, Peter.(2005). *The Immune System*. 2nd Edition, Garland Science.
4. Abbas, A.K. (2007). *The Cellular and Molecular Immunology*. 6th Edition, Sanders / Elsevier.
5. Weir D.M. and Stewart, John (2000). *Immunology*. 8th Edition, Churchill Pvt. Ltd.

Websites/ e-Learning Resources

1. https://www.slideshare.net/adammbbs/pathogenesis-3-rd-internal-updated-43458567
2. https://www.bio.fiocruz.br/en/images/stories/pdfs/mpti/2013/selecao/vaccine-processtechnology.pdf
3. https://www.dcvmn.org/IMG/pdf/ge_healthcare_dcvmn_introduction_to_pd_for_vaccine_production_29256323aa_10mar2017.pdf
4. https://www.sciencedirect.com/science/article/pii/B9780128021743000059
5. https://www.researchgate.net/publication/313470959_Vaccine_Scaleup_and_Manufacturing

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	1	2	3	--	3	1	2
CO2	3	2	3	2	3	2	3	2	2	3
CO3	3	2	3	3	3	3	3	3	3	3
CO4	2	2	3	3	3	3	3	3	2	2
CO5	3	2	3	1	3	3	3	3	3	2
Average	**2.8**	**2**	**2.8**	**2**	**2.8**	**2.8**	**3**	**2.8**	**2.2**	**2.4**

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

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIC3501	**Bacteriology and Mycology**	**Core**	**5**	**5**

This course aims at enhancing the knowledge of medically important bacteria and fungi and the challenges to humankind and other life forms. It covers mechanisms of infectious disease transmission, principles of aseptic practice, and the role of the human body's normal microflora. It enlightens basic principles of bacterial and fungal pathogenesis. It deals with host response to infection, immunity and vaccines in disease prevention. It also sheds light on the preventive strategies relevant to the morphology, pathology, symptoms and the etiology of diseases.

Course Outcomes:

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

CO1: discuss the role of normal flora and pathogenic microbes in infectious disease cycle.
CO2: describe the epidemiology of pathogenic Gram-positive bacteria.
CO3: analyze the symptoms, diagnosis, treatment, and modes of infection of disease-causing Gram-negative bacteria.
CO4: compare the fungal pathogens and their disease mechanisms.
CO5: assess the general characteristics and mode of action of various antimicrobial agents.

UNIT I: History and classification of medically important microbes (15 Hours)

Koch's, and River's postulates-A brief account on the normal microbial flora of the healthy human body – Host-pathogen interactions: Definitions of infection, invasion, primary and opportunistic pathogens, pathogenicity, virulence, toxigenicity, carriers, endemic, epidemic, pandemic diseases and epidemiology – putative virulence factors of human pathogens –infectious disease cycle. Collection and transport of clinical specimens for bacterial and fungal infections.

UNIT II: Medically important Gram-positive bacteria (15 Hours)

Causative agent, clinical symptoms, pathogenesis, mode of transmission, prevention and treatment of the following bacterial diseases (a) Streptococcal infections (*Streptococcus pyogenes, Streptococcus faecalis*), (b) Staphylococcal infections (*Staphylococcus aureus*), (c) Tetanus (*Clostridium tetani*) (d) Diphtheria (*Corynebacterium diphtheriae)* (e) Anthrax (*Bacillus anthracis*) (f) Tuberculosis (*Mycobacterium tuberculosis*), (g) Leprosy (*Mycobacterium leprae).*

UNIT III: Medically important Gram-negative bacteria (15 Hours)

Causative agent, clinical symptoms, pathogenesis, mode of transmission, prevention, and treatment of the following bacterial diseases (a) Meningitis (*Streptococcus pneumoniae*) (b) typhoid (*Salmonella typhi*) (c) cholera (*Vibrio cholerae*) (d) bacillary dysentery (*Shigella dysenteriae*); Sexually Transmitted disease (syphilis–*Treponema pallidum*); Nosocomial infections – definition, importance, and their control.

UNIT IV: Medically important fungal diseases (15 Hours)

Classification of medically important fungi; superficial mycoses: Pityriasis versicolor*;* Tinea Nigra*;* Piedra. Cutaneous mycoses: *Microsporum spp., Trichophyton spp.,* and *Epidermophyton floccosum*. Subcutaneous mycoses: Chromoblastomycosis; Sporotrichosis; Systemic Mycoses - Blastomycosis; Histoplasmosis; Opportunistic Infections -Candidiasis; Cryptococcosis; Zygomycosis; Mycotoxins: Aflatoxin. Pneumocystis gerosi.

UNIT V: Antimicrobial agents (15 Hours)

General characteristics and mode of action of Antibacterial agents: Modes of action with an example for each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin.

Learning Resources:

Textbooks

1. Dube H. S (2024) *A Textbook of Fungi, Bacteria and Viruses* (Student Edition) - 3rd Edition - 2024 Jaypee brothers medical publishers.
2. Sastry, A. S., Bhat, S. (2021). *Essentials of Medical Microbiology*: (Revised Edition). India: Jaypee Brothers Medical Publishers Pvt. Limited.
3. Parker T M. Leslie H. Collier. (1990). *Topley & Wilson's Principles of Bacteriology*, Virology and Immunity, 8th Edition. London: Edward Arnold.
4. Greenwood, D., Slack, R.B. and Peutherer, J.F. (2012) *Medical Microbiology*, 18th Edition. Churchill Livingstone, London.
5. Finegold, S.M. (2000) *Diagnostic Microbiology*, 10th Edition. C.V. Mosby Company, St. Louis.
6. Ananthanarayanan, R. and Jayaram Panicker C.K. (2020) *Text book of Microbiology*. Orient Longman, Hyderabad.
7. Chander J (2018). *Textbook of Medical Mycology*, 4th edition, Jaypee brothers medical publishers.

References

1. Gerhardt, P., Murray, R.G., Wood, W.A. and Kreig, N.R. (Editions) (1994) *Methods for General and Molecular Bacteriology*. ASM Press, Washington, DC.
2. Kavanagh K (2018). *Fungi Biology and Applications 3rd Edition.* Wiley Blackwell publishers.
3. Alexopoulos C. J , Mims C. W, Blackwell. M, (2007). *Introductory Mycology*, 4th edition. Wiley publishers.
4. Salle A.J (2007). *Fundamental principles of bacteriology*, fourth edition, Tata McGraw-Hill Publications.
5. Kibbler C. C, Richard Barton, Neil A. R. Gow, Susan Howell, Donna M. MacCallum, Rohini J. Manuel (2017). *Oxford Textbook of Medical Mycology*. Oxford University Press.

Websites/ e-Learning Resources

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

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	2	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	2	3	3
Average	**3**	**3**	**3**	**2.8**	**3**	**3**	**3**	**2.8**	**3**	**3**

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

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIC3503	**Virology and Parasitology**	**Core**	**5**	**5**

This course will highlight the medically significant viruses and parasites causing diseases in humans. It provides knowledge on the cellular and molecular mechanisms of viral and parasitic diseases. It deals with the emergence, modes of transmission, mechanisms of infection, clinical presentations, diagnosis, treatment and prevention of viruses and parasites. It also furnishes knowledge on the existing treatment strategies and vaccines against infectious diseases.

Course Outcomes:

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

CO1: recognize the structure and properties of viruses, cultivation methods and diagnosis of viral diseases.
CO2: explain the pathogenesis of medically important viruses.
CO3: discuss the causes and prevention of re-emerging viral infections.
CO4: identify the aetiology of intestinal protozoan pathogens and prevention strategies
CO5: categorize nematodes and develop skills in the diagnosis of parasitic infestations.

UNIT I: Introduction to virology (15 Hours)

General Properties, replication and Classification of viruses (Baltimore classification), Cultivation of viruses- in animals, embryonated eggs and tissue culture – co-culture, cell line culture, Virus purification assays - collection and transport of clinical specimens for viral infections.

UNIT II: Viral diseases (15 Hours)

Symptoms, pathogenesis, transmission, prophylaxis and control – Arboviruses (*Flavivirus*), Picornaviruses (*Poliovirus* and *Rhinovirus*), Hepatitis viruses (HAV, HBV, HCV, HDV, HEV), *Rabies virus*, Orthomyoviruses (*Influenza virus*) and Paramyxoviruses (*Mumps* and *Measles* virus), Poxviruses (*Variola, Vaccinia*), Herpes viruses (*Herpes simplex, Varicella zoster*), *Adeno viruses, Rotaviruses* and *HIV* viruses. Oncogenic viruses (*Human Papilloma virus*): Introduction, characteristics of transformed cells, mechanism of viral oncogenesis and clinical manifestations.

UNIT III: Emerging and reemerging viral infections (15 Hours)

SARS, Swine flu, Ebola, Dengue and Chikungunya – Causes, spread and preventive measures. Detection of viruses in clinical specimens – Serological and Molecular diagnosis of virus infections – Antiviral agents, Interferons and Viral Vaccines, Immunization schedules.

UNIT IV: Introduction to medical parasitology (15 Hours)

Classification of medically important parasites. Morphology, life cycle, pathogenesis, clinical features, laboratory diagnosis, prevention and treatment of diseases caused by the following organisms: *Entameoba histolytica*, flagellates (*Giardia lamblia, Leishmania donovani*), Sporozoa- *Plasmodium spp.* – Examination of blood for parasites.

UNIT V: Introduction to Helminthes (15 Hours)

Platyhelminthes – *Taenia* – *Fasciola* – *Paragonimus* – *Schistosoma spp*. Nemathelminthes – *Ascaris*– *Ankylostoma* – *Enterobius* – *Trichuris* – *Trichinella* – *Wuchereria* – *Dracanculus*. Collection, transport and examination of specimen Laboratory techniques in parasitology Examination of faeces for ova and cyst by direct wet mount and iodine wet mount, Concentration methods (Floatation and Sedimentation techniques). Cultivation of parasites

Learning Resources:

Textbooks

1. Tille P. (2020). *Bailey & Scott's Diagnostic Microbiology.* 14th edn. Elsevier Health Sciences.
2. Sastry SA. & Bhat S. (2021). *Essentials of Medical Microbiology*. Jaypee Brothers, Medical Publishers Pvt. Limited.
3. S., Rajan (2007). *Medical microbiology*, MJP publisher.
4. Jeyaram Paniker, C.K. (2006). *Text Book of Parasitology* Jay Pee Brothers, New Delhi.
5. Arora D.R. and Arora B. (2002). *Medical Parasitology*, 1stEdition CBS Publishers & Distributors, New Delhi.
6. Chatterjee (1986). *Medical Parasitology*. Tata McGraw Hill, Calcutta.
7. Parija S. C. (1996). *Text Book of Medical Parasitology*.4th edition, Orient Longman, AllIndia Publishers & Distributors.

