AUXILIUM COLLEGE (AUTONOMOUS)

VELLORE – 632 006

Post Graduate Department of Microbiology

B.Sc. MICROBIOLOGY

SYLLABUS AND REGULATIONS

(Based on TANSCHE Model Syllabus)

Under

OUTCOME BASED EDUCATION PATTERN

With

CHOICE BASED CREDIT SYSTEM

For the Candidates Admitted from 2024-2025 Onwards

B.Sc. MICROBIOLOGY

(Effective from the academic year 2024 - 2025)

Vision of the Department:

The Bachelors in Microbiology Programme will enable the development of a new generation of Microbiologists who are capable of excelling in their chosen career dealing with premium process and applications of Science profoundly influencing the existing paradigm of agriculture, industry, health care sectors and restoration of environment providing sustainable competitive edge of present society by fostering knowledge on appropriate scientific vocabulary, reasoning skills, effective oral and written communication abilities.

Mission:

To provide a conducive learning environment with a student-centric atmosphere that allows them to achieve academic excellence in all aspects of Microbiology.

Objectives:

- To provide an in-depth knowledge in Microbiology.
- To acquire skill and competency in practical.
- To expose the students to the recent trends in Microbiology and related sciences.
- To motivate the students for life-long learning and train students towards research.
- To train economically backward students and make them eligible for higher education and job opportunities.
- To tap out the talents through extracurricular and co-curricular activities.
- To get sensitized to social and environmental realities.

Eligibility for admission to B.Sc. Microbiology:

- A pass in higher secondary with Mathematics, Physics, Chemistry and Biology (Category I).
- A pass in higher secondary with Physics, Chemistry, Zoology and Botany (Category II).

Allied Subjects:

1. Biochemistry
2. Biostatistics

Highlights of the Revamped Curriculum:

- Student-centric, meeting the demands of industry & society, incorporating industrial components, hands-on training, skill enhancement modules, industrial project, project with viva-voce, exposure to entrepreneurial skills, training for competitive examinations, sustaining the quality of the core components and incorporating application-oriented content wherever required.

- The Core subjects include latest developments in the education and scientific front, practical training, catering to the needs of stakeholders with research aptitude.

- The curriculum is designed to strengthen the industry-academia interface and provide more job opportunities for the students.

- The Internship during the second-year vacation will help the students gain valuable work experience, that connects classroom knowledge to real world experience and to narrow down and focus on the career path.

- Project with viva-voce component in the fifth semester enables the students to apply their conceptual knowledge to practical situations. Such innovative provisions of the industrial training/project/internships will give students an edge over the counterparts in the job market.

- State-of Art techniques from the streams of multi-disciplinary, cross disciplinary and inter disciplinary nature are incorporated as Elective and Skill Enhancement Courses, covering conventional topics to the application oriented.

Value additions in the Revamped Curriculum:

Semester	Newly introduced Components	Outcome / Benefits
I	**Foundation Course in Microbiology** To ease the transition of learning from higher secondary to higher education, providing an overview of the pedagogy of learning Microbiology and its concepts.	● Instil confidence among students ● Create interest for the subject
I, II, III & IV	**Skill Enhancement papers** (Discipline centric/ Generic / Entrepreneurial)	● Industry ready graduates ● Skilled human resource ● Students are equipped with essential skills to make them employable
		● Entrepreneurial skill training will provide an opportunity for independent livelihood generating self- employment by creating small scale entrepreneurs ● Discipline centric skill will improve the technical knowhow of solving real life problems
III, IV, V & VI	**Elective papers-** An open choice of topics categorized under Generic and Discipline Centric	● Strengthening the domain knowledge ● Introducing the stakeholders to the state-of art techniques from the streams of multi-disciplinary, cross disciplinary and inter disciplinary nature ● Emerging topics related to industry are introduced to facilitate advanced learning in the respective domains
II Year Vacation activity	Internship / Industrial Training	● Practical training at the Industry/ Chemical Companies/Educational institutions, enable the students gain professional experience and become responsible citizens.
V Semester	Project with Viva – voce	● Self-learning is enhanced ● Application of the concept to real situation is conceived resulting in tangible outcome
VI	Introduction of	● Enhancing various advanced

Semester	Professional Competency component	techniques for application in the field of quality control and quality assurance by analyzing microbial standards involving its execution.

Skills acquired from the Courses	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

TANSCHE BASED PROGRAMME STRUCTURE FOR B.Sc. MICROBIOLOGY (For the candidates admitted from the academic year 2024-2025)									
Sem	Part	Category	Paper Code	Title	Hours/ Week	Exam		Credits	Marks
						Th	Pr		
I	I	Tamil/Language	ULTAA24	Language I: Tamil– I	5	3	-	3	40 + 60
	II	English	UENGA24	Language II: English– I	6	3	-	3	40 + 60
	III	Core Course 1	UCMBA24	Fundamentals of Microbiology and Microbial Diversity	5	3	-	5	40 + 60
		Core Course 2	UCMBB24	Practical - I: Fundamentals of Microbiology and Microbial Diversity	3	-	3+3	3	40 + 60
		Generic Elective 1	UGEBCA24	Generic Elective I: Biochemistry- I	4	3	-	3	40 + 60
			UGEBCB24	Generic Elective Practical: Biochemistry	2	-	3	2	40 + 60
	IV	Skill Enhancement Course SEC 1	USMB124	SEC: Social and Preventive medicine	2	-	-	2	100
		Foundation Course FC	UFMB24	FC: Introduction to microbial world	2	2	-	2	40 + 60
		Value Education	UVEDA22*	Value Education	1	-	-	-	-
				Total	**30**			**23**	**800**
II	I	Tamil/Language	ULTAB24	Language I: Tamil– II	6	3	-	3	40+ 60
	II	English	UENGB24	Language II: English– II	5	3	-	3	40 + 60
	III	Core Course 3	UCMBC24	Microbial Physiology and Metabolism	5	3	-	5	40 + 60
		Core Course 4	UCMBD24	Practical - II: Microbial Physiology and Metabolism	3	-	3+3	3	40 + 60
		Generic Elective 2	UGEBCC24	Generic Elective II: Biochemistry - II	4	3	-	3	40 + 60
			UGEBCD24	Generic Elective Practical: Biochemistry	2	-	3	2	40 + 60
	IV	Skill Enhancement Course SEC 2	USMB224	SEC: Nutrition and Health Hygiene	2	-	-	2	100
		Skill Enhancement Course SEC 3	USMB324	SEC: Bioinstrumentation	2	-	-	2	100
		Value Education	UVEDA22**	Value Education	1	-	-	-	-
				Total	**30**			**23**	**800**
III	I	Tamil/Language	ULTAC24	Language I: Tamil– III	5	3	-	3	40+ 60
	II	English	UENGC24	Language II: English– III	6	3	-	3	40 + 60
	III	Core Course 5	UCMBE24	Molecular Biology and Microbial Genetics	5	3	-	5	40 + 60
		Core Course 6	UCMBF24	Practical - III: Molecular Biology and Microbial Genetics	3	-	3+3	3	40 + 60
		Generic Elective 3	UGEBSA24	Generic Elective - III: Biostatistics – I	6	3	-	5	40 + 60
		Skill Enhancement Course SEC 4	USMB424	SEC: Aquaculture	1	-	-	1	100
	IV	Skill Enhancement Course SEC 5	USMB524	SEC: Organic Farming and Biofertiliser technology	2	-	-	2	100
		EVS	UNEVS24*	Environmental Studies	1	-	-	-	-
		Value Education	UVEDA22**	Value Education	1	-	-	-	-
				Total	**30**			**22**	**700**

Sem	Part	Category	Paper Code	Title	Hours / Week	Exam		Credits	Marks
						Th	Pr		
IV	I	Tamil/Language	ULTAD24	Language I: Tamil– IV	**6**	3	-	**3**	40+ 60
	II	English	UENGD24	Language II: English– IV	**5**	3	-	**3**	40 + 60
	III	Core Course 7	UCMBG24	Immunology and Immunotechnology	**5**	3	-	**5**	40 + 60
		Core Course 8	UCMBH24	Practical - IV: Immunology and Immuno technology	**3**	-	3+3	**3**	40 + 60
		Generic Elective 4	UGEBSB24	Allied - IV: Biostatistics – II	**6**	3	-	**6**	40 + 60
		Skill Enhancement Course SEC 6	USMB624	SEC: Vaccine Technology	**2**	-	-	**2**	100
	IV	Skill Enhancement Course SEC 7	USMB724	SEC: Apiculture	**1**	-	-	**1**	100
		EVS	UNEVS24	Environmental Studies	**1**	2	-	**2**	40 + 60
		Value Education	UVEDA22 ****	Value Education	**1**	-	-	-	-
				Total	**30**			**25**	**800**
V	III	Core Course 9	UCMBI24	Bacteriology and Mycology	5	3	-	5	40 + 60
		Core Course 10	UCMBJ24	Virology and Parasitology	5	3	-	4	40 + 60
		Core Course 11	UCMBK24	Practical - V: Medical Microbiology	5	-	3+3	3	40 + 60
		Core Course 12 (Group Project)	UCMBL24	Project	5	-	-	4	40 + 60
		Discipline Specific Elective 1	UEMBA24	Elective: Recombinant DNA technology	5	3	-	3	40 + 60
			UEMBB24	Elective: Fundamentals of Cell Biology					
		Discipline Specific Elective 2	UEMBC24	Elective: Clinical Laboratory technology	4	3	-	3	40 + 60
			UEMBD24	Elective: Marine Microbiology					
	IV	Value Education	UVEDA22 *****	Value Education	1	-	-	-	-
		Summer Internship/Industrial Training	UIMB24	Internship	-	-	-	2	40 + 60
				Total	**30**			**24**	**700**
VI	III	Core Course 13	UCMBM24	Environmental and Agriculture Microbiology	5	3	-	3	40 + 60
		Core Course 14	UCMBN24	Food, Dairy and Probiotic Microbiology	5	3	-	3	40 + 60
		Core Course 15	UCMBO24	Practical - VI: Applied Microbiology	5	-	3+3	4	40 + 60
		Core Course 16	UCMBP24	Biosafety & Bioethics	3	3	-	2	40 + 60
		Discipline Specific Elective 3	UEMBE24	Elective: Pharmaceutical Microbiology	5	3	-	3	40 + 60
			UEMBF24	Elective: Microbial Nanotechnology					
		Discipline Specific Elective 4	UEMBG24	Elective: Entrepreneurship and Bio-business	4	3	-	3	40 + 60
			UEMBH24	Elective: Advanced Microbiology					
	IV	Professional Competency SEC 8	UPMB24	Microbial Quality Control and testing	2	2	-	2	40 + 60
		Value Education	UVEDA22	Value Education	1	2	-	2	40 + 60
	V	Extension Activity	-	Extension Activity (90 hours)	-	-	-	1	-
				Total	**30**			**23**	**800**
				Grand Total	**180**			**140 +2***	**4600**