References

1. Jawetz, E., Melnick, J.L. and Adelberg, E.A. (2000). *Review of Medical Microbiology*, 19th Edition. Lange Medical Publications, U.S.A.

2. Ananthanarayan, R. and Jeyaram Paniker, C.K. (2009). *Text Book of Microbiology*, 8th Edition. Orient Longman, Chennai.
3. Conrat HF, Kimball PC and Levy JA. (1988). *Virology*. II edition. Prentice Hall, Englewood Cliff, New Jersey.
4. Topley & Wilsons's (1990). *Principles of Bacteriology, Virology and Immunity*, 8th Edition, Vol. III Bacterial Diseases, Edward Arnold, London.
5. Finegold, S.M. (2000). *Diagnostic Microbiology*, 10th Edition. C.V. Mosby Company, St. Louis.

Websites/ e-Learning Resources

1. http://textbookofbacteriology.net/nd
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4047123/
3. https://www.ncbi.nlm.nih.gov/pubmed/21722309
4. https://www.sciencedirect.com/science/article/pii/S2211753919300193
5. https://cmr.asm.org/content/30/3/811
6. https://www.nejm.org/doi/full/10.1056/NEJMoa1811400

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	2	3	3	3	3	3	3	3	3
CO2	3	3	3	2	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	2	3	3	3	3	3	3	3
CO5	3	3	2	3	3	3	3	3	3	3
Average	**3**	**2.6**	**2.6**	**2.8**	**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
24MIC3401	**Medical Microbiology Lab**	**Core**	**4**	**4**

This lab course is designed to provide a practical experience with the fundamental techniques related to medical microbiology. It highlights the test procedures and interpretation routinely applied in diagnosis of infectious diseases with a special 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: develop skills in the collection, transport, and processing of clinical samples.
CO2: identify pathogenic microorganisms and interpret their sensitivity towards the clinically relevant antibiotics.
CO3: demonstrate the experimental tools used to characterize clinically important viruses.
CO4: recognize medically important fungi, their culture and identification techniques.
CO5: examine parasites of medical importance and identify them from clinical specimens.

List of Experiments:

1. Collection and transport of clinical specimens.
2. Simple, Differential and special staining of clinical samples.
3. Culture techniques used to isolate microorganisms.
4. Identification of bacterial pathogens by their biochemical reactions.
5. Antimicrobial susceptibility testing by disc-diffusion technique and determination of Minimum Inhibitory Concentration.
6. Isolation of Bacteriophages from Sewage and other natural sources.
7. Identification of Viruses in Slides/Smears/Spotters. Demonstration of Negri bodies (Staining).
8. Cultivation of Viruses in Embryonated eggs – Amniotic, Allantoic, Yolk sac routes and Chorio-allantoic membrane.
9. Microscopic identification of medically important Fungi – KOH and Lactophenol cotton Blue staining.
10. Slide culture techniques for fungal Identification
11. Identification of Dermatophytes.

12. Germ tube test for *Candida albicans*, Carbohydrate fermentation and assimilation tests for Yeasts.
13. Direct Examination of Faeces – wet mount and Iodine mount – Demonstration of Protozoan cysts and Helminthes eggs.
14. Concentration techniques of stool specimen – Floatation and Sedimentation methods.
15. Examination of blood for Malarial parasites – thin and thick smear preparations.
16. Identification of Medically important parasites in slides / specimens as spotters. Important parasites in slides / specimens as spotters.

Learning Resources:

Textbooks

1. Dubey, R.C. and Maheswari, D.K. (2020). *Practical Microbiology*. S. Chand Publishers. ISBN-13: 978-8121921534, ISBN-10: 8121921538.
2. K.R. Aneja (2017). *Experiments in Microbiology, Plant Pathology, Tissue Culture and Microbial Biotechnology*. 5th Edition. New Age International Publishers. ISBN-10: 9386418304, ISBN-13: 978-9386418302.
3. Collee, J.G., Fraser, A.G., Marnion, B.P. and Simmons, A. (1996). *Mackie & McCartney Practical Medical Microbiology*. 14th Edition. Elsevier. ISBN-10: 813120393X, ISBN-13: 978-8131203934.
4. Prince CP (2009). *Practical Manual of Medical Microbiology*, Ist edition, Jaypee digital publishing.
5. James H. Jorgensen, Karen C. Carroll, Guido Funke, Michael A. Pfaller, Marie Louise Landry, Sandra S. Richter, David W. Warnock (2015). *Manual of Clinical Microbiology*, 11th Edition, ASM press

References

1. Patricia M. Tille (2021). *Bailey & Scott's Diagnostic Microbiology*, 15th Edition. Elsevier. ISBN-10: 0323681050, ISBN-13: 978-0323681056.
2. Monica Cheesbrough (2006). *District Laboratory Practice in Tropical Countries*. Part 1. 2nd Edition. Cambridge University Press. ISBN-10: 0521171571, ISBN-13: 978-0521171571.
3. Michael A. Pfaller (ed.) (2015). *Manual of Clinical Microbiology*. Vol. 1 and 2. 11th Edition. ASM Press. ISBN-10: 9781555817374, ISBN-13: 978-1555817374.
4. Josephine A. Morello, Paul A. Granato and Helen EckelMizer (2002). *Laboratory Manual and Workbook in Microbiology*. 7th Edition. The McGraw Hill Company. ISBN: 0-07-246354-6.

5. Rowland, S.S., Walsh, S.R., Teel, L.D. and Carnahan, A.M. ((1994). *Pathogenic and Clinical Microbiology: A Laboratory Manual.* Lippincott Williams & Wilkins. ISBN-10: 0316760498, ISBN-13: 9780316760492.

Websites/ e-Learning Resources

1. https://www.microcarelab.in/media/microcarelab.in/files/Sample-Collection-Manual.pdf
2. http://ssu.ac.ir/cms/fileadmin/user_upload/Daneshkadaha/pezeshki/microb/file_amuzeshi/Lab_QA_Microbiology_QA.pdf
3. https://www.academia.edu/11977315/Basic_Laboratory_Procedures_in_Clinical_Bacteriology
4. https://cmr.asm.org/content/31/3/e00062-17.full.pdf
5. https://microbiologyinfo.com/techniques-of-virus-cultivation/

CO – PSO Mapping

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

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

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIC3403	Recombinant DNA Technology Lab	Core	4	4

This course aims to train students in the basic techniques required for rDNA technology i.e., genomic DNA and plasmid DNA isolation, restriction digestion, screening and selection 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: analyse DNA and RNA isolated from different tissues using basic nucleic acid isolation and quantification protocols
CO2: discuss the use of restriction enzymes in rDNA technology
CO3: demonstrate the steps involved in introduction and expression of foreign DNA into bacteria and their screening.
CO4: prepare basic plant tissue culture techniques
CO5: design basic animal tissue culture procedures

List of Experiments:

1. Isolation of genomic DNA from bacteria, plants, animal tissue.
2. Estimation of DNA (Spectrophotometric method).
3. Isolation of RNA from Mammalian tissue and yeast.
4. Demonstration of Polymerase chain reaction Analysis of amplified gene on Agarose Gel Electrophoresis.
5. Restriction digestion of genomic DNA and plasmid
6. Transformation by $CaCl_2$ method- competent cell preparation
7. Selection of mutants by blue-white screening method.
8. Demonstration of southern and western blotting

Plant tissue culture

9. Preparation of Tissue Culture Media.
10. Callus formation- Shoot and root induction.
11. Protoplast isolation and fusion.
12. Synthetic seed preparation.

Animal cell and tissue culture

13. Preparation and Sterilization of Tissue and Cell Culture Media.
14. Primary culture from chick embryo.
15. Cell separation and Viability assays.

Learning Resources:

Textbooks

1. Sambrook J and Russell D.W (2012) *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, RI. (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. ed., 2013. *Plant molecular biology—a laboratory manual*. Springer Science & Business Media.
3. Mather, JP. & Barnes, D. (1998). *Methods in cell biology*. Volume 57: Animal cell culture methods. Academic press.
4. Sinha, BK. & Kumar, R. (2008). *Principles of Animal Cell Culture*: Students Compendium.
5. Davis, JM. (Ed.). (2011). *Animal Cell Culture: Essential Methods*. John Wiley & Sons

Websites/ e-Learning Resources

1. https://www.rpi.edu
2. https://webstor.srmist.edu.in/web_assets/srm_mainsite/files/files/BT%20050%20-%20M_Tech%20r-DNA%20Technology%20lab%20manual.pdf
3. Recombinant DNA | Definition, Steps, Examples, & Invention | Britannica
4. Recombinant DNA and genetic techniques | Virtual Genetics Education Centre | University of Leicester

CO – PSO Mapping

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

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

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIC3405	Recombinant DNA Technology	DSE	5	4

This course aims to impart the principles of rDNA technology and the molecular tools employed in gene cloning. It discusses the importance of various gene transfer methods in biotechnology. The significance of PCR and gene sequencing is emphasized. Basics of animal and 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: underline the steps and enzymes involved in gene cloning.
CO2: explain the various gene transfer methods, cloning vectors and their applications.
CO3: illustrate the usage and advantages of molecular tools in rDNA technology.
CO4: analyze the basics of plant tissue and animal cell culture methods for transgenics.
CO5: evaluate the application of genetic engineering and gene therapy.

UNIT I: Enzymes used in rDNA technology (15 Hours)

Milestones in rDNA Technology- Gene Manipulation- Steps involved in Gene Cloning. Isolation of Chromosomal and Plasmid DNA. Restriction endonuclease - Discovery, Types, Mode of action- Application of Ligase, DNA Polymerase, DNA Modifying enzymes and Topoisomerases. Use of Linkers and Adapters.