- Any one course of the following to be completed during III semester (15 hours teaching and 15 hours activities):
  i) Fundamentals of Computer and MS Office (Computer Science & B.C.A)

- Advanced Excel
- Multimedia Using Flash
- Photoshop

ii) Health and Fitness (Physical Education)

Methods of Evaluation						
S. No.	**Category**	**Assessment Tool**	**Maximum Marks**	**Exam Theory**	**Weightage**	
1	Core Courses/Generic & Discipline Specific Electives	I Continuous Assessment (ICA)	50	1 ½ h	35	40
		II Continuous Assessment (IICA)	50	1 ½ h		
		Innovative Component (IC)	5	-	5	
		End Semester Examination	100	3 h		60
2	Foundation Course/Professional Competency	I Continuous Assessment (ICA)	30	1 h	35	40
		II Continuous Assessment (IICA)	30	1 h		
		Innovative Component (IC)	5	-	5	
		End Semester Examination	60	2 h		60
3	EVS	Continuous Assessment (IICA)	25	1 h		40
		Innovative Component (IC)	25	-		
		End Semester Examination	60	2 h		60

Activity-based Assessment for Skill Enhancement Courses:

Activity 1 for Unit I: (Nature of Activity) – 20 marks
Activity 2 for Unit II: (Nature of Activity) – 20 marks
Activity 3 for Unit III: (Nature of Activity) – 20 marks
Activity 4 for Unit IV: (Nature of Activity) – 20 marks
Activity 5 for Unit V: (Nature of Activity) – 20 marks

Nature of Activity – Field visit / Industrial visit / Project (individual or group) / Exhibits / Model making/Hands on training / Lab practice / Product making / Extempore / Block and Tackle / Debate / Report writing / Case study / Interpretation of data or results / Transcription/Quiz (LMS) / Problem solving / Designing / Role play / Start-up proposal / Research proposal / Poster presentation / Oral presentation (live or video recorded) /Survey (Field or Online) / Group discussion / Problem solving / Problem

formulation / Interviews / Concept mapping / Mind mapping / Promoting public awareness etc.

Record of Assessment will be maintained by the course instructors and verified by the Head of the Department.

Cognitive Levels of Assessment	
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, short summary or overview
Application (K3)	Suggest idea/concept with examples, suggest formulae, Solve problems, Observe, Explain
Analyze (K4)	Problem-solving questions, finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

PROGRAMME OUTCOMES (PO)

On completion of the UG Programme, the students will be able to:

PO1: Attain knowledge and understand the principles and concepts in the respective discipline.

PO2: Acquire and apply analytical, critical and creative thinking, and problem-solving skills.

PO3: Effectively communicate general and discipline-specific information, ideas and opinions.

PO4: Appreciate biodiversity and enhance eco-consciousness for sustainable development of the society.

PO5: Emulate positive social values and exercise leadership qualities and team work.

PO6: Pursue higher knowledge, qualify professionally, enhance entrepreneurial skills and contribute towards the needs of the society.

PROGRAMME SPECIFIC OUTCOMES (PSO)

On completion of the UG Programme in Microbiology, the students will be able to:

PSO1: Acquire an in-depth knowledge on the fundamental concepts and scope of Microbiology and its related fields.

PSO2: Realize the application-oriented aspects of Microbiology and assimilate the technical skills in basic, medical and applied microbiology.

PSO3: Develop and execute oral and writing skills necessary for effective communication of discipline specific information and experimental results.

PSO4: Understand and explain the diversity of microorganisms and its interaction with the environment for sustainable development.

PSO5: Efficiently work as a team involving multiple disciplines with social and ethical values.

PSO6: Attain higher knowledge by developing competency in the field of Microbiology assuring and enhancing entrepreneurial skills for the betterment of the society.

PSO/PO	PO1	PO2	PO3	PO4	PO5	PO6
PSO1	H	M	H	M	M	H
PSO2	H	H	H	M	M	M
PSO3	H	M	H	H	M	M
PSO4	H	M	H	H	M	M
PSO5	H	M	H	M	M	M
PSO6	H	H	H	H	H	H

(HIGH - 3, MODERATE - 2, LOW - 1)

<table>
<tr><td>Title of the Course</td><td colspan="8">FUNDAMENTALS OF MICROBIOLOGY AND MICROBIAL DIVERSITY</td></tr>
<tr><td>Paper No.</td><td colspan="8">Core Course I</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td>Credits</td><td>5</td><td>Course Code</td><td colspan="2">UCMBA24</td></tr>
<tr><td>Semester</td><td>I</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>5</td><td>-</td><td colspan="3">-</td><td colspan="2">5</td></tr>
<tr><td>Objectives of the course</td><td colspan="8">• Learn the fundamental principles about different aspects of Microbiology including recent developments in the area.
• Describe the structural organization, morphology and reproduction of microbes.
• Explain the methods of cultivation of microbes and measurement of growth.
• Understand the microscopy and other basic laboratory techniques – culturing, disinfection and sterilization in Microbiology.
• Compare and contrast the different methods of sterilization.</td></tr>
<tr><td>Course Outline</td><td colspan="8">UNIT I (15 hours) (K1, K2, K3 & K4)
History of Microbiology and Microbial Biodiversity
1.1 History and Evolution of Microbiology,
1.2 Classification – Three kingdom, five kingdom, six kingdom and eight kingdom.
1.3 Microbial biodiversity: Introduction to microbial biodiversity- ecological niche.
1.4 Basic concepts of Eubacteria.
1.5 Archaebacteria and Eucarya.
1.6 Conservation of Biodiversity.</td></tr>
<tr><td></td><td colspan="8">UNIT II (15 hours) (K1, K2, K3 & K4)
General characteristics & structure of cellular and acellular microbes
2.1 General characteristics of cellular microorganisms (Bacteria, Algae, Fungi and Protozoa).
2.2 Acellular microorganisms - (Viruses, Viroids, Prions).
2.3 Differences between prokaryotic and eukaryotic microorganisms.
2.4 Structure of Bacterial cell wall, cell membrane, capsule, flagella, pili, mesosomes, chlorosomes, phycobilisomes, spores, and gas vesicles.
2.5 Structure of fungi (Mold and Yeast)
2.6 Structure of microalgae.</td></tr>
<tr><td></td><td colspan="8">UNIT III (15 hours) (K1, K2, K3 & K4)
Culture media and culture techniques
3.1 Bacterial culture media.
3.2 Pure culture techniques – streak plate.
3.3 Pure culture techniques – spread plate and pour plate
3.4 Mode of cell division.
3.5 Quantitative measurement of growth.
3.6 Anaerobic culture techniques.</td></tr>
</table>

	UNIT IV (15 hours) (K1, K2, K3 & K4) **Microscopy and staining methods** 4.1 Microscopy – Simple, bright field, dark field. 4.2 Phase contrast, fluorescent. 4.3 Electron microscope – TEM & SEM. 4.4 Confocal microscopy. 4.5 Atomic Force Microscopy. 4.6 Stains and staining methods.
	UNIT V (15 hours) (K1, K2, K3 & K4) **Sterilization and Disinfection** 5.1 Sterilization–moist heat – autoclaving. 5.2 Dry heat – Hot air oven. 5.3 Radiation – UV, Ionization. 5.4 Filtration – membrane filter 5.5 Disinfection. 5.6 Antiseptic and Antimicrobial agents.
Text Books	1. Pelczar. M. J., Chan E.C.S. and Noel. R.K. (2007). Microbiology. 7thEdition., Mc Graw –Hill, New York. 2. Willey J., Sherwood L., and Woolverton C. J., (2017). Prescott's Microbiology. 10th Edition., McGraw-Hill International. 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. 7thEdition., McGraw Hill Inc. New York. 5. Boyd, R.F. (1998). General Microbiology,2nd Edition., Times Mirror, Mosby College Publishing, St Louis.
Reference Books	1. Jeffrey C. Pommerville. (2010). Alcamo's Fundamentals of Microbiology 9th Edition. Jones &Bartlett learning publishers. 2. Stanier R.Y, Ingraham J. L., Wheelis M. L., and Painter R. R. (2010). General Microbiology, 5thEdition., MacMillan Press Ltd 3. Tortora, G.J., Funke, B.R. and, Case, C.L (2011). Microbiology -An Introduction, 10th Edition., Benjamin Cummings. 4. Nester E., Anderson D., Roberts C. E., and Nester M. (2006). Microbiology-A Human Perspective, 5thEdition., 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.
Web 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/bzx/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	Course Outcomes
On completion of this course, students will be able to;	
CO1	Study the historical events that led to the discoveries and inventions and understand the Classification of Microorganisms.
CO2	Gain Knowledge of detailed structure and functions of prokaryotic cell organelles.
CO3	Understand the various microbiological techniques, different types of media, and techniques involved in culturing microorganisms.
CO4	Explain the principles and working mechanism of different microscopes/Microscope, their function and scope of application.
CO5	Understand the concept of asepsis and modes of sterilization and disinfectants**.**

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	M	H	M	L	H
CO2	H	H	H	L	H	M
CO3	H	M	H	H	H	L
CO4	H	L	H	H	H	L
CO5	H	L	H	L	L	M