UNIT II: Gene transfer methods (15 Hours)

Artificial Gene Transfer methods- Calcium Chloride Induction, Electroporation, Microinjection, Biolistic method, Liposome and Viral-mediated delivery. Cloning vectors –Properties and Applications - Plasmid Based Vectors- Natural Vectors- pSC101 and pMB1. Artificial Vectors- pBR322 and pUC. Phage Based Vectors- Lambda phage. Hybrid Vectors, Phagemid, Cosmid, BAC and YAC. Screening of Recombinants. Genomic DNA and cDNA library- Construction and Screening.

UNIT III: Molecular tools used in rDNA technology (15 Hours)

Molecular Tools- PCR- Types. Gel Electrophoresis- AGE and PAGE Blotting Techniques-Southern, Western & Northern. DNA sequencing methods- Sanger’s and

Automated method. Recent Trends in Genetic Engineering- Targeted Genome Editing- ZFNs, TALENs, CRISPRs. Gene Targeting- Knock-in & Knock-outs. DNA Fingerprinting.

UNIT IV: Plant and animal biotechnology (15 Hours)

Plant Biotechnology – Media, Growth Regulators and Equipment for Plant Tissue Culture-Explant Culture- Micropropagation- Callus and Protoplast Culture- Production of Bio-Active Secondary Metabolites by Plant Tissue Culture - *Agrobacterium* and Crown Gall Tumors, Ti Plasmid and Ri Plasmid- Animal Biotechnology-Principles of Animal Cell Culture, Media and Equipment for Animal Cell Culture – Primary and Secondary Cultures- Cell Lines- Types, Establishment and Maintenance of Cell Lines.

UNIT V: Applications of rDNA technology (15 Hours)

Applications of Genetic Engineering - Transgenic Animals – Mice and Sheep- Recombinant Cytokines and their use in the Treatment of Animal infections- Monoclonal Antibodies in Therapy- Vaccines and their Applications in Animal Infections (Rabies vaccine) - Human Gene Therapy-Germ line and Somatic Cell Therapy -*Ex-vivo* Gene Therapy- SCID (Severe Combined Immunodeficiency) – *In-vivo* Gene Therapy- CFTR (Cystic Fibrosis Transmembrane Regulator) –Vectors in Gene Therapy- Viral and Non-Viral Vectors. Transgenic Plants– Bt Cotton, Bt Corn, Round Ready soybean, FlavrSavr Tomato and Golden Rice.

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. Keya Chaudhuri (2013). *Recombinant DNA technology*. The Energy and Resources Institute
4. Siddra Ijaz, Imran Ul Haq (2019). *Recombinant DNA Technology*. Cambridge Scholars Publishing.
5. Monika Jain (2012). *Recombinant DNA Techniques: A Textbook*, 1st Edition, Alpha Science International Ltd

References

1. Maloy S. R., Cronan J.E. Jr. and FreifelderD. (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. Snyder 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, Mark Zoller (1992). *Recombinant DNA*. Scientific American Books
6. 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://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. Recombinant DNA and genetic techniques | Virtual Genetics Education Centre | University of Leicester

CO – PSO Mapping

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

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

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIC3407	Bioprocess Technology	DSE	5	4

This course focuses on the scope and historical development of bioprocess technology. It enables the students to understand the concepts of fermentation, its types, media formulation, bioreactor design and its optimization. It also provides insights into the downstream processing for the production of economically valuable products.

Course Outcomes:

At the end of the course, students will able to

CO1: recall the scope and historical development of bioprocess technology
CO2: describe the fermentor design and its types
CO3: illustrate the upstream processes in fermentation
CO4: appraise the product recovery methods
CO5: evaluate the production of economically valuable products

UNIT I: Introduction to bioprocess technology (15 Hours)

Scope – Historical development of fermentation technology – types of fermentation – solid state, submerged, types of culture systems – batch, continuous, fed batch – fermentation economics-metabolic pathway and control mechanism.

UNIT II: Bioreactors (15 Hours)

Fermentors – design and types – stirred tank reactor, bubble column reactor, airlift bioreactor, fluidized bed reactor – tower fermentor, stirring and mixing, gas exchange and mass transfer. Instrumentation control, physical and chemical sensors.

UNIT III: Upstream process (15 Hours)

Strain improvement – Media formulation, inoculum preparation, Batch and continuous – process control in fermentation. Fermentor pre – culture and production – Aeration and agitation, and antifoaming agents. Role of computers in fermentation process.

UNIT IV: Downstream process (15 Hours)

Product recovery – intracellular and extracellular – cell disruption – flocculation – flotation – filtration – centrifugation – dialysis and electro dialysis, distillation, chromatography, crystallization – precipitation and drying.

UNIT V: Fermentation products **(15 Hours)**

Antibiotic Production – Penicillin, Streptomycin. Organic acid – Vinegar. Enzymes – amylase, protease – amino acids –L – Glutamic acid and Lysine, Vitamins – Vitamin B12, Vitamin C, Beverages – Beer, Wine and Immobilization techniques.

Learning Resources:

Text Books

1. Casida LE. (1991). *Industrial Microbiology*. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). *Biotechnology: A textbook of Industrial Microbiology*. 2nd edition, Panima Publishing Co. New Delhi.
3. Patel AH. (1996). *Industrial Microbiology*. 1st edition, Macmillan India Limited.
4. Jackson AT., *Bioprocess Engineering in Biotechnology*, Prentice Hall, Engelwood Cliffs, 1991.
5. Kalaichelvan PT and Arul Pandi I. (2019). *Bioprocess Technology*, MJP Publishers.

References

1. Shuler ML and Kargi F., *Bioprocess Engineering: Basic concepts*, 2nd Edition, Prentice Hall, Engelwood Cliffs, 2002.
2. Stanbury RF and Whitaker A., *Principles of Fermentation Technology*, Pergamon press, Oxford, 1997.
3. Baily JE and Ollis DF., *Biochemical Engineering fundamentals*, 2nd Edition, McGraw-Hill Book Co., New York, 1986.
4. *Comprehensive Biotechnology: The Principles, Applications and Regulations of Biotechnology in Industry*, Agriculture and Medicine, Vol 1, 2, 3 and 4. Young M.M., Reed Elsevier India Private Ltd, India, 2004.
5. Mansi EMTEL, Bryle CFA. *Fermentation Microbiology and Biotechnology*, 2nd Edition, Taylor & Francis Ltd, UK, 2007.

Websites/ e – Learning Resources

1. https://bioprocessing.weebly.com
2. https://www.engy.colostate.edu
3. https://www.esiultraprue.com>up
4. https://www.mt.com>fermentation
5. https://chem.libretexts.org>

CO – PSO Mapping

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

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

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIC3301	**Biosafety and Bioethics**	**GE**	**4**	**3**

This course provides ethical pursuit in the biological laboratory practices. It also deals with the various aspects of biosafety regulations and bioethics in concern with commercialization of bioproducts. This course deals with the regulatory aspects of Intellectual property Rights for the innovative research and patent.

Course Outcomes:

At the end of the course, students will able to

CO1: describe the control measures of laboratory hazards and to practice safety strategies.
CO2: discuss the ethical perspectives with reference to the use of genetically modified organisms and Hazardous waste management.
CO3: practice safety measures in the laboratory, research and health care institutions.
CO4: analyze social and ethical implications of biotech products.
CO5: appraise the procedures and legal implications in patent filing.

UNIT I: Basics of biosafety (12 Hours)

Laboratory Hazards and Hazard symbols. Definitions on Biohazard, Biosafety and Biosecurity- Biohazard- LAI, BP. Biohazard Classification. Biological Risk Groups. Need and application of biosafety. Good Laboratory Practices (GLP), Good Manufacturing Practices (GMP), Good Clinical Practices (GCP).

UNIT II: Biosafety concerns (12 Hours)

Hazardous materials in Biotechnology - Categories of Waste in the Biotechnology Laboratories, Biohazardous waste and their disposal and treatments- issues in use of GMO's, risk for animal/human/ agriculture and environment owing to GMO. Hazardous materials, Emergency response/ first aids in Laboratories.

UNIT III: Ethical practices (12 Hours)

Biological Safety Containment in Laboratory - Primary and secondary containments - Physical and biological containment. Types of biosafety containments (level I, II, III), PPE, Biosafety guidelines in India - Roles of Institutional Biosafety Committee, RCGM, GEAC.

UNIT IV: Need for bioethics **(12 Hours)**

Introduction and need of Bioethics - its relationship with other branches, Ethical implications of biotechnological products and techniques. Ethical Issues involving human cloning, human genome project, prenatal diagnosis, agriculture and animal rights, Social and ethical implications of biological weapons.

UNIT V: Intellectual property rights and patents **(12 Hours)**

IPR, Patents and Patent laws - Intellectual property rights - TRIPS - GATT International conventions patents, Methods of application of patents, Legal implications. Biodiversity and farmer rights, Objectives of the patent system, Basic principles and general requirements of patent law, Biotechnological inventions, and patent law. Legal development-Patentable subjects and protection in biotechnology. The patenting of living organisms.

Learning Resources:

Textbooks

1. Usharani.B, S Anbazhagi, C K Vidya, (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. Deepa Goel and Shomini Parashar, (2013). *IPR, Biosaftey and Bioethics*- 1st Edition, Pearson education: Chennai, ISBN-13: 978-8131774700.
4. Rajmohan Joshi (2006). *Biosafety and Bioethics.* Gyan Books publisher.
5. Sateesh. M.K. (2013). *Bioethics and Biosafety*. International pvt, Ltd.

References

1. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management, India, IN: Cengage Learning India Private Limited, ISBN-10: 9386668572
2. Neeraj, P., & Khusdeep, D. (2014). Intellectual Property Rights, India, IN: PHI learning Private Limited, ISBN: 9788120349896
3. Ahuja, V K. (2017). Law relating to Intellectual Property Rights, India, IN: Lexis Nexis, ISBN-10: 8131251659.
4. Edited by Sylvia Uzochukwu, Nwadiuto (Diuto) Esiobu, Arinze Stanley Okoli, Emeka Godfrey Nwoba, Ezebuiro Nwagbo Christpeace, Charles OluwaseunAdetunji, Abdulrazak B. Ibrahim, Benjamin Ewa Ubi (2022). Biosafety and Bioethics in Biotechnology-Policy, Advocacy, and Capacity Building,1st edition. CRC Press.

5. Dr. Muthuraj. (2019). Biosafety in Microbiological Laboratories. Notion Press. ISBN: 9781645878858.

Websites/ e-Learning Resources

1. https://www.vumc.org>safety.
2. https://nanocollect.com>blog
3. https://www.wallstreetmojo.com
4. http://bioethics.msu.edu>
5. http://www.oreilly.com>view>

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	1	3	3	2	2	3
CO2	3	3	2	3	2	3	3	3	2	3
CO3	3	2	2	2	2	3	3	2	3	2
CO4	3	3	2	3	2	3	3	3	2	2
CO5	3	3	2	2	2	3	3	2	2	3
Average	**3**	**2.8**	**2**	**2.4**	**1.8**	**3**	**3**	**2.4**	**2.2**	**2.6**

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

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIC3303	**Biocomposting**	**GE**	**4**	**3**

This course is designed to provide basics of composting, methods and its applications. It aims to infuse knowledge about biocomposting, vermicomposting and the maximum utilization of waste into economically valuable products such as biogas and bioethanol by means of composting. It also covers the strategies to manage composting.

Course Outcomes:

At the end of the course, students will able to

CO1: relate various eco-friendly methods for waste management.
CO2: explain the process of vermicompost production.
CO3: illustrate the utilization of agro-wastes through fermentation.
CO4: analyze the importance of biofuels.
CO5: formulate the strategies for the management of biocomposting

UNIT I: Introduction to biocomposting **(12 Hours)**

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

UNIT II: Vermicomposting **(12 Hours)**

Definition - collection - characterization - vermicomposting methods - factors involved - maintenance – harvesting and marketing.

UNIT III: Agro-waste recycling **(12 Hours)**

Collection - role of microbes - fermentation - recovery of products such as organic acids, vitamins and amino acids for commercialization.

Unit IV: Biofuels and their marketability **(12 Hours)**

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

Unit V: Composting management **(12 Hours)**

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

Learning Resources:

Textbooks

1. Campbell, Stu. (1998). *The Gardener's Guide to Composting*, 3rd edition, by North Adams, Massachusetts: Storey Publishing.
2. Singh R.K. and Longkumer, T.E. *(*2018). *The black gold*. Krishi Vigyan Kendra Phek, ICAR – NRC on Mithun Porba, Phek, Nagaland,
3. Meena Sharma (2021). *In Agriculture areas, reduces soil salinity by biocompost*, ASIN: B098F8M2QK.
4. Arumugam, N. (2021). *Biocomposting for Entrepreneurship*, Ist edition, Saras Publication, ISBN: 9789394196490.
5. Vayas, S.C., Vayas, S. and Modi, H.A. (1998). *Biofertilizers and organic farming*, Akta Prakashan, Nadiad.

References

1. P.D. Grover and S.K. Mishra, *Biomass Briquetting: Technology and Practices*. Published by FAO Regional Wood Energy Development Programme in Asia, Bangkok, Thailand, 1996.
2. Magdalena Muradin and Zenon Foltynowicz, *Potential for Producing Biogas from Agricultural Waste in Rural Plants in Poland*. Sustainability, 2014, 6, 5065-5074.
3. R. Krishna Murthy, *A Manual on compost and other organic manures*, ISBN: 9789391734626, 2023.
4. B. Capon, *Principles and practices of post harvest technology*, Kalyani Publishers, New Delhi, 2007.
5. N.S. Subha Rao, *Soil Microbiology*, Oxford & IBH publishers, New Delhi, 2000.

Websites/ e-Learning Resources

1. https://www.elsevier.com/books/the_composting_-_handbook/rynk/978-0-323-85602-7
2. https://wikifarmer.com>bio-compost.
3. https://soilandhealth.org>com
4. https://www.irjet.net>archives
5. https://www.epa.gov>recycle>compost

CO – PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	2	2	3	3	3	3	2	2
CO2	3	3	2	3	2	3	3	2	2	2
CO3	3	2	2	2	2	3	3	3	3	3
CO4	3	3	2	3	3	3	3	2	2	2
CO5	3	3	2	3	3	3	3	2	3	2
Average	**3**	**2.8**	**2**	**2.6**	**2.6**	**3**	**3**	**2.4**	**2.4**	**2.2**

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

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIC3255	**Internship**	**IS**	**-**	**2**

The objective of the course is to equip the students to bridge the knowledge gap between the classroom and real-world applications. This course aims to develop students with the knowledge, abilities, and practical experience needed to succeed in various sectors like medical, food, agricultural, environmental and industrial microbiology.

Course Outcomes:

At the end of the course, students will able to

CO1: relate theoretical concepts with practical experience.
CO2: express attributes such as keen observational skills, collaborative talents, and interpersonal competencies acquired during site visits.
CO3: demonstrate technological expertise in their specialized fields of study.
CO4: apply the skills learnt in internships in their profession.
CO5: create a professional network to increase their employment opportunities.

Students will be pursuing hands-on training internships in the medical, food, agricultural, environmental and industrial microbiology institutions/laboratories in their respective interested fields to submit their internship reports. The students will be given marks based on their performance in the presentation/viva.

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	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
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
24MIC3201	**Stem Cell Technology**	**SEC**	**3**	**2**

This course enlightens the students with stem cell technology and its applications for betterment of the society. The course is designed to give a broad view of properties, biology, different types of mammalian stem cells and methods to culture them. The topics will cover bioengineering and therapeutic applications of the stem cells to potential treatments of human diseases along with the ethical, legal and biosafety considerations.

Course Outcomes:

At the end of the course, students will able to

CO1: recall the properties of stem cells and their medical applications.
CO2: explain the biology of different types of stem cells.
CO3: describe the regulatory mechanism in stem cells and animal cloning.
CO4: interpret the therapeutic applications of stem cell technology.
CO5: evaluate the ethics and biosafety considerations of stem cell therapies.

UNIT I: Introduction to stem cell (9 Hours)

Introduction to stem cells Definition, properties, proliferation, culture of stem cells, medical applications of stem cells, ethical and legal issues in use of stem cells.

UNIT II: Types of stem cells and their biology (9 Hours)

Types of stem cells- Adult stem cell, Embryonic Stem Cells- Stem Cell biology – culture, preservations and revival- Therapeutic benefits of stem cells.

UNIT III: Regulatory mechanism in stem cells technology (9 Hours)

Core regulatory, DNA methylation, Histone modifications, histone modifiers, chromatin remodelers, Spatial organization of genome during ESC development and differentiation, Generation of chimeric animals and animal cloning.

UNIT IV: Therapeutic applications of stem cells (9 Hours)

Stem cells in Gene Therapy: Introduction, History and evolution of Gene therapy, optimal disease targets, Genetic Perspectives, Gene Delivery methods: Viral vectors and Non-viral Vectors; Success, failures (Case studies) and future prospects.

UNIT V: Ethical and biosafety considerations of stem cell therapies (9 Hours)

Ethical Issues associated with use of stem cell in regenerative medicine. Regulatory and ethical considerations of stem cells in gene therapy, assessing human stem cell safety and use of genetically modified stem cells in experimental gene therapies.

Learning Resources:

Textbooks

1. Swift, J. H. (2023). *Introduction to Stem Cell Technology*. Noah.J.Hecks publishers.
2. Meshorer, E and Plath, K. 2010. *The Cell Biology of Stem Cells*. Springer Science+ Business media. LLC. Landes Biosciences, Germany.
3. Kallosm M.S. 2011. *Embryonic Stem Cells - Basic Biology to Bioengineering*. Intech Open Access Publisher, UK

References

1. Clarke, M. and Frampton, J. 2020. 1st Edition. *Core Concepts in Stem Cell Biology*. Routledge Taylor & Francis Group, UK.
2. Lanza, R. and Atala, A. 2014. *Essentials of Stem Cell Biology.* Elsevier, Netherlands.
3. Li, S., Herureux, N.L., Elisseeff, J. 2011. *Stem Cell and Tissue Engineering.* 1st Edition. World Scientific Publishers, Singapore
4. Slack, J.M.W. 2017. *The Science of Stem Cells.* John Wiley & Sons, Inc.

CO – PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	2	2	1	2	3	2	3	2	2
CO2	3	2	2	1	2	3	2	3	2	2
CO3	3	3	2	1	2	3	2	3	2	2
CO4	3	3	3	3	3	3	2	3	3	2
CO5	3	2	2	2	3	3	2	3	3	2
Average	**3**	**2.4**	**2.2**	**1.6**	**2.4**	**3**	**2**	**3**	**2.4**	**2**

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

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIC3402	Environmental and Agriculture Microbiology	Core	4	4

This course is designed to make students understand the distribution and association of microorganism in various ecosystems. It highlights the role of microorganisms in water pollution and water quality management. Emphasise will be given on using microbes as biofertilizers and biocontrol agents. This course also facilitates the use of microbes in environmental clean-up. Students will also learn about plant pathogens and plant disease management.

Course Outcomes:

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

CO1: discuss the distribution of microorganisms in various ecosystems.
CO2: explain the role of microorganisms in water pollution and water quality management.
CO3: demonstrate the role of microbes as biofertilizers and biocontrol agents.
CO4: analyze the process of solid waste management and sewage water treatment.
CO5: compare various plant diseases and pathogens.

UNIT I: Microbial habitats (12 Hours)

Microorganisms and their Habitats: Structure and function of ecosystems Terrestrial Environment: Soil profile and soil microflora, Microbial succession in decomposition of soil organic matter. Role of microorganisms in elemental cycles in nature: Carbon, Nitrogen. Aquatic Environment: Microflora of fresh water and marine habitats, factors influencing microbial growth in the aquatic environments. Atmosphere: Aeromicroflora and dispersal of microbes, Assessment of air quality, Enumeration of microorganism in air, Air sanitation. Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic and osmotic pressures, salinity and low nutrient levels.