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	H	M	L	H
CO2	H	H	H	L	L	M
CO3	H	M	H	H	L	L
CO4	H	L	H	H	L	L
CO5	H	L	H	L	L	M

(HIGH - 3, MODERATE - 2, LOW - 1)

<table>
<tr><td>Title of the Course</td><td colspan="7">PRACTICAL -I: FUNDAMENTALS OF MICROBIOLOGY AND MICROBIAL DIVERSITY</td></tr>
<tr><td>Paper No.</td><td colspan="7">Core Course II</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core Practical</td><td>Year</td><td>I</td><td>Credits</td><td>3</td><td>Course Code</td><td>UCMBB24</td></tr>
<tr><td>Semester</td><td>I</td><td colspan="3"></td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>-</td><td>-</td><td colspan="3">3</td><td colspan="2">3</td></tr>
<tr><td>Objectives of the course</td><td colspan="7">• Acquire knowledge on Cleaning of glass wares, GLP and sterilization.
• Gain knowledge on media preparation and cultural characteristics.
• Learn the pure culture technique.
• Learn the microscopic techniques and staining methods.
• Acquire knowledge on stain and staining methods</td></tr>
<tr><td>Course Outline (Experiments)</td><td colspan="7">1. Cleaning of glass wares, 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. Preparation of basal, differential, enriched, enrichment, transport, and selective media preparation- quality control of media, growth supporting properties, sterility check of media.
5. Pure culture techniques: streak plate, pour plate, decimal dilution.
6. Culture characteristics of microorganisms: growth on different media, growth characteristics, and description.
7. Demonstration of pigment production.
8. Microscopy: light microscopy and bright field microscopy.
9. Staining techniques: smear preparation, simple staining, Gram’s staining and endospore staining.
10. Study on Microbial Diversity using Hay Infusion Broth-Wet mount to show different types of microbes, hanging drop.</td></tr>
<tr><td>Text Books</td><td colspan="7">1. James G Cappucino and N. Sherman M B (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) Sundarraraj publications.
4. Gunasekaran, P. (1996). Laboratory manual in Microbiology. New Age International Ltd., Publishers, New Delhi.
5. R C Dubey and D K Maheswari (2002). Practical Microbiology. S. Chand Publishers.</td></tr>
<tr><td>Reference Books</td><td colspan="7">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.</td></tr>
</table>

	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. Lim D. (1998). Microbiology, 2ndEdition, WCB McGraw Hill Publications.
Web resources	1. http://www.biologydiscussion.com/micro-biology/sterilisation-and-disinfection methods-and-principles-microbiology/24403. 2. https://www.ebooks.cambridge.org/ebook.jsf?bid=CBO9781139170635 3. https://www.grsmu.by/files/file/university/cafedry//files/essential_microbiology.pdf 4. https://microbiologyinfo.com/top-and-best-microbiology-books/ 5. https://www.cliffsnotes.com/studyguides/biology/microbiology/introduction-to-microbiology/a-brief-history-of-microbiology

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Practice sterilization methods; learn to prepare media and their quality control.
CO2	Learn streak plate, pour plate and serial dilution and pigment production of microbes.
CO3	Understand Microscopy methods, different Staining techniques and motility test.
CO4	Observe culture characteristics of microorganisms.
CO5	Study Microbial Diversity using Hay Infusion Broth by Wet mount.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	H	M	L	H
CO2	H	H	M	H	M	M
CO3	M	M	L	H	L	L
CO4	M	L	M	H	M	L
CO5	H	L	H	L	L	M

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	L	L	M
CO2	H	H	H	H	L	M
CO3	H	H	H	H	L	M
CO4	H	H	H	H	L	M
CO5	H	H	H	H	L	M

(HIGH - 3, MODERATE - 2, LOW - 1)

<table>
<tr><td>Title of the Course</td><td colspan="7">SKILL ENHANCEMENT COURSE: SOCIAL AND PREVENTIVE MEDICINE</td></tr>
<tr><td>Paper No.</td><td colspan="7">SEC I</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Skill Enhancement Course</td><td>Year</td><td>I</td><td>Credits</td><td>2</td><td>Course Code</td><td>USMB124</td></tr>
<tr><td>Semester</td><td>I</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>2</td><td>-</td><td colspan="3">-</td><td colspan="2">2</td></tr>
<tr><td>Objectives of the course</td><td colspan="7">• Describe the concepts of health and disease and their social determinants.
• Summarize the health management system.
• Know about the various health care services.
• Outline the goals of preventive medicine.
• Gain knowledge about alternate medicine.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (6 hours) (K1, K2, K3 & K4)
Introduction to social medicine.
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.</td></tr>
<tr><td></td><td colspan="7">UNIT II (6 hours) (K1, K2, K3 & K4)
Health management.
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 hazards and their control. Occupational hazards and their control.</td></tr>
<tr><td></td><td colspan="7">UNIT III (6 hours) (K1, K2, K3 & K4)
Health care and services.
Health care of the community-information, education, communication and training in health- maternal health & child health -school health services-Geriatrics- care and welfare of the aged- mental health-health services through general practitioners.</td></tr>
<tr><td></td><td colspan="7">UNIT IV (6 hours) (K1, K2, K3 & K4)
Preventive medicine.
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.</td></tr>
</table>

	UNIT V (6 hours) (K1, K2, K3 & K4) **Prevention through alternate medicine.** Unani, Ayurveda, systems in epidemic and pandemic outbreaks. Homeopathy, Naturopathy systems in epidemic and pandemic outbreaks. International health regulations. Infectious disease outbreak case studies and precautionary response during SARS and MERS outbreaks. Infectious disease outbreak case studies and precautionary response during coronavirus, and novel SARS-COV2 outbreaks. Infectious disease outbreak case studies and precautionary response during Ebola outbreaks.
Text Books	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 brother's medical publishers. 3. Chun-Su Yuan, Eric J. Bieber, Brent Bauer (2006). Textbook of Complementary and Alternative Medicine. Second Edition. Routledge publishers. 4. Vivek Jain (2020). Review of Preventive and Social Medicine: Including Biostatics. 12th edition, Jaypee Brothers Medical Publishers. 5. Lal Adarsh Pankaj Sunder (2011). Textbook of Community Medicine: Preventive and Social Medicine, CBS publisher.
Reference Books	1. Howard Waitzkin, Alina Pérez, Matt Anderson (2021). Social Medicine and the coming Transformation. First Edition. Routledge publishers. 2. GN Prabhakara (2010). Short Textbook of Preventive and Social Medicine. Second Edition. Jaypee publishers. 3. Jerry M. Suls, Karina W. Davidson, Robert M. Kaplan (2010). Handbook of Health Psychology and Behavioral Medicine.Guilford Press. 4. Marie Eloïse Muller, Marie Muller, MarthieBezuidenhout, KarienJooste (2006). Health Care Service Management. Juta and Company Ltd. 5. Geoffrey Rose (2008). Rose's Strategy of Preventive Medicine: The Complete.OUP Oxford.
Web resources	1. https://www.omicsonline.org/scholarly/social--preventive-medicine-journals-articles-ppts-list. 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	Course Outcomes
On completion of this course, students will be able to;	
CO1	Identify the health information system.
CO2	Associate various factors with health management system.
CO3	Choose the appropriate health care services.
CO4	Appraise the role of preventive medicine in community setting.
CO5	Recommend the usage of alternate medicine during outbreaks.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	H	L	H	H
CO2	H	H	H	L	M	M
CO3	H	H	H	L	M	M
CO4	H	H	H	L	M	M
CO5	H	H	H	L	M	M

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	L	H	H
CO2	H	H	H	L	M	M
CO3	H	H	H	L	M	M
CO4	H	H	H	L	M	M
CO5	H	H	H	L	M	M

(HIGH - 3, MODERATE - 2, LOW - 1)

<table>
<tr><td>Title of the Course</td><td colspan="8">FC: INTRODUCTION TO MICROBIAL WORLD</td></tr>
<tr><td>Paper No.</td><td colspan="8">FC</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Foundation Course</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">2</td><td rowspan="2">Course Code</td><td rowspan="2">UFMB24</td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>2</td><td>-</td><td colspan="3">-</td><td colspan="2">2</td></tr>
<tr><td>Objectives of the course</td><td colspan="8">• To emphasize economic importance of bacteria.
• To gain knowledge on beneficial and harmful aspects of fungi.
• To explore the role of algae in various sectors.
• To acquire basic insight on significance of viruses.
• To impart importance of protozoa in day-to-day life</td></tr>
<tr><td>Course Outline</td><td colspan="8">UNIT I (6 hours) (K1, K2, K3 & K4)
General features and economic importance of bacteria.
General characteristics and morphology of bacteria, mycoplasma, and archaebacteria. Economic importance of bacteria with examples in antibiotic production (Streptomyces), biofertilizer (Rhizobium), superbugs (Pseudomonas), fermentation (Lactobacillus). Harmful aspects such as food spoilage (Clostridium) and diseases (Xanthomonas, Salmonella, Vibrio).</td></tr>
<tr><td></td><td colspan="8">UNIT II (6 hours) (K1, K2, K3 & K4)
General features and economic importance of fungi.
General characteristics and morphology of fungi, Economic importance of fungi with examples in biopesticide (Beauveria), industry (Saccharomyces), medicine (Penicillium). Harmful aspects-food spoilage (mold), diseases in crops (Fusarium), humans (Aspergillus), allergic reactions (Mucor).</td></tr>
<tr><td></td><td colspan="8">UNIT III (6 hours) (K1, K2, K3 & K4)
General features and economic importance of algae.
General characteristics and morphology of algae. Beneficial aspects of algae with examples in single cell protein (Spirulina), soil fertility (Anabaena), environment (Phytoplanktons). Harmful aspectsEutrophication and phycotoxins.</td></tr>
<tr><td></td><td colspan="8">UNIT IV (6 hours) (K1, K2, K3 & K4)
General features and economic importance of virus.
General characteristics of virus. Economic importance of virus with examples in vaccine production (Rabies virus), gene therapy (Adenovirus), biopesticides (Cauliflower mosaic virus). Harmful aspects - diseases (plant-TMV, human-Influenza virus).</td></tr>
</table>