UNIT II: Water potability (12 Hours)

Water potability: Sources and types of water- surface, ground, stored, distilled, mineral and de-mineralized water and their pollution, biological indicators of water Pollution, Eutrophication. Conventional Bacteriological standards of Water Quality, MPN index, coliform test, Membrane filtration. BOD, COD. Advanced molecular

methods for water analysis. Water borne diseases. Central Pollution Control Board (CPCB) standards**.**

UNIT III: Microbial interactions (12 Hours)

Symbiosis, neutralism, commensalism, competition, Ammensalism, Synergism, parasitism, and predation. Rhizosphere microflora. Concepts of Nitrogen fixation – Symbiotic and asymbiotic nitrogen fixers. General account and Significance of Biofertilizers and biocontrol agents – Bacterial, cyanobacterial andVAM. Mass production of Rhizobial biofertilizer. Biocontrol agents – Bacterial, viral, fungal.

UNIT IV: Environmental clean-up (12 Hours)

Waste treatment and bioremediation**:** Solid waste management: Sources and types of solid waste, composting, vermicomposting and production of biogas. Liquid waste management: Primary, secondary, and tertiary sewage treatment. Bioremediation and waste management: Need and scope of bioremediation. Degradation of hydrocarbons, oil spills, heavy metals – Chromium, lead, and xenobiotics – PCB.

UNIT V: Plant pathogens (12 Hours)

Plant pathology: Mode of entry of pathogens, Microbial enzymes, toxins, growth regulators and suppressor of plant defense in plant diseases. Plant defense mechanisms. Bacterial diseases – Citrus canker, Blight of paddy. Viral disease – TMV, CAMV. Fungal disease- red rot of sugarcane, Tikka disease. Plant disease management.

Learning Resources:

Textbooks

1. Joseph C. Daniel. (2006). Environmental aspects of Microbiology 2nd Edition. BrightSun Publications.
2. Pradipta. K.M. (2008). Textbook of Environmental Microbiology.I.K.Publishing. House.
3. Ramanathan, and Muthukaruppan SM. (2005). Environmental Microbiology. Om Sakthi Pathipagam, Annamalai Nagar.
4. K. Vijaya Ramesh. (2004).Environmental Microbiology. 1st Edition. MJP Publishers.
5. Subba Rao. N.S. (2017). Soil Microbiology.4th Edition. Oxford and IBH Publishing Pvt. Ltd.

References

1. Dirk, J. Elasas, V., Trevors, J.T., Wellington, E.M.H. (1997). *Modern Soil Microbiology,* Marcel Dekker INC, New York, Hong Kong.

2. Ec Eldowney S, Hardman D.J., Waite D.J., Waite S. (1993). *Pollution: Ecology and*
Biotreatment – Longman Scientific Technical.
3. Mitchel, R. (1992). *Environmental Microbiology*. Wiley –John Wiley and Sons. Inc. Publications, New York.
4. Clescri, L.S., Greenberg, A.E. and Eaton, A.D. (1998). *Standard Methods for Examination of Water and Wastewater*, 20th Edition. American Public Health Association.
5. Atlas, R.M. and Bartha, R. (1992). *Microbial Ecology: Fundamentals and Applications*, 2nd Edition. The Benjamin / Cummings Publishing Co., Redwood City, CA.

Websites/ e-Learning Resources

1. https://nptel.ac.in/courses/126105016
2. https://www.classcentral.com/course/swayam-plant-pathology-and-soil-health-14236
3. https://www.wasteonline.org.uk/resources/InformationSheets/WasteDisposal.htm
4. https://plantpath.cornell.edu/labs/enelson/PDFs/Hill_et_al_2000.pdf
5. https://onlinelibrary.wiley.com/doi/full/10.1111/j.1365-2389.2005.00781.x

CO – PSO Mapping

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

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

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIC3404	**Food, Dairy and Probiotic Microbiology**	**Core**	**4**	**4**

This course is designed to make students understand the nutritional composition of food, factors influencing microbial spoilage, and preservation. It provides information about food-borne infection and intoxication. This course also facilitates the understanding of milk composition, types, processing and microbial spoilage. Students will also learn various fermented products and the role of probiotics in health.

Course Outcomes:

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

CO1: explain the basic components of food and their preservation techniques.
CO2: analyze the factors influencing the food spoilage, food - borne diseases and food safety measures.
CO3: discuss the processing and packaging of milk..
CO4: formulate appropriate fermentation methods for various food products.
CO5: appraise the knowledge of probiotics, prebiotics and functional foods for the health benefits.

UNIT I: Food microbiology and preservation (12 Hours)

Food as a substrate for microorganisms. Microorganisms important in food microbiology; Molds, yeasts and bacteria -General Characteristics - Classification and importance. Principles of food preservation - Asepsis - Removal of microorganisms, - High temperature - Low temperature - Drying - Food additives. Nanoscience in food preservation; microencapsulation.

UNIT II: Food spoilage and food - borne diseases (12 Hours)

Contamination and spoilage of food products -Food-borne infections (*Bacillus cereus*, Salmonellosis, Shigellosis, *Listeria monocytogenes* and *Campylobacter jejuni*) and intoxications – (*Staphylococcus aureus, Clostridium botulinum, Clostridium perfringens* and mycotoxins) Food borne disease outbreaks - newly emerging pathogens. Conventional and Novel technology in control of food borne pathogens and preventive measures - Food sanitation - plant sanitation - Employees' health standards. Regulatory agencies & criteria for food safety.

UNIT III: Milk processing and spoilage (12 Hours)

Microflora of raw milk - sources of contamination. Spoilage and preservation of milk and milk products. -antimicrobial systems in raw milk. Importance of biofilms, their role in transmission of pathogens in dairy products and preventive strategies.

UNIT IV: Fermented products (12 Hours)

Food fermentations: Indian Pickles Bread, vinegar, fermented vegetables (sauerkraut), fermented dairy products (yoghurt, cheese, acidophilus, milk, kefir, koumiss). Oriental fermented foods- Miso, Tempeh, Ontjom, Natto, Idli. Spoilage and defects of fermented dairy products. Functional fermented foods, nutraceuticals, bioactive proteins and bioactive peptides, and genetically modified foods.

UNIT V: Probiotic and prebiotic microbes and their applications (12 Hours)

Probiotic microorganisms, concept, definition safety of probiotic microorganisms, legal status of probiotics Characteristics of Probiotics for selection: stability maintenance of probiotic microorganisms. Role of probiotics in health and disease: Mechanism of probiotics. Application of bacteriocins in foods. Biopreservation. Prebiotics: concept, definition, criteria, types and sources of prebiotics, prebiotics and gut microflora - Prebiotics and health benefits: mineral absorption, immune response, cancer prevention, elderly and infant health, prebiotics in foods.

Learning Resources:

Textbooks

1. Niyas Ahmed, I., Sharmila, G., Manogari, R., Vinayaka, K.S. 2024. *Textbook of food, dairy and environmental microbiology*. Association of Indian Biologists publications. ISBN: 978-93-93968-10-4.
2. Dharumadurai Dhanasekaran and Alwarappan Sankaranarayanan. 2021. *Advances in Probiotics.* 542p.
3. Lucy Phillip. 2017. *Microbiology: Probiotics and Related Applications*. Syrawood Publishing House. 242p.
4. Frazier WC and West off DC. (2017). *Food microbiology*. 5th Edition TATA McGraw Hill Publishing Company Ltd. New Delhi.
5. Adams, M.R., Moss, M.O. (2018). *Food Microbiology* 1st edition. New Age Publishers by New Age International (P) Ltd., Publishers.

References

1. Jay JM, Loessner MJ and Golden DA. (2005). *Modern Food Microbiology*. 7th Edition CBS Publishers and Distributors, Delhi, India.
2. Prescott, Harley and Klein Wim. (2008). *Microbiology*, 7th Edition McGraw Hill Publications.
3. Robinson, R. K. (2002). *Dairy Microbiology Handbook - The Microbiology of Milk and Milk Products* (Third Edition), A John Wiley & Sons, Inc., New York.
4. Yuankunlee, Sepposalminen. (2008). *Handbook of probiotics and prebiotics* Second Edition. A John Wiley & Sons publication Inc.
5. Dharumaurai Dhansekaran, Alwarappan Sankaranarayanan. (2021). *Advances in Probiotics Microorganisms in Food and Health* 1st Edition. eBook ISBN:9780128230916.

Websites/ e-Learning Resources

1. https://www.researchgate.net/publication/15326559_A_Dynamic_Approach_to_Predicting_Bacterial-Growth_in_Food
2. https://s27415.pcdn.co/wp-content/uploads/2020/01/64ER20-7/Microbial/1-Bacteriological-Analytical-Manual-BAM_-Ch1_Food-Sampling_Preparation-of-Sample-Homogenate-_-FDA.pdf
3. https://www.researchgate.net/publication/228662659_Fermented_Dairy_Products_Starter_Cultures_and_Potential_Nutritional_Benefits/link/000084160cf23f86393d5764/download.
4. https://www.fda.gov/food

CO – PSO Mapping

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

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

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIC3302	Environmental and Agriculture Microbiology Lab	Core	3	3

The objective of this course is to give practical experience in understanding the principles of Environmental and Agricultural Microbiology. Experiments on the analysis of soil, air and water samples will be conducted. The students will be trained to isolate and identify microorganisms from plants and industrial effluents. Plant growth promoting microbes in biofertilizers will be tested for their efficacy.

Course Outcomes:

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

CO1: record pH, moisture content and water holding capacity of various soil samples.
CO2: demonstrate the screening, isolation and enumeration of microbes from different sources.
CO3: analyze the potability of water; BOD and COD of waste water.
CO4: propose different methods of isolation and identification of beneficial microbes from various sources.
CO5: compare the plant growth promoting properties of commercially available biofertilizers.