	UNIT V (6 hours) (K1, K2, K3 & K4) **General features and economic importance of protozoa.** General characteristics of protozoa. Beneficial applications of protozoa with examples – Biocontrol (Haemogregarina), sanitation (Amoeba), oil exploration (Radiolaria). Harmful aspects –diseases (Entamoeba, Giardia).
Text Books	1. Pelczar, M.J., Chan, E. C. S. and Kreig, N. R. (2006). Microbiology. 5th edition, Tata Mc Grow Hill Inc, New York. 2. Dubey, R.C. and Maheswari, D.K. (2005). A Text book of Microbiology. S.Chand &Company Ltd, New Delhi. 3. Subba Rao, N.S. (1995). Soil microorganisms and plant growth, Oxford and IBH publishing Co. Pvt. Ltd. New Delhi. 4. Boyd, R.F. (1998). General Microbiology,2nd Edition., Times Mirror, Mosby College Publishing, St Louis. 5. Jeffrey C. Pommerville. (2010). Alcamo's Fundamentals of Microbiology 9th Edition. Jones &Bartlett learning publishers.
Reference Books	1. Willey J., Sherwood L., and Woolverton C. J., (2017). Prescott's Microbiology. 10th Edition., McGraw-Hill International. 2. Hurst, C.J., Crawford, R.L., Garland, J.L., Lipson, D.A. and Mills, A.L. (2002). Manual of Environmental Microbiology, 2nd Edition. A. SM Press, New Delhi. 3. Atlas, R.A. (1995). Principles of Microbiology. Mosby Publications, USA. 4. Madigan, M.T. and Martinko, J.M. (2014). Brock Biology of Microorganisms. 14th Edition. Prentice Hall International Inc., USA. 5. Nester E., Anderson D., Roberts C. E., and Nester M. (2006). Microbiology-A Human Perspective, 5thEdition., McGraw Hill Publications.
Web resources	1. https://microbiologyinfo.com/category/basic-microbiology/ 2. https://microbiologyinfo.com/category/basic-microbiology/ 3. https://www.britannica.com/science/microbiology 4. https://www.cliffsnotes.com/study guides/ biology/ microbiology/ introduction-to-microbiology/a-brief-history-of-microbiology 5. https://microbiologyinfo.com/top-and-best-microbiology-books/

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Understand the economic importance of bacteria.
CO2	Explain on the beneficial and harmful aspects of fungi.
CO3	Explore the role of algae in various sectors.
CO4	Acquire basic insight on significance of viruses.
CO5	Elaborate on the importance of protozoa in day-to-day life.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	M	H	M	L	H
CO2	H	H	H	L	H	M
CO3	H	M	H	H	H	L
CO4	H	L	H	H	H	L
CO5	H	L	H	L	L	M

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	H	M	L	H
CO2	H	H	H	L	L	M
CO3	H	M	H	H	L	L
CO4	H	L	H	H	L	L
CO5	H	L	H	L	L	M

(HIGH - 3, MODERATE - 2, LOW - 1)

<table>
<tr><td>Title of the Course</td><td colspan="7">MICROBIAL PHYSIOLOGY AND METABOLISM</td></tr>
<tr><td>Paper No.</td><td colspan="7">Core Course III</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td>Credits</td><td>5</td><td>Course Code</td><td>UCMBC24</td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>5</td><td>-</td><td colspan="3">-</td><td colspan="2">5</td></tr>
<tr><td>Objectives of the course</td><td colspan="7">• Study the basic principles of microbial growth.
• Understand the basic concepts of aerobic and anaerobic metabolic pathways.
• Analyze the role of individual components in overall cell function.
• Provide information on sources of energy and its utilization by microorganisms.
• Study the different types of metabolic strategies.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (15 hours) (K1, K2, K3 & K4)
Physiology of microbial growth.
1.1 Batch culture.
1.2 continuous culture.
1.3 synchronous culture.
1.4 Growth Curve.
1.5 Measurement method (turbidity, biomass, and cell count).
1.6 Control of microbial growth.</td></tr>
<tr><td></td><td colspan="7">UNIT II (15 hours) (K1, K2, K3 & K4)
Nutritional requirements and transport mechanism.
2.1 Photoautotrophs, Photoorganotrophs.
2.2 Chemolithotrophs.
2.3 Ammonia, Nitrite, Sulfur, Hydrogen, Iron oxidizing Bacteria.
2.4 Chemoorganotrophs.
2.5 Nutrition transport mechanisms – Passive diffusion and Active transport.
2.6 Factors affecting microbial growth.</td></tr>
<tr><td></td><td colspan="7">UNIT III (15 hours) (K1, K2, K3 & K4)
Overview of Metabolism.
3.1 Embden Meyerhof Pathway, Entner-Doudoroff Pathway,
3.2 Pentose Phosphate Pathway,
3.3 Tricarboxylic Acid Cycle.
3.4 Electron Transport Chain and
3.5 Oxidative Phosphorylation. ATP synthesis.
3.6 Fermentation-Homolactic Fermentation, Heterolactic Fermentation, Mixed Acid Fermentation, Butanediol Fermentation.</td></tr>
</table>

	UNIT IV (15 hours) (K1, K2, K3 & K4) **Photosynthesis.** 4.1 An Overview of chloroplast structure. 4.2 Photosynthetic Pigments. 4.3 Light Reaction-Cyclic and non-cyclic. 4.4 Light Reaction- non-cyclic. 4.5 Photophosphorylation. 4.6 Dark Reaction - Calvin Cycle.
	UNIT V (15 hours) (K1, K2, K3 & K4) **Microbial reproduction.** 5.1 Bacterial reproduction – Binary fission, Budding. 5.2 Reproduction through conidia, cyst formation. 5.3 Endospore formation. 5.4 Fungi asexual and sexual reproduction. 5.5 Microalgae reproduction. 5.6 Asexual and sexual reproduction of protozoa.
Text Books	1. Schlegal, H.G. (1993). General Microbiology.,7th Edition, Press syndicate of the University of Cambridge. 2. RajapandianK.(2010). Microbial Physiology, Chennai: PBS Book Enterprises India. 3. MeenaKumari. S. Microbial Physiology, Chennai 1st Edition MJP Publishers 2006. 4. Dubey R.C. and Maheswari, S. (2003). A textbook of Microbiology, New Delhi: S. Chand & Co. 5. S. Ram Reddy, S.M. Reddy (2008). Microbial Physiology. Anmol Publications Pvt Ltd.
Reference Books	1. Robert K. Poole (2004). Advances in Microbial Physiology, Elsevier Volume 49. Academic Press, New York. 2. Kim B.H., Gadd G.M. (2008). Bacterial Physiology and Metabolism. Cambridge University Press, Cambridge. 3. Daniel R. Caldwell. (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. Bhanu Shrivastava. (2011). Microbial Physiology and Metabolism: Study of Microbial Physiology and Metabolism. Lambert academic Publication.
Web resources	1. https://sites.google.com/site/microbial physiologyoddsem/teaching-contents 2. https://courses.lumenlearning.com/boundlessmicrobiology/chapter/microbial-Nutrition 3. https://onlinecourses.swayam2.ac.in/cec20_bt14/preview 4. http://web.iitd.ac.in/~amittal/2007_Addy_Enzymes_Chapter.pdf 5. https://www.frontiersin.org.microbial-physiology-and-metabolism

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Describe microorganisms based on nutrition.
CO2	Know the concept of microbial growth and identify the factors affecting bacterial growth.
CO3	Explain the methods of nutrient uptake.
CO4	Describe anaerobic and aerobic energy production.
CO5	Elaborate on the process of bacterial photosynthesis and reproduction.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	M	H	M	L	H
CO2	H	H	M	L	M	M
CO3	H	M	L	L	L	L
CO4	H	L	M	H	M	L
CO5	H	L	H	L	L	M

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	M	L	L	L
CO2	H	H	M	L	L	L
CO3	H	M	M	L	L	L
CO4	H	L	M	L	L	L
CO5	H	L	M	L	L	L

(HIGH - 3, MODERATE - 2, LOW - 1)

<table>
<tr><td>Title of the Course</td><td colspan="7">PRACTICAL -II: MICROBIAL PHYSIOLOGY AND METABOLISM</td></tr>
<tr><td>Paper No.</td><td colspan="7">Core Course IV</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core Practical</td><td>Year</td><td>I</td><td>Credits</td><td>3</td><td>Course Code</td><td>UCMBD24</td></tr>
<tr><td>Semester</td><td>II</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>-</td><td>-</td><td colspan="3">3</td><td colspan="2">3</td></tr>
<tr><td>Objectives of the course</td><td colspan="7">• Understand the principles of motility test.
• Understand the basic concepts of staining methods.
• Learn the bacterial count using different methods and anaerobic culture.
• Study the morphological demonstration of microorganisms and identification.
• Study the biochemical identification of the bacteria.</td></tr>
<tr><td>Course Outline (Experiments)</td><td colspan="7">1. Motility demonstration: hanging drop, wet mount preparation, semi-solid agar, Craigie’s tube method.
2. Staining techniques: Smear preparation, permanent specimen preparation, Capsular, and Acid-fast staining.
3. Direct counts – Direct cell count (Petroff-Hausser counting chamber), Turbidometry.
4. Viable count - pour plate, spread plate.
5. Bacterial growth curve.
6. Antibiotic sensitivity testing: Disc diffusion test- quality control with standard strains.
7. Morphological variations in algae, fungi and protozoa.
8. Micrometry: Demonstration of the size of yeast, fungal filaments and protozoa.
9. Biochemical tests: IMViC test, H_2S, TSI, Oxidase, catalase, urease test, and Carbohydrate fermentation test.
10. Anaerobic culture methods and Maintenance of pure culture - paraffin method, stab culture.</td></tr>
<tr><td>Text Books</td><td colspan="7">1. James G Cappucino and N. Sherman 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) Sundararaj publications.
4. Gunasekaran. P (2007). Laboratory manual in Microbiology. New age international publisher.
5. Elsa Cooper (2018). Microbial Physiology: A Practical Approach. Callisto Reference publisher.</td></tr>
<tr><td>Reference Books</td><td colspan="7">1. DavidWhite., James Drummond., Clay Fuqua (2012) Physiology and Biochemistry of Prokaryotes. 4th Ed. Oxford University Press, New York.
2. Robert K. Poole (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.</td></tr>
</table>