List of Experiments:

1. Analysis of soil – pH, moisture content and water holding capacity.
2. Screening and Isolation of microbes (bacteria and fungi) from soil.
3. Enumeration of microorganisms from air droplets and soil.
4. Analysis of potable water: SPC and MPN method.
5. Determination of Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD) of waste water samples.
6. Isolation of free living and symbiotic nitrogen fixing bacteria from soil and root nodule - *Azotobacter, Rhizobium*, Phosphate solubilising bacteria.
7. Isolation and identification of microorganisms from phylloplane region.
8. Isolation and identification of microorganisms from phyllosphere region.
9. Isolation of microflora from different industrial effluents.
10. Staining and observation of Vesicular Arbuscular Mycorrhizal (VAM) fungi.
11. Cultivation of plants using biofertilizers – Pot culture technique.
12. Production of Vermicompost using Bedding and Pit Methods.

Learning Resources:

Textbook

1. Dubey R.C., and Maheswari D.K., (2020) *Practical Microbiology*, S. Chand & Company Ltd., New Delhi.
2. Aneja K.R., (2005) *Experiments in Microbiology*, Plant pathology and Biotechnology, New Age International Publishers, Fourth Edition.

References

1. Cappucino J. and Sherman N.C., (2015) *Microbiology-A Laboratory Manual*, The Benjamin– Cummings Publishers, Ninth edition.
2. Gunasekaran P (2018) *Lab Manual in Microbiology*, *New Age International* Pvt Ltd.

CO – PSO Mapping

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

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

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIC3304	**Food, Dairy and Probiotic Microbiology Lab**	**Core**	**3**	**3**

This Lab course is designed to train the students on microbial analyses of potable water, milk, eggs, soft drinks, pickles, bakery products, canned foods and spoiled fruits and vegetables. Laboratory exercises like grading of milk, microbial and qualitative analyses of raw, pasteurized milk and other dairy products will be carried out. Besides, students will gain knowledge on probiotic organisms by isolating them to prepare fermented products. Also, the students will visit industrial units related to food and dairy microbiology.

Course Outcomes:

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

CO1: examine the water quality and potability.
CO2: measure the microflora of milk and milk quality parameters.
CO3: compare various extracellular enzyme producers for industrial production.
CO4: interpret the constituent microflora of various fermented foods.
CO5: select microbial isolates for preparation of probiotic products.

List of Experiments:

1. Physical, chemical, and microbiological assessment of water and potability test for water.
    - Physical – Color, pH.
    - Chemical - alkalinity, acidity, DO.
    - Microbiological – MPN index (Presumptive, Completed and Confirmatory test).
2. Study of air microflora by settle plate method.
3. Isolation and identification of bacteria and fungi from fruits, vegetables, meat and fish.
4. Direct microscopic count of milk.
5. Methylene blue reductase test and Resazurin test.
6. Microbiological examination of milk by SPC.
7. Isolation of extracellular enzyme producers –Amylase, protease, lipase.
8. Isolation of constituent flora of fermented milk.
9. Growth of probiotic *Lactobacillus spp.* in broth, milk and whey.

10. Preparation of probiotic fermented dairy products like curd, yoghurt, lassi and whey drink.
11. Visit to food / dairy industry

Learning Resources:

Textbooks

1. Photis Papademas. 2023. *Dairy Microbiology A Practical Approach.* CRC Press. ISBN 9780367738693, 256p.
2. Cappucino J and Sherman N. (2010). *Microbiology: A Laboratory Manual*. 9th Edition. Pearson Education Limited.
3. R C Dubey and D K Maheswari. (2002). *Practical Microbiology*. S. Chand Publishing.
4. Neelima Garg, K.L. Garg, K.G. Mukerji (2010). *Laboratory Manual of Food Microbiology*, Wiley publication.
5. Aneja, KR. (2010). *Experiments in Microbiology, Plant Pathology and Biotechnology*. New Age International (P) Limited.

References

1. Christon J. Hurst Editor in Chief, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, Linda D. Stetzenbach (2007). *Manual of Environmental Microbiology*, Third Edition,Wiley publication.
2. James G Cappucino and Natalie Sherman (2016). *Microbiology – A Laboratory manual*. 4th Edition. The Benjamin Publishing Company, New York.
3. Marylynn V. Yates, Cindy H. Nakatsu, Robert V. Miller, Suresh D. Pillai 2016). *Manual of Environmental Microbiology*, 4th Edition, ASM press.
4. Burns, Richard G (2005). *Environmental Microbiology A Laboratory Manual*, 2nd Edition .Lippincott Williams & Wilkins, Inc.
5. Ian Pepper, Charles Gerba, Jeffrey Brendecke (2004). *Environmental Microbiology laboratory manual*, Elsevier.

Websites/ e-Learning Resources

1. https://micobenotes.com/fields-of-microbiology/
2. https://bio.libretexts.org
3. https://www.google.com
4. https://www.sfamjournals.onlinelibrary.wiley.com
5. https://www.degruyter.com

CO – PSO Mapping

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

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

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIC3406	**Project**	**Core**	**4**	**4**

This course offers transition for students from theoretical learning to application of their knowledge. It offers an opportunity for the students to relate their profession and translate their education for holistic enlightenment. The major objective of the project is to enable the students to summarize the acquired skills to compile and present their findings for academic documentation. Also this course will encourage the students to inculcate passion for research.

Course Outcomes:

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

CO1: recall all the scientific concepts learnt in the theory.
CO2: identify the earlier forerunners in research for performing experiments.
CO3: manage resources and schedule timelines for generation of data.
CO4: relate knowledge with application for life sciences and related fields.
CO5: score aptitude to initiate research projects.

The students will be doing their project work and present their findings in the form of a dissertation followed by 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	3	3	2	3	3	2	3	3
CO2	3	3	3	3	3	3	3	2	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	2	3	3	3	3	3
CO5	3	3	3	3	2	3	3	3	3	3
Average	**3**	**3**	**3**	**3**	**2.4**	**3**	**3**	**2.6**	**3**	**3**

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

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIC3408	Pharmaceutical Microbiology	DSE	5	4

This course will familiarize students with general concepts of the prevalence of microorganisms in the pharmaceutical manufacturing unit. It provides ample understanding of the wide scope of applications of microorganisms in pharmaceutical processing. Students will explore drug development for different pharmacological effects. Emphasis will also be given to pharmaceutical regulations, clinical trials, marketing and patenting.

Course Outcomes:

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

CO1: list the prevalence and control of microbes in the pharmaceutical industry
CO2: state the assays and methods of testing pharmaceutical products.
CO3: sketch the steps in drug discovery and development.
CO4: assess the quality of immunological products.
CO5: evaluate the legislations and marketing procedures in the pharmaceutical industry.

UNIT I: Introduction to pharmaceutical microbiology (15 Hours)

Introduction to Pharmaceutical microbiology: Occurrence of microorganisms in pharmaceutical industry: Atmosphere, water, skin and respiratory flora of workers, raw materials, packaging, building and equipments and their control measures; Design and layout of sterile manufacturing.

UNIT II: Microbial aspects of pharmaceutical processing (15 Hours)

Microbial contamination and spoilage of pharmaceutical products: Microbial aspects of pharmaceutical products; Sterilization of pharmaceutical products: Heat, gaseous, radiation, and filtration; Contamination and Spoilage of Pharmaceutical products: sterile injectable and non-injectable, ophthalmologic preparation, implants.

UNIT III: Drug discovery and development (15 Hours)

Production of antibiotics: Production of antibacterial – Penicillin, Tetracycline; antifungal – Griseofulvin, Amphotericin; antiparasitic agents – Artemesin, Metronidazole; Semi-synthetic antibiotics and anticancerous agents; Additional application of microorganisms in pharmaceutical sciences: Enzymes- Streptokinase,

Streptodornase, L-asperginase and clinical dextrin; Immobilization procedures for pharmaceutical applications (liposomes); Biosensors in pharmaceuticals. Biosimilars.

UNIT IV: Pharmacological processing (15 Hours)

Production of immunological products and their quality control: Vaccines - DNA vaccines, synthetic peptide vaccines, multivalent vaccines; Vaccine clinical trials; Immunodiagnostics - immuno sera and immunoglobulin; Quality control in Pharmaceutical: In – Process and Final Product Control; Sterility tests.

UNIT V: Quality assessment and legislations (15 Hours)

Quality Assurance and Validation: Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry; Regulatory aspects of quality control; Quality assurance and quality management in pharmaceuticals – BIS (IS), ISI, ISO, WHO and US certification.

Learning Resources:

Textbooks

1. Chand Pasha Kedernath. (2021). *Textbook of Pharmaceutical Microbiology*. Ramnath Publisher.
2. Hugo, W.B., and A. D. Russell. 2021. *Pharmaceutical Microbiology*. Blackwell Science. ISBN:9780632064670
3. Priyatama Powar, Shital Nimbargi, VaijayantiSapre (2020). *Pharmaceutical Microbiology*, I edition, Technical publications.
4. Kuntal Das (2019). *Pharmaceutical Microbiology*, second edition, Nirali Prakashan.
5. Franklin, DJ. and Snow, GA. (2013). *Biochemistry of antimicrobial action*. Chapman & Hall.

References

1. Handa, S.S. and Kapoor, V.K. (2022). *Pharmacognosy*. 4thEdition.Vallabh Prakashan Publishers, New Delhi.
2. Kokate, C.K., Durohit, A.P. and Gokhale, S.R., (2002). *Pharmacognosy*. 12th edition
   Nirali Prakasham Publishers, Pune.
3. S. P. Vyas & V. K. Dixit. (2003). *Pharmaceutical Biotechnology*. CBS Publishers & Distributors, New Delhi.
4. Wallis, T.E. (2005). *Textbook of Pharmacognosy*. 5th edition. CBS publishers and distributors, New Delhi.
5. Garrod, L.P., Lambert, HP. And C'Grady, F. (1973). *Antibiotics and Chemotherapy*. (eds). Churchill Livingstone.