	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.
Web 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	Course Outcomes
On completion of this course, students will be able to;	
CO1	Describe 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	Explain antibiotic sensitivity testing: Disc diffusion test- quality control with standard strains.
CO4	Describe demonstration of the size of yeast, fungal filaments and protozoa.
CO5	Elaborate on the bacterial identification by biochemical methods.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	H	M	L	H
CO2	H	H	M	H	M	M
CO3	M	M	L	H	L	L
CO4	M	L	M	H	M	L
CO5	H	L	H	L	L	M

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	L	L	M
CO2	H	H	H	H	L	M
CO3	H	H	H	H	L	M
CO4	H	H	H	H	L	M
CO5	H	H	H	H	L	M

(HIGH - 3, MODERATE - 2, LOW - 1)

<table>
<tr><td>Title of the Course</td><td colspan="7">SKILL ENHANCEMENT COURSE: NUTRITION AND HEALTH HYGIENE</td></tr>
<tr><td>Paper No.</td><td colspan="7">SEC II</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Skill Enhancement Course</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">2</td><td rowspan="2">Course Code</td><td rowspan="2">USMB224</td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="2">Lab Practice</td><td colspan="3">Total</td></tr>
<tr><td>2</td><td>-</td><td colspan="2">-</td><td colspan="3">2</td></tr>
<tr><td>Objectives of the course</td><td colspan="7">• Learn about nutrition and their importance.
• Make student understand the nutritional facts for a better life.
• Learn information to optimize our diet.
• Impart knowledge on different health care programs taken up by India.
• Learn knowledge on different health indicators and types of hygiene methods.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (6 hours) (K1, K2, K3 & K4)
Basics of nutrition.
Nutrition – 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.</td></tr>
<tr><td></td><td colspan="7">UNIT II (6 hours) (K1, K2, K3 & K4)
Balanced Diet.
Nutrition for Life Cycle: Balanced diet - Normal, Pregnant, lactating women, Infancy, young children Adolescents, Adults, and the Elderly; Diet Chart; Nutritive value of Indian foods.</td></tr>
<tr><td></td><td colspan="7">UNIT III (6 hours) (K1, K2, K3 & K4)
Malnutrition and nutritional disorders.
Improper diets: Definition, Identification, Signs and Symptoms - malnutrition, under-nutrition, over-nutrition, Protein Energy Malnutrition, obesity; Nutritional Disease and Disorder - hypertension, diabetes, anemia, osteomalacia, cardiovascular disease.</td></tr>
</table>

	UNIT IV (6 hours) (K1, K2, K3 & K4) **Health Policy and Health Organization.** Health - Determinants of health, Key Health Indicators, Environment health & Public health; Health-Education: Principles and Strategies. Health Policy & Health Organizations: Health Indicators and National Health Policy of Govt. of India; Functioning of various nutrition and health organizations in India.
	UNIT V (6 hours) (K1, K2, K3 & K4) **Community and Personal Hygiene.** Hygiene – Definition; Personal, Community, Medical and Culinary hygiene; WASH (Water, Sanitation and Hygiene) programme. Rural Community Health: Village health sanitation & Nutritional committee. Community & Personal Hygiene: Environmental Sanitation and Sanitation in Public places.
Text Books	1. Bamji, M.S., K. Krishnaswamy& G.N.V. Brahmam (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. SK. Haldar (2022). Occupational Health and Hygiene in Industry. CBS Publishers. 4. Acharya, Sankar Kr. Rama Das, Minati Sen (2021). Health Hygiene and Nutrition Perception and Practices.Satish Serial Publishing House. 5. Dass (2021). Public Health and Hygiene, Notion Press.
Reference Books	1. VijayaKhader (2000). Food, nutrition & health, Kalyan Publishers, New Delhi. 2. Srilakshmi, B., (2010). Food Science, (5th Edition) New Age International Ltd., New Delhi. 3. Arvind Kumar Goel (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.
Web resources	1. National Rural Health Scheme: https://nhm.gov.in/index1.php?lang=1&level=1&sublinkid=969&lid=49 2. National Urban Health Scheme: https://nhm.gov.in/index1.php?lang=1&level=1&sublinkid=970&lid=137 3. Village health sanitation & Nutritional committee https://nhm.gov.in/index1.php?lang=1&level=1&sublinkid=149&lid=225 4. Health Impact Assessment - https://www.who.int/hia/about/faq/en/ 5. Healthy Living https://www.nhp.gov.in/healthylivingViewall

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Learn the importance of nutrition for a healthy life.
CO2	Study the nutrition for life cycle.
CO3	Know the health care programmes of India.
CO4	Learn the importance of community and personal health & hygiene measures.
CO5	Create awareness on community health and hygiene.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	H	L	L	H
CO2	H	H	H	H	L	H
CO3	H	H	H	L	M	M
CO4	H	M	H	M	M	M
CO5	H	M	H	M	M	M

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	L	L	H
CO2	H	H	H	H	L	H
CO3	H	H	H	L	M	M
CO4	H	M	H	M	M	M
CO5	H	M	H	M	M	M

(HIGH - 3, MODERATE - 2, LOW - 1)

<table>
<tr><td>Title of the Course</td><td colspan="7">SKILL ENHANCEMENT COURSE: BIOINSTRUMENTATION</td></tr>
<tr><td>Paper No.</td><td colspan="7">SEC III</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Skill Enhancement Course</td><td>Year</td><td>I</td><td>Credits</td><td>2</td><td>Course Code</td><td>USMB324</td></tr>
<tr><td>Semester</td><td>II</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>2</td><td>-</td><td colspan="3">-</td><td colspan="2">2</td></tr>
<tr><td>Objectives of the course</td><td colspan="7">• Understand the analytical instruments and study the basic principles in the field of sciences.
• To gain knowledge about principles of spectroscopy.
• Understand the analytical techniques of Chromatography and electrophoresis.
• To understand the principle of different types of scans used in medical diagnosis.
• To gain information about the principles of radioactivity and its measurements.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (6 hours) (K1, K2, K3 & K4)
Basic instruments.
Basic instruments: 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.</td></tr>
<tr><td></td><td colspan="7">UNIT II (6 hours) (K1, K2, K3 & K4)
Spectroscopic Techniques.
Spectroscopic Techniques: Spectroscopic Techniques: Colorimeter, Ultraviolet and visible, Infra-red and Mass Spectroscopy.</td></tr>
<tr><td></td><td colspan="7">UNIT III (6 hours) (K1, K2, K3 & K4)
Chromatography and Electrophoresis.
Chromatographic and Electrophoresis Techniques: Chromatographic Techniques: Paper, Thin Layer, Column, HPLC and GC. Electrophoresis Techniques: Starch Gel, AGE, PAGE.</td></tr>
<tr><td></td><td colspan="7">UNIT IV (6 hours) (K1, K2, K3 & K4)
Imaging Techniques.
Imaging techniques: Principle, Instrumentation and application of ECG, EEG, EMG, MRI, CT and PET scan radioisotopes.</td></tr>
</table>

	UNIT V (6 hours) (K1, K2, K3 & K4) **Fluorescence and Radiation based Techniques.** Fluorescence and radiation-based techniques: Spectrofluorimeter, Flame photometer, Scintillation counter, Geiger Muller counter, Autoradiography.
Text Books	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 th Edition -.MJP publishers. 4. Upadhyay, 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. Himalaya Publishing House, Mumbai.
Reference Books	1. Rodney.F.Boyer (2000). Modern Experimental Biochemistry, 3rd Edition. Pearson Publication. 2. SkoogA.,WestM (2014). Principles of Instrumental Analysis – 14th Edition W.B.SaundersCo.,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.7thEdition. Cambridge University Press. 5. Webster, J.G. (2004). Bioinstrumentation- 4th Edition - John Wiley & Sons (Asia) Pvt.Ltd, Singapore.
Web 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	Course Outcomes
On completion of this course, students will be able to;	
CO1	Gain knowledge about the basics of instrumentation.
CO2	Exemplify the structure of atoms and molecules by using the principles of spectroscopy.
CO3	Evaluate by separating and purifying the components.
CO4	Understand the need and applications of imaging techniques.
CO5	Categorize the working principle and applications of fluorescence and radiation.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	H	L	L	M
CO2	H	H	H	L	L	M
CO3	H	H	H	L	L	M
CO4	H	H	H	L	L	M
CO5	H	H	H	L	L	M

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	L	L	M
CO2	H	H	H	L	L	M
CO3	H	H	H	L	L	M
CO4	H	H	H	L	L	M
CO5	H	H	H	L	L	M

(HIGH - 3, MODERATE - 2, LOW - 1)

<table>
<tr><td>Title of the Course</td><td colspan="7">MOLECULAR BIOLOGY AND MICROBIAL GENETICS</td></tr>
<tr><td>Paper No.</td><td colspan="7">Core Course V</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">5</td><td rowspan="2">Course Code</td><td rowspan="2">UCMBE24</td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>5</td><td>-</td><td colspan="3">-</td><td colspan="2">5</td></tr>
<tr><td>Objectives of the course</td><td colspan="7">• Provide knowledge on structure and replication of DNA.
• Illustrate the significance and functions of RNA in protein synthesis.
• Explain the cause and types of DNA mutation and DNA repair mechanisms.
• Outline the role of plasmids and phages in genetics.
• Examine mechanisms of gene transfer and recombination.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (15 hours) (K1, K2, K3 & K4)
DNA structure and replication.

1.1 DNA Structure - Salient features of double helix, forms of DNA.
1.2 Denaturation and renaturation.
1.3 DNA topology – Supercoiling, linking number, topoisomerases.
1.4 DNA organization in prokaryotes, viruses, eukaryotes.
1.5 Replication of DNA in prokaryotes and eukaryotes - Bidirectional and unidirectional replication, semi-conservative and semi-discontinuous replication.
1.6 Mechanism of DNA replication – enzymes involved – DNA polymerases, DNA ligase, primase. DNA replication modes - rolling circle, D-loop modes.</td></tr>
<tr><td></td><td colspan="7">UNIT II (15 hours) (K1, K2, K3 & K4)
Transcription and Gene expression system.

2.1 Transcription in Prokaryotes. Concept of transcription. RNA Polymerases - prokaryotic and eukaryotic.
2.2 General transcription factors in eukaryotes. Distinction between transcription processes in prokaryotes versus eukaryotes.
2.3 Translation in prokaryotes and eukaryotes - Translational machinery - ribosome structure in prokaryotes and eukaryotes, tRNA structure and processing.
2.4 Inhibitors of protein synthesis in prokaryotes and eukaryotes.
2.5 Overview of regulation of gene expression - lac, trp and ara operons as examples.
2.6 Regulation of gene expression by DNA methylation.</td></tr>
<tr><td></td><td colspan="7">UNIT III (15 hours) (K1, K2, K3 & K4)
Mutation

3.1 Mutation - Definition and types.
3.2 Base substitutions, frame shifts, deletions, insertions, duplications, inversions, silent, conditional, and lethal mutations.
3.3 Physical and chemical mutagens.</td></tr>
</table>

	3.4 Reversion and suppression. 3.5 Uses of mutations. 3.6 Repair Mechanisms - Photoreactivation, Nucleotide Repair, Base Excision Repair, Methyl Directed Mismatch Repair and SOS Repair.
	UNIT IV (15 hours) (K1, K2, K3 & K4) **Plasmids** 4.1 Plasmid replication and partitioning, host range, plasmid incompatibility, plasmid amplification, regulation of plasmid copy number, curing of plasmids. 4.2 Types of plasmids – R Plasmids, F plasmids, colicinogenic plasmids, metal resistance plasmids. 4.3 Ti plasmid, linear plasmids, yeast 2µ plasmid. 4.4 Bacteriophage-T4, Virulent Phage – Structure and lifecycle. 4.5 Lambda phage-Structure, Lytic and Lysogenic cycle. 4.6 Applications of Phages in Microbial Genetics.
	UNIT V (15 hours) (K1, K2, K3 & K4) **Gene Transfer Mechanism.** 5.1 Gene Transfer Mechanisms- Conjugation and its uses. 5.2 Transduction - Generalized and Specialized. 5.3 Transformation - Natural Competence and Transformation. 5.4 Transposition and Types of Transposition reactions. 5.5 Mechanism of transposition: Replicative and non- replicative transposition. 5.6 Transposable elements - Prokaryotic transposable elements – insertion sequences, composite, and non-composite transposons. Uses of transposons.
Text Books	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. Trun N. and Trempy J. (2009). Fundamental Bacterial Genetics. 1st Edition. Blackwell Science Ltd. 4. Brown T. A. (2016). Gene Cloning and DNA Analysis- An Introduction. (7th Edition). John Wiley and Sons, Ltd. 5. 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.
Reference Books	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). 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. Primrose S.B. and Twyman R. M. (2006). Principles of Gene Manipulation and Genomics. (7th Edition). Blackwell Publishing.

Web 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	Course Outcomes
On completion of this course, students will be able to;	
CO1	Analyze the significance of DNA and elucidate the replication mechanism.
CO2	Illustrate the types of RNA and protein synthesis machinery.
CO3	Infer the causes and types of DNA mutation and summarize the DNA repair mechanisms.
CO4	Evaluate the importance of plasmids and phages in genetics.
CO5	Evaluate the importance of plasmids and phages in genetics.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	H	M	L	M
CO2	H	H	H	L	L	M
CO3	H	H	H	M	M	L
CO4	H	H	H	H	M	M
CO5	H	H	H	L	L	M

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	L	L	H
CO2	H	H	H	L	M	H
CO3	H	H	H	L	M	M
CO4	H	H	H	M	L	H
CO5	H	H	H	L	M	M

(HIGH - 3, MODERATE - 2, LOW - 1)

<table>
<tr><td>Title of the Course</td><td colspan="7">PRACTICAL -III: MOLECULAR BIOLOGY AND MICROBIAL GENETICS</td></tr>
<tr><td>Paper No.</td><td colspan="7">Core Course VI</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core Practical</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">UCMBF24</td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>-</td><td>-</td><td colspan="3">3</td><td colspan="2">3</td></tr>
<tr><td>Objectives of the course</td><td colspan="7">• Provide knowledge on structure and replication of DNA.
• Elucidate the methods of Genomic and Plasmid DNA isolation.
• Explain methods of protein separation.
• Explain artificial transformation method.
• Outline the role of phages in genetics.</td></tr>
<tr><td>Course Outline (Experiments)</td><td colspan="7">1. Study of different types of DNA and RNA using micrographs and model / schematic representations.
2. Study of semi-conservative replication of DNA through micrographs / schematic representations.
3. Isolation of Genomic and Plasmid DNA from E. coli and Analysis by Agarose gel electrophoresis.
4. Estimation of DNA using colorimeter (diphenylamine reagent), UV spectrophotometer (A260 measurement).
5. Resolution and visualization of proteins by polyacrylamide gel electrophoresis (SDS-PAGE) – (Demonstration).
6. UV induced auxotrophic mutant production and isolation of mutants by replica plating technique – (Demonstration).
7. Perform artificial Transformation in E. coli - (Demonstration).
8. Isolation of antibiotic resistant mutants by gradient plate method.
9. Screening and isolation of phages from sewage.
10. Perform RNA isolation and Estimate RNA.</td></tr>
<tr><td>Text Books</td><td colspan="7">1. Crichton. M. (2014). Essentials of Biotechnology. Scientific International Pvt Ltd, New Delhi.
2. Sambrook J. and Russell D.W. (2001). 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.</td></tr>
<tr><td>Reference Books</td><td colspan="7">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.</td></tr>
</table>

	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. (2016). Gene Cloning and DNA Analysis. (7th Edition). John Wiley and Jones Ltd.
Web 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	Course Outcomes
On completion of this course, students will be able to;	
CO1	Illustrate different types of DNA and RNA.
CO2	Utilize hands-on training in isolation of genomic and plasmid DNA.
CO3	Analyze importance of experimental microbial genetics.
CO4	Apply the knowledge of molecular techniques in various fields.
CO5	Investigate the significance of Phages.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	H	M	L	H
CO2	H	L	M	L	L	H
CO3	H	M	L	M	M	H
CO4	H	L	M	H	M	H
CO5	H	L	H	L	L	M

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	L	H	L	L	L
CO2	H	L	H	M	M	L
CO3	H	H	H	M	M	L
CO4	H	M	H	L	L	L
CO5	H	H	H	L	L	M

(HIGH - 3, MODERATE - 2, LOW - 1)

<table>
<tr><td>Title of the Course</td><td colspan="7">SKILL ENHANCEMENT COURSE: AQUACULTURE</td></tr>
<tr><td>Paper No.</td><td colspan="7">SEC IV</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Skill Enhancement Course</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">1</td><td rowspan="2">Course Code</td><td rowspan="2">USMB424</td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>1</td><td>-</td><td colspan="3">-</td><td colspan="2">1</td></tr>
<tr><td>Objectives of the course</td><td colspan="7">• Provide a deeper knowledge in aquaculture systems and methods.
• Explain the significance and functions of design, types and construction of aquaculture ponds.
• Demonstrate the biological characteristics of various aquaculture species.
• Discuss the methods involved in post stocking management.
• Illustrate major cultivatable species for aquaculture.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (6 hours) (K1, K2, K3 & K4)
Aquaculture systems and methods.
Aquaculture Systems and Methods - Scope and definition. Traditional, extensive, semi - intensive and intensive culture. Monoculture, polyculture, composite culture, mixed culture, mono-sex culture, cage culture, pen culture, raft culture, race way culture.</td></tr>
<tr><td></td><td colspan="7">UNIT II (6 hours) (K1, K2, K3 & K4)
Aquaculture Engineering.
Aquaculture Engineering - Design and construction of pond, layout and design of aquaculture farm, construction, water intake system, drainage system - aeration and aerators. Ponds - Types of ponds.</td></tr>
<tr><td></td><td colspan="7">UNIT III (6 hours) (K1, K2, K3 & K4)
Species selection and Stocking.
Selection of Species - Biological characteristics of aquaculture species; economic and market considerations; seed resources, collection and transportation. Pre-Stocking Management-Sun drying, ploughing / tilling, desilting, liming and fertilization, eradication of weed fishes. Stocking - Acclimatization of seed and release - species combinations - stocking density and ratio.</td></tr>
<tr><td></td><td colspan="7">UNIT IV (6 hours) (K1, K2, K3 & K4)
Post Stocking Management.
Post Stocking Management - Water and soil quality parameters required for optimum production, control of aquatic weeds and aquatic insects, algal blooms and microorganisms. Food conversion ratio (FCR). Growth - Measurement of growth, length - weight relationship.</td></tr>
</table>