Websites/ e-Learning Resources

1. https://www.pharmapproach.com/introduction-to-pharmaceutical-microbiology/
2. https://www.iptsalipur.org/wpcontent/uploads/2020/08/BP303T_PMB_UNIT_I.pdf
3. https://www.pharmanotes.org/2021/11/pharmaceutical-microbiology-b-pharma.html
4. https://snscourseware.org/snscphs/notes.php?cw=CW_604b15c6313c5
5. https://www.thermofisher.com

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	3	3	3	3	2	2	3
CO2	3	3	3	2	2	3	3	3	3	3
CO3	2	3	3	2	2	2	3	3	3	3
CO4	3	3	2	1	3	2	3	2	2	3
CO5	3	3	2	1	3	3	3	2	2	3
Average	**2.8**	**3**	**2.4**	**1.8**	**2.6**	**2.6**	**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
24MIC3410	**Nanobiotechnology**	**DSE**	**5**	**4**

This course enlightens the students to appreciate the revolutionary field "Nanobiotechnology". It provides basics of biological macromolecules and explains the unique properties and advantages of different types of nanomaterials. This course will enable the students to understand the nano-bio interface and how nanotechnology can be useful in several biotechnological applications in various fields such as environment, food, health and disease for the detection and monitoring along with their promising future perspectives.

Course Outcomes:

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

CO1: recall the basics of biological macromolecules
CO2: describe the unique features of nanomaterials and development of nanobiotechnology.
CO3: explain the applications of nanobiosensors.
CO4: evaluate the production and applications of plant and microbial nanodevices.
CO5: appraise the nanobiotechnological applications in environment, food and health.

UNIT I: Basic biology for nanobiotechnology (15 Hours)

Basics of biology - cell, organelles and nucleic acids as genetic material. Complexity and size of Biomacromolecules - Carbohydrates, lipids, proteins and Nucleic acids.

UNIT II: Introduction to nanobiotechnology (15 Hours)

Nanomaterial in biotechnology - unique properties and advantages of nanoparticles, quantum dots, nanotubes and nanowires. Nano-bio interface; Nanobiotechnology- Definition- History and development of nanobiotechnology – overview, timelines and progress.

UNIT III: NanoBiosensors (15 Hours)

NanoBiosensors - different classes of molecular recognition elements, transducing elements- motion, temperature, chemical, light and pressure sensitive biosensors. Applications of different analytes in nanosensing.

UNIT IV: Nanodevices (15 Hours)

Nanodevices –definition - types and applications, lab on a chip concept. Biological nanoparticles - plant and microbial – production and applications.

UNIT V: Applications of nano biotechnology (15 Hours)

Nanobiotechnological applications in environment and food - detection and mitigation; Nanobiotechnological applications in health and disease - infectious and chronic diseases - Nanomedicine – promises and future perspectives of nanobiotechnology.

Learning Resources:

Text Books

1. Niemeyer, C.M. and Mirkin, C.A ―*Nanobiotechnology: Concepts, Applications and perspectives*, 2004, Wiley Press.
2. *Nanobiotechnology: Principles and Applications*. (2023). Singapore: Bentham Science Publishers.
3. Lateef, A., Gueguim-Kana, E. B., Dasgupta, N., Ranjan, S. (2021). *Microbial Nanobiotechnology: Principles and Applications.* Singapore: Springer Singapore, Imprint: Springer.
4. Stergios Logothetidis (Editor) *Nanomedicine and Nanobiotechnology*. (2012). Germany: Springer Berlin Heidelberg.
5. Anal, A. K. (2018). *Bionanotechnology: Principles and Applications*. United Kingdom: CRC Press

References

1. Goodsell, D.S., ―*Bionanotechnology: Lessons from Nature*, Wiley Press.
2. Jeremy Ramsden - *Nanotechnology: An Introduction*, 2011, Elsevier Publishers
3. Labhasehwar, V., and Leslie-Pelecky, D.L., (editor), ―*Biomedical Applications of Nanotechnology*, Wiley Press.
4. Paulter Adans, R.L., Knwler, L., and Leader, D.P., ―*The Biochemistry of the Nucleic Acids*‖ Springer verlag GmbH.
5. Niemeyer C.M. & Mirkin *Nanobiotechnology- Concepts, Applications and Perspectives*, C.A. 2007. Wiley-VCH Verlag.
6. *Bionanotechnology- Lessons from Nature*, Goodsell, David S. 2004, John Wiley & Sons INC., Publication.
7. Sandro Carrara, *Nano-Bio-Sensing*, 2011, Springer Publishers
8. Huw Summers - *Nanomedicine*, 2013, Elsevier Publishers.

Websites/ e-Learning Resources

1. https://www.nature.com/subjects/nanobiotechnology#:~:text=Nanobiotechnology%20is%20a%20discipline%20in,biomolecule%20delivery%20in%20cellular%20systems.
2. http://www.iitr.ac.in/academics/uploads/File/2015/syllabi/syllabinano.pdf
3. http://jntuh.ac.in/new/academic/nano-science.html
4. http://jntuk.edu.in/directorates/evaluation/news/news-editor/article-1361884380
5. http://vtu.ac.in/nano-technology/
6. http://jntua.ac.in/syllabus/ECE/M.Tech.%20%20Micro%20and%20NanoElectronics.pd

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	1	2	1	1	3	2	1	2	1
CO2	3	1	2	1	1	3	2	2	2	1
CO3	3	1	2	1	3	3	2	3	2	2
CO4	3	1	2	3	3	3	2	3	3	2
CO5	3	2	2	2	3	3	2	3	3	2
Average	**3**	**1.2**	**2**	**1.6**	**2.2**	**3**	**2**	**2.4**	**2.4**	**1.6**

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

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIC3306	**Entrepreneurship and Biobusiness**	**GE**	**4**	**3**

This course is intended to give students an impetus to launch a start-up or pursue biobusiness. It will cover the global opportunities in biobusiness with diverse business models. In order to develop a core idea for the market, the finance, and the marketing methods, it will give the students access to a variety of industrial applications and funding opportunities.

Course Outcomes:

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

CO1: underline the basic concepts in bioentrepreneurship and its importance for economic development
CO2: describe the effectiveness of different entrepreneurial strategies in Agricultural Biotechnology.
CO3: express the Entrepreneurship Opportunities in Biotechnology Industry.
CO4: analyze the commercial production of therapeutic and fermented products.
CO5: compare the different funding resources to evolve as an entrepreneur.

UNIT I: Bioentrepreneurship (12 Hours)

Bioentrepreneurship: Introduction to bio-business, SWOT analysis of bio-business. Ownership, Development of Entrepreneurship; Stages in entrepreneurial process; Government schemes and funding. Small scale industries: Definition; Characteristics; Need and rationale.

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

Entrepreneurship Opportunity in Agricultural Biotechnology: Business opportunity, Essential requirement, marketing, strategies and schemes. Nutraceuticals, value added herbal products. Bioethanol production using Agricultural waste, Algal source. Biosensor development in Agriculture management.

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

Entrepreneurship Opportunity in Industrial Biotechnology**:** Business opportunity, Essential requirement, marketing strategies, schemes, challenges, and scope- Pollution monitoring and Bioremediation for Industrial pollutants.

UNIT IV: Therapeutic and fermented products (12 Hours)

Therapeutic and Fermented products: Stem cell production, stem cell bank, production of monoclonal/polyclonal antibodies, secondary metabolite production – antibiotics, probiotic and prebiotics.

UNIT V: Project management, technology management and startup schemes (12 Hours)

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

Learning Resources:

Textbooks

1. Craig Shimasaki. (2020) *Biotechnology Entrepreneurship: Leading, Managing and Commercializing Innovative Technologies*, Second edition. Academic Press, India.
2. Ashton Acton, O. (2012). *Biological Pigments– Advances in Research and Application* Scholorly Editions: Atlanta, Georgia.
3. Jennifer Merritt, Jason Feifer (2018). *Start Your Own Business,* 7th edition, Entrepreneur Press publisher.
4. Leah Cannon (2017). How *to Start a Life Science Company: A Comprehensive Guide for First-Time Entrepreneurs*. International Kindle paperwhite.
5. Peter F. Drucker (2006). *Innovation and Entrepreneurship*. Harper Business publisher.

References

1. Crueger, W, and Crueger. A. (2000). *Biotechnology: A Text Book of Industrial microbiology*, 2nd Edition, Sinauer Associates: Sunderland. Mass.
2. Paul S Teng. (2008). *Bioscience Entrepreneurship in AsiaWorld* Scientific Publishing Company.
3. Charles E. Bamford, Garry D. Bruton (2015). *ENTREPRENEURSHIP: The Art, Science, and Process for Success*, 2nd Edition, McGraw Hill publisher.
4. Yali Friedman (2014). *Building Biotechnology: Biotechnology Business, Regulations, Patents, Law, Policy and Science* 4th Edition, Logos press publication.

5. Stephanie A. Wisner (2022). *Building Backwards to Biotech: The Power of Entrepreneurship to Drive Cutting-Edge Science to Market*, International Kindle paperwhite.

Websites/ e-Learning Resources

1. https://www.bio-rad.com/webroot/web/pdf/lse/literature/Biobusiness.pdf.
2. https://www.crg.eu/biobusiness-entrepreneurship.
3. https://www.entrepreneur.com.
4. https://www.birac.nic.in.
5. https://www.springer.com.

CO – PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	1	2	2	3	3	3	3
CO2	3	2	2	1	3	2	2	3	3	2
CO3	3	3	3	2	2	2	3	3	3	3
CO4	3	2	2	3	3	2	2	3	3	3
CO5	3	3	2	1	2	3	2	3	3	3
Average	**3**	**2.6**	**2.4**	**1.6**	**2.4**	**2.2**	**2.4**	**3**	**3**	**2.8**

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

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIC3308	**Scientific Writing**	**GE**	**4**	**3**

This course aims to impart proficiency in communication for scientific research. It emphasizes on the basic grammar and the patterns to improve the art of writing. It also can enhance the students' ability to write scientific concepts in a coherent manner. It also informs the students about the ethics in scientific reporting. It is aimed at improving the precision and the clarity of presenting the scientific concepts. Also it will train students to communicate scientific data through different formats with professional quality.

Course Outcomes:

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

CO1: construct sentences and paragraphs with proper grammar and punctuations.
CO2: prepare scientific reports by reviewing literature.
CO3: identify reference formats and avoid plagiarism.
CO4: recognize and apply diverse scientific terminologies and vocabulary.
CO5: construct letters and emails, summarize data for scientific presentations.

UNIT I: Basics for scientific writing **(12 Hours)**

Participle clauses, Articles, Subject-verb agreement, Prepositions, tense forms and punctuations, Sentence construction- Spell check and Grammar Check software.