	UNIT V (6 hours) (K1, K2, K3 & K4) **Major cultivable species for aquaculture.** Major cultivable species for aquaculture –Culture of Indian Major Carps. Culture of Giant fresh water prawn, Macrobrachium rosenbergii - seed collection formation sources. Hatchery management. Culture of tiger shrimp, Penaeusmonodon and Litopenaeus Vannamei. Culture of pearl oysters. Culture of sea weeds. Methods of Crab culture. Culture of ornamental fishes. Culture of Molluscs.
Text Books	1. Santhanam, R. Velayutham, P. Jegatheesan, G. A (2019). Manual of Freshwater Ecology: An Aspect of Fishery Environment. Daya Publishing House, New Delhi. 2. Stickney, R.R. (2016). Aquaculture: An Introductory Text. 3rd Edition. Centre for Agriculture and Bioscience International Publishing. 3. Ackefors H., Huner J and Konikoff M. (2009). Introduction to the General Principles of Aquaculture. CRC Press. 4. Mushlisin Z. A. (2012). Aquaculture. In Tech press. 5. Akpaniteaku R.C. (2018).Basic Handbook of Fisheries and Aquaculture. AkiNik Publications.
Reference Books	1. Arumugam N. (2014). Aquaculture. Saras Publication. 2. Pillay T. V. R. and Kutty M.N. (2005). Aquaculture : Principles and Practices. 2ndEdition. Wiley India Pvt. Ltd. 3. Tripathi S. D., Lakra W.S. and Chadha N.K. (2018). Aquaculture in India. Narendra Publishing House. 4. Rath R.K. (2011). Fresh Water Aquaculture. 3rdEdition. Scientific Publishers. 5. Lucas J. S., Southgate P.C. and Tucker C.S. (2019). Aquaculture: Farming Aquatic Animals and Plants. Wiley Blackwell.
Web resources	1. Aquaculture: Types, Benefits and Importance (Fish Farming) - Conserve Energy Future (conserve-energy-future.com) 2. Fisheries Department - Tamil Nadu (tn.gov.in) 3. Aquaculture - Google Books 4. Aquaculture | Definition, Industry, Farming, Benefits, Types, Facts, & Methods | Britannica 5. Fisheries & Aquaculture (investindia.gov.in)

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Analyze the significance and importance of aquaculture.
CO2	Illustrate the types and construction of aquaculture ponds.
CO3	Analyze the biological characteristics of species and choose the best species for aquaculture.
CO4	Follow methods involved for optimal growth of aquaculture species.
CO5	Summarize major species suitable for aquaculture in a particular environment.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	H	M	L	H
CO2	H	H	H	L	L	H
CO3	H	M	M	M	M	M
CO4	H	H	H	M	M	H
CO5	H	H	H	M	M	H

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	M	H	H
CO2	H	H	H	H	M	H
CO3	H	M	H	M	L	M
CO4	H	H	H	M	L	H
CO5	H	H	H	L	L	H

(HIGH - 3, MODERATE - 2, LOW - 1)

<table>
<tr><td>Title of the Course</td><td colspan="7">SKILL ENHANCEMENT COURSE: ORGANIC FARMING AND BIOFERTILISER TECHNOLOGY</td></tr>
<tr><td>Paper No.</td><td colspan="7">SEC V</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Skill Enhancement Course</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">2</td><td rowspan="2">Course Code</td><td rowspan="2">USMB524</td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>2</td><td>-</td><td colspan="3">-</td><td colspan="2">2</td></tr>
<tr><td>Objectives of the course</td><td colspan="7">• Impart knowledge about the significance of organic farming and strategies to increase the yield to conserve environment.
• To encourage organic farming in urban areas.
• Comprehensive knowledge about bacterial biofertilizers, its advantages and future perspective.
• Structure and characteristic features of Cyanobacterial and fungal biofertilizer
• Develop the knowledge and skill to produce, analyze the quality of packaging, storage and assess the shelf life and bio efficacy of biofertilizers.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (6 hours) (K1, K2, K3 & K4)
Principle of Organic Farming
Principle of organic farming: 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.</td></tr>
<tr><td></td><td colspan="7">UNIT II (6 hours) (K1, K2, K3 & K4)
Composting and vermicomposting.
Organic farming for urban space; Create a Sustainable Organic Garden (Backyard-Square Foot Gardening, Small Space Gardening, Mini Farming) Composting, Vermicomposting.</td></tr>
<tr><td></td><td colspan="7">UNIT III (6 hours) (K1, K2, K3 & K4)
Bacterial Biofertilizers.
Biofertilizers: Introduction, advantages and future perspective. Structure and characteristic features of bacterial biofertilizers- Azospirillum, Azotobacter, Bacillus, Pseudomonas, Rhizobium and Frankia.</td></tr>
<tr><td></td><td colspan="7">UNIT IV (6 hours) (K1, K2, K3 & K4)
Cyanobacterial and fungal biofertilizers.
Structure and characteristic features of Cyanobacterial biofertilizers- Anabaena, Nostoc ; Structure and characteristic features of fungal biofertilizers- AM mycorrhiza.</td></tr>
</table>

	UNIT V (6 hours) (K1, K2, K3 & K4) **Biofertilizer – Quality control and storage.** Production of Rhizobium, Azotobacter, Anabena; Biofertilizers -Storage, shelf life, quality control and marketing.
Text Books	1. Sharma, A.K. (2006). Hand book of Organic Farming, Agrobios India. 2. Gaur, A.C. (2017). Hand book of Organic Farming and Biofertilizers. Ambica publication. 3. Subbarao, N.S. (2017). Bio-fertilizers in Agriculture and Forestry (4th Edition) Med tech publisher. 4. SubbaRao, N. S. (2002). Soil Microbiology. Soil Microorganisms and Plant Growth. (1st Edition), Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi. 5. Dubey, R. C. (2008). A Textbook of Biotechnology. S. Chand & Co., New Delhi.
Reference Books	1. Masanobu Fukuoka, Frances Moore Lappe Wendell Berry (2009). The One-Straw Revolution: An Introduction to Natural Farming, 1st edition, YRB Classics. 2. Sujit Chakrabarty (2018). Organic Home Gardening Made Easy, 1st Edition, Notion Press. 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.
Web 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/ 5. https://vlab.amrita.edu/index.php?sub=3&brch=272

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Become an entrepreneur with wide knowledge about farming and sustainable resources.
CO2	Implement organic farming in urban areas with knowledge on compost.
CO3	Gain knowledge about the bacterial biofertilizers and its advantages
CO4	Understand the significance about Cyanobacterial and fungal biofertilizers
CO5	Understand and implement the use of bio fertilizers.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	H	M	L	H
CO2	H	H	H	L	L	H
CO3	H	M	M	M	M	M
CO4	H	H	H	M	M	H
CO5	H	H	H	M	M	H

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	M	H	H
CO2	H	H	H	H	M	H
CO3	H	M	H	M	L	M
CO4	H	H	H	M	L	H
CO5	H	H	H	L	L	H

(HIGH - 3, MODERATE - 2, LOW - 1)

<table>
<tr><td>Title of the Course</td><td colspan="7">IMMUNOLOGY AND IMMUNOTECHNOLOGY</td></tr>
<tr><td>Paper No.</td><td colspan="7">Core Course VII</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>II</td><td>Credits</td><td>5</td><td>Course Code</td><td>UCMBG24</td></tr>
<tr><td>Semester</td><td>IV</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>5</td><td>-</td><td colspan="3">-</td><td colspan="2">5</td></tr>
<tr><td>Objectives of the course</td><td colspan="7">• To gain knowledge about immune system, organs of immunity and cells involved.
• To distinguish the types of antigens and antibodies; their properties.
• To provide in-depth knowledge on immuno-techniques.
• To discuss the role of MHC system in transplantation; functions of Tumor specific antigens.
• To impart knowledge on immunological disorders.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (15 hours) (K1, K2, K3 & K4)
Organs and Cells in Immune System and Immune Response.
1.1 Primary lymphoid organs, secondary lymphoid organs, and lymphoid tissues.
1.2 T – cell and B –cell membrane bound receptors – apoptosis.
1.3 T - cell processing, presentation and regulation; T –cell subpopulation, properties, functions and T – cell suppression.
1.4 Physiology of immune response- innate, humoral immunity.
1.5 cell mediated immunity.
1.6 Immunohematology.</td></tr>
<tr><td></td><td colspan="7">UNIT II (20 hours) (K1, K2, K3 & K4)
Antigen and Antibody.
2.1 Antigens - Properties of haptens, epitopes, adjuvants, and cross reactivity.
2.2 Antibodies- structure, properties, classes.
2.3 Antigen and Antibody Reactions: precipitation, agglutination, complement fixation, opsonization, neutralization.
2.4 Vaccines – active and passive immunization.
2.5 Classification of vaccines; Other approaches to new vaccines.
2.6 Types of vaccine - antibacterial, antiviral; Vaccination schedule.</td></tr>
<tr><td></td><td colspan="7">UNIT III (15 hours) (K1, K2, K3 & K4)
Immunoassay and Immunotechniques.
3.1 Preparation and standardization of bacterial antigens.
3.2 Raising of monoclonal and polyclonal antibodies.
3.3 Purification of antibodies. Immunotechniques - RIA, RAST.
3.4 ELISA.
3.5 Immuno fluorescence techniques.
3.6 Flow cytometry.</td></tr>
</table>