UNIT II: Organizing a scientific report **(12 Hours)**

Exercises to read and write from Titles, Abstracts, Materials and Methods, Results, Discussion and Conclusion.

UNIT III: Bibliography and Plagiarism **(12 Hours)**

Review of literature, paraphrasing, citations, Reference Formats, Bibliography; Plagiarism, Plagiarism-checkers.

UNIT IV: Expressions and Vocabulary in science **(12 Hours)**

Definitions- glossary- Vocabulary - misnomers, jargons and complex words, Empty and redundant expressions.

UNIT V: Presentations, Emails and Cover Letters (12 Hours)

Preparing content for oral and poster presentation, graphical representations, drafting emails 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 – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	1	1	3	3	3	3	3	3
CO2	3	2	1	2	3	3	3	3	3	3
CO3	3	2	1	1	2	3	3	3	3	3
CO4	3	1	1	1	3	3	3	2	3	3
CO5	3	2	1	1	3	3	3	2	3	3
Average	**3**	**1.6**	**1**	**1.2**	**2.8**	**3**	**3**	**2.6**	**3**	**3**

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

Course Code	Name of the Course	Category	Hours/ Wk.	Credits
24MIC3266	**Professional Competency Skill**	**SEC**	**3**	**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 under graduate program the students are trained to be technically proficient and competent through internships at national and international level. 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 exams with confidence. The theoretical and practical knowledge gained will enable the students to pursue higher studies and to become competent for employability.

Course Outcomes:

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

CO1: relate knowledge to pursue higher studies.
CO2: formulate innovative ideas for bio-business.
CO3: prepare for competitive exams 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 (UG)
Value Added Courses

Sem	Course Code	Course Title	Hours/Wk.	Credits
2	24MIC122V	Fundamentals of Sanitation	2	2
3	24MIC222V	Basics of Epidemiology	2	2
5	24MIC321V	Hazard Analysis and Critical Control Point System (HACCP)	2	2

Course Code	Name of the Course	Category	Hours/Wk	Credits
24MIC122V	**Fundamentals of Sanitation**	**VAC**	**2**	**2**

This course helps students to understand the imperative of hygienic practices in reducing disease outbreaks associated with poor sanitation. To that end, the course provides insight into the various practices involved in maintaining sanitation in hospital, other healthcare facilities and food plants as these are some of the most important sources of deadly disease outbreaks. Students will learn about various disinfectants, detergents, sanitizers and cleaning equipment used to maintain hygiene in healthcare facilities and food plants.

Course Outcomes:

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

CO1: discuss the importance of personal hygiene, nosocomial infections, infectious disease burden in India.

CO2: explain the hospital environment, chemicals and equipment used for maintaining hygiene in healthcare facilities (HCF).

CO3: compare different disinfection and sterilization practices adapted by HCFs.

CO4: analyze the importance of food safety and various disease outbreaks related to poor handling of food.

CO5: assess the various food safety measures taken by diverse food industries to minimize contamination.

UNIT I: Introduction to sanitation (6 Hours)

Nomenclature/terms- significance of sanitation- basic principles of personal hygiene- healthcare associated infections (HCAI)- anti-microbial resistance (AMR)- diseases associated with poor sanitation- infectious disease burden in India

UNIT II: Hospital housekeeping I (6 Hours)

Hospital environment and different hazards- Detergents and disinfectants- Cleaning procedures for different areas of the hospital- Cleaning equipments- operation and maintenance- waste disposal and treatment.

UNIT III: **Hospital housekeeping II** **(6 hours)**

Infection control measures- disinfection and sterilization- types and practices- prevention and control of hospital infection- WASH in healthcare facilities- WHO guidelines.

UNIT IV: Food safety I **(6 Hours)**

Biosecurity and sanitation- foodborne bioterrorism- food contamination sources- allergens in food- sanitizers- sanitary equipments- pest control

UNIT V: Food Safety II **(6 Hours)**

Sanitation in different types of food industries- dairy processing plants- meat and poultry – seafood plant sanitation- fruit and vegetable processing plants- beverage plant sanitation.

Learning Resources:

Textbook

1. Marriott, N. G., Schilling, M. W., & Gravani, R. B. (2018). *Principles of food sanitation*. Springer.
2. World Health Organization (2019). Water, Sanitation and Hygiene in Healthcare Facilities: Practical Steps to Achieve Universal Access to Quality Care. Geneva: World Health Organization.

References

1. World Health Organization Staff, & World Health Organization. (2004). Laboratory Biosafety Manual. World Health Organization.

CO – PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	2	2	2	1	2	2	2
CO2	2	2	2	2	2	2	1	2	2	2
CO3	3	2	2	3	2	2	2	2	2	3
CO4	2	3	2	3	3	3	3	3	3	3
CO5	2	3	3	2	3	3	2	3	3	2
Average	**2.4**	**2.6**	**3**	**2.8**	**2.4**	**2.4**	**1.8**	**2.4**	**2.4**	**2.4**

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

Course Code	Name of the Course	Category	Hours/Wk	Credits
24MIC222V	Basics of Epidemiology	VAC	2	2

This course introduces the principles and basic methods of modern epidemiology. It covers the methods involved in surveillance of diseases and assessing and validating the reliability of screening and diagnostic tests. The course also covers the aspects of epidemiological approaches in identifying the cause of diseases and assessing the preventive and therapeutic measures of disease outbreak.

Course Outcomes:

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

CO1: explain the modes of transmission and outbreak of epidemiological diseases.
CO2: analyze and interpret the epidemiological data.
CO3: assess and validate the reliability of screening and diagnostic tests.
CO4: discuss the various epidemiological approaches in identifying the cause of disease.
CO5: evaluate the methods in assessing preventive and therapeutic measures of disease outbreak.

UNIT I: Dynamics of disease transmission (6 Hours)

Epidemiological terms – prevalence, incidence, endemic, epidemic, pandemicand sporadic. Modes of transmission - clinical and sub-clinal diseases - disease outbreaks - immunity and susceptibility - incubation period - herd immunity - attack rate

UNIT II: Measuring occurrence of disease (6 Hours)

Surveillance - stages of disease in population - measures of morbidity - incidence and prevalence rates - measures of mortality - mortality rate - case-fatality rate - proportionate mortality

UNIT III: Assessing and validating reliability of screening and diagnostic tests (6 Hours)

Biologic variations in human population - validity of screening tests - tests with dichotomous results - tests of continuous variables - use of multiple tests - reliability of tests - kappa statistic.

UNIT IV: Epidemiological approach to identify the cause of disease (6 Hours)

Observational studies - Case reports and case series - Ecologic studies - Cross-sectional studies -Case control studies - Cohort studies - Confounding.

UNIT V: Assessing preventive and therapeutic measures (6 Hours)

Randomized trials - selection of subjects - studies with and without comparison - factorial design - phases of testing drugs - multiple risk factor intervention trial - registration of clinical trials - ethical considerations

Learning Resources:

Textbook

1. Celentano DD and Szklo M (2019) Gordis Epidemiology. Sixth Edition, Elsevier Inc., Canada.

References

1. Beaglehole R, Bonita R and Kjellstrom T (1993) Epidemiology. World Health Organization, Geneva
2. Rothman KJ (1998) Modern epidemiology. Little Brown and Company, Boston/Toronto

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	3	2	2	2	1	2	2
CO2	3	2	2	3	2	2	2	1	2	2
CO3	2	3	2	2	3	2	2	2	2	3
CO4	2	3	2	2	3	2	1	2	2	3
CO5	2	3	2	2	2	2	1	3	2	2
Average	**2.4**	**2.6**	**2**	**2.4**	**2.4**	**2**	**1.6**	**1.8**	**2**	**2.4**

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

Course Code	Name of the Course	Category	Hours/Wk	Credits
24MIC321V	**Hazard Analysis and Critical Control Point System (HACCP)**	**VAC**	**2**	**2**

This course focuses on the application on hazard analysis and risk-based preventive controls (HARPC) that align with the Food Safety Modernization Act (FSMA) regulations and HACCP principles. It includes the FDA-recognized "standardized curriculum" developed by the Food Safety Preventive Controls Alliance (FSPCA).

Course Outcomes:

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

CO1: explain the principles and applications of HACCP
CO2: discuss the control Food Hazards
CO3: analyze the significance of Critical Control Points
CO4: assess the identification preventive measures of food hazards
CO5: plan legislations with regards to HACCP

UNIT I: Introduction and Overview (6 Hours)

History and Introduction to HACCP, Principles and applications of HACCP. Prerequisite programs, Good manufacturing practices (GMP), Standard Operating Procedures (SOP), and Sanitation Standard Operating Procedures (SSOP). TACCP and VACCP, Codex Alimentarius Commission.

UNIT II: Application of HACCP to control Food Hazards (6 Hours)

Definition of the terms: Hazard, Risk, Food business operation, Critical Control Point, Risk assessment, Hazard analysis, Control measure corrective action, critical limit, deviation, monitor, validation and verification.

UNIT III: Critical Control Points (CCP) (6 Hours)

Application of CCP food business operation - methods of identifying CCP to ensure food safety, Critical limits specification.

UNIT IV: Identification and Prevention of Hazard (6 Hours)

Identification of biological, chemical, and physical hazards - food (Food additives and adulterants), Allergens (Natural and Artificial residues) - Drugs (Veterinary drug residues). Preventive measures.

UNIT V: HACCP plan and Legislations (6 Hours)

Monitoring procedures, Verification, and record-keeping procedures within a food manufacturing industry. Food Hygiene Regulations 2006 and the EU Regulations - Codes of Practice with regard to the system of HACCP. Implementation procedures based on HACCP principles. Labelling under the EU Consumer Information (Consumer Regulation 1169/2011, Food Information Regulations 2014).

Learning Resources:

Textbook

1. *HACCP: A Systematic Approach to Food Safety*, Jeffrey T. Barach and Melinda M. Hayman, Fifth Edition 2014.

References

1. Food Quality and Safety Systems - A Training Manual on Food Hygiene and the Hazard Analysis and Critical Control Point (HACCP) System, John R. Lupien(1998), Publishing Management Group, FAO Information Division ISBN 92-5-104115-6

CO – PO Mapping

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

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