	UNIT IV (15 hours) (K1, K2, K3 & K4) **Transplantation and Tumor Immunology.** 4.1 MHC Antigens - structure and function. 4.2 HLA system - Regulation and response to immune system. 4.3 Transplantation immunology - tissue transplantation and grafting; Mechanism of graft acceptance and rejection. 4.4 HLA typing. 4.5 Tumor specific antigens; Immune response to tumors. 4.6 Immune diagnosis; cancer immune therapy.
	UNIT V (10 hours) (K1, K2, K3 & K4) **Immunological disorders and diseases.** 5.1 Hypersensitivity reactions- Type I. 5.2 Type II. 5.3 Type III 5.4 Type IV 5.5 Acquired immunodeficiency syndrome; 5.6 Auto immune disorders and diseases: organ specific and non-organ specific.
Text Books	1. Richard Coico, Geoffrey Sunshine, Eli Benjamini. (2003). Immunology – A Short Course. 5thEdition., Wiley-Blackwell, New York. 2. Judith A.Owen, Jenni Punt, Sharon A. Stranford, Janis Kuby. (2013). Immunology, 7thEdition., W. H. Freeman and Company, New York. 3. Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai. (2021). Cellular and Molecular Immunology, 10thEdition, Elsevier. 4. Robert R. Rich, Thomas A. Fleisher, William T. Shearer, Harry Schroeder, Anthony J. Frew, Cornelia M. Weyand. (2018). Clinical Immunology: Principles and Practice, 5th Edition. Elsevier. 5. Pravash Sen Gupta. (2003). Clinical Immunology. Oxford University Press.
Reference Books	1. Janeway Travers. (1997). Immunobiology- the immune system in health and disease. Current Biology Ltd. London, New York. 3rd Edition. 2. Peter J. Delves, Seamus Martin, Dennis R. Burton, Ivan M. Roitt. (2006). Roitt's Essential Immunology, 11thEdition.,Wiley-Blackwell. 3. William R Clark. (1991). The Experimental Foundations of Modern Immunology. 3rdEdition. John Wiley and Sons Inc. New York. 4. Frank C. Hay, Olwyn M. R. Westwood. (2002). Practical Immunology, 4thEdition., Wiley-Blackwell. 5. Noel R. Rose, Herman Friedman, John L. Fahey. (1986). Manual of Clinical Laboratory Immunology. ASM.3rd Edition.
Web resources	1. https://www.ncbi.nlm.nih.gov/books/NBK279395/ 2. https://med.stanford.edu/immunol/phd-program/ebook.html 3. https://ocw.mit.edu/courses/hst-176-cellular-and-molecular-immunology-fall-2005/pages/lecture-notes/ 4. Immunology Overview - Medical Microbiology - NCBI Bookshelf (nih.gov) 5. Immunology - an overview | ScienceDirect Topics

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Assess the fundamental concepts of immunity, contributions of the organs and cells in immune responses.
CO2	Investigate the structures of Ag and Ab; Immunization.
CO3	Justify the Immunoassay and Immunotechniques.
CO4	Explain about the immunologic processes governing graft rejection and therapeutic modalities for immunosuppression in transplantation
CO5	Analyze the overreaction by our immune system leading to hypersensitive conditions and its consequences.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	M	H	M	L	H
CO2	H	L	M	L	M	M
CO3	H	M	L	M	M	M
CO4	H	L	M	H	M	L
CO5	H	L	H	L	L	M

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	H	H	H
CO2	H	L	M	L	L	H
CO3	H	H	M	L	L	L
CO4	H	L	M	L	L	M
CO5	H	L	H	L	L	L

(HIGH - 3, MODERATE - 2, LOW - 1)

<table>
<tr><td>Title of the Course</td><td colspan="7">PRACTICAL -IV: IMMUNOLOGY AND IMMUNOTECHNOLOGY</td></tr>
<tr><td>Paper No.</td><td colspan="7">Core Course VIII</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core Practical</td><td>Year</td><td>II</td><td>Credits</td><td>3</td><td>Course Code</td><td>UCMBH24</td></tr>
<tr><td>Semester</td><td>IV</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>-</td><td>-</td><td colspan="3">3</td><td colspan="2">3</td></tr>
<tr><td>Objectives of the course</td><td colspan="7">• To gain hands-on knowledge to identify Blood group and typing.
• To acquire adequate skill to perform latex agglutination reactions.
• To analyze precipitation reactions in gels.
• To investigate the antigen & antibody reactions in electrophoresis.
• To familiarize with Separation of Lymphocytes.</td></tr>
<tr><td>Course Outline (Experiments)</td><td colspan="7">1. Identification of blood group and typing.
2. Coomb’s test.
3. TPHA.
4. T cell identification (Demonstration)
5. Latex Agglutination reactions- RF, ASO, CRP.
6. Ouchterlony’s Double Diffusion Method (antigen pattern).
7. Single Radial Immuno Diffusion Method.
8. Electrophoresis - Serum, Counter and Immuno.
9. Separation of Lymphocytes by gradient centrifugation method.
10. ELISA: Hepatitis/ HIV (Demonstration).</td></tr>
<tr><td>Text Books</td><td colspan="7">1. Talwar. (2006). Hand Book of Practical and Clinical Immunology, Vol. I, 2nd edition, CBS.
2. Asim Kumar Roy. (2019). Immunology Theory and Practical, Kalyani Publications.
3. Richard Coico, Geoffrey Sunshine, Eli Benjamini. (2003). Immunology – A Short Course. 5thEdition., Wiley-Blackwell, New York.
4. Judith A. Owen, Jenni Punt, Sharon A. Stranford, Janis Kuby. (2013). Immunology, 7thEdition., W. H. Freeman and Company, New York.
5. Pravash Sen. Gupta. (2003). Clinical Immunology. Oxford University Press.</td></tr>
<tr><td>Reference Books</td><td colspan="7">1. Frank C. Hay, Olwyn M. R. Westwood. (2008). Practical Immunology, 4th Edition, Wiley-Blackwell.
2. Wilmore Webley. (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. 3rd Edition. Current Biology Ltd. London, New York.
5. Peter J. Delves, Seamus Martin, Dennis R. Burton, Ivan M. Roitt. (2006). Roitt’s Essential Immunology, 11th Edition, Wiley-Blackwell.</td></tr>
</table>

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

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Assess the blood groups and types.
CO2	Perform serological diagnostic tests such as RF, ASO, CRP.
CO3	Illustrate the antigen antibody reactions in gel.
CO4	Compare & contrast antigens and antibodies in electrophoresis.
CO5	Examine the concept of ELISA.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	H	M	L	H
CO2	H	L	M	L	L	H
CO3	H	M	L	M	M	H
CO4	H	L	M	H	M	H
CO5	H	L	H	L	L	M

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	L	H	L	L	L
CO2	H	L	H	M	M	L
CO3	H	H	H	M	M	L
CO4	H	M	H	L	L	L
CO5	H	H	H	L	L	M

(HIGH - 3, MODERATE - 2, LOW - 1)

<table>
<tr><td>Title of the Course</td><td colspan="7">SKILL ENHANCEMENT COURSE: VACCINE TECHNOLOGY</td></tr>
<tr><td>Paper No.</td><td colspan="7">SEC VI</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Skill Enhancement Course</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">2</td><td rowspan="2">Course Code</td><td rowspan="2">USMB624</td></tr>
<tr><td>Semester</td><td>IV</td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>2</td><td>-</td><td colspan="3">-</td><td colspan="2">2</td></tr>
<tr><td>Objectives of the course</td><td colspan="7">• To provide knowledge on the basics of immunization and induction of immunity.
• To learn the types of vaccines, its immunological effects and regulatory guidelines.
• To learn the role of rDNA in vaccine technology.
• To provide the knowledge on conventional to recent technology of vaccine production.
• To learn about ethical issues and regulations in vaccine production and clinical trials.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (6 hours) (K1, K2, K3 & K4)
History of Vaccination and Immunogenicity.
History of vaccination, Active and passive immunization; requirements for induction of immunity, Epitopes, linear and conformational epitopes, characterization and location of APC, MHC and immunogenicity.</td></tr>
<tr><td></td><td colspan="7">UNIT II (6 hours) (K1, K2, K3 & K4)
Types of Vaccine.
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, Bacterial Vaccine - Anthrax vaccines, Cholera vaccines, Diphtheria toxoid, Parasitic vaccine - Malaria Vaccine.</td></tr>
<tr><td></td><td colspan="7">UNIT III (6 hours) (K1, K2, K3 & K4)
Vaccine technology.
Vaccine technology- Role and properties of adjuvants, recombinant DNA and protein-based vaccines, plant-based vaccines, reverse vaccinology; Peptide vaccines, conjugate vaccines. Recent advances in Malaria, Tuberculosis, HIV.</td></tr>
</table>

	UNIT IV (6 hours) (K1, K2, K3 & K4) **Vaccine Strategies.** 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 (6 hours) (K1, K2, K3 & K4) **Vaccine Ethics and Legal issues.** 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. Vaccine safety ethics and Legal issues.
Text Books	1. Ronald W. Ellis. (2001). New Vaccine Technologies.Landes Bioscience. 2. Cheryl Barton. (2009). Advances in Vaccine Technology and Delivery.Espicom Business Intelligence. 3. Male, David. Ed. (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 J.K, Male D, Roitt I.M. (2002). Clinical Immunology. 6th Edition, Gower Medical Publishing.
Reference Books	1. Stanley A. Plotkin, Walter Orenstein& Paul A. Offit.(2013). Vaccines, 6th Edition. BMA Medical Book Awards Highly Commended in Public Health. Elsevier Publication. 2. Coico, R. etal. (2003). Immunology: A Short Course. 5th Edition, Wiley – Liss. 3. Parham, Peter.(2005). The Immune System. 2nd Edition, Garland Science. 4. Abbas, A.K. etal. (2007). The Cellular and Molecular Immunology. 6th Edition, Sanders / Elsevier. 5. Weir, D.M. and Stewart, John (2000). Immunology. 8th Edition, Churchill Pvt. Ltd.
Web 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	Course Outcomes
On completion of this course, students will be able to;	
CO1	Explain the significance of critical antigens, immunogens and adjuvants in developing effective vaccines.
CO2	Understand the types of vaccines.
CO3	Construct vaccine applying rDNA technology.
CO4	Formulate the strategies for developing an innovative vaccine technology with different mode of vaccine delivery.
CO5	Evaluate the regulatory issues and guidelines for the management of vaccine production.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	H	M	L	H
CO2	H	H	H	L	L	H
CO3	H	M	M	M	M	M
CO4	H	H	H	M	M	H
CO5	H	H	H	M	M	H

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	M	H	H
CO2	H	H	H	H	M	H
CO3	H	M	H	M	L	M
CO4	H	H	H	M	L	H
CO5	H	H	H	L	L	H

(HIGH - 3, MODERATE - 2, LOW - 1)

<table>
<tr><td>Title of the Course</td><td colspan="7">SKILL ENHANCEMENT COURSE: APICULTURE</td></tr>
<tr><td>Paper No.</td><td colspan="7">SEC VII</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Skill Enhancement Course</td><td>Year</td><td>II</td><td>Credits</td><td>1</td><td>Course Code</td><td>USMB724</td></tr>
<tr><td>Semester</td><td>IV</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>1</td><td>-</td><td colspan="3">-</td><td colspan="2">1</td></tr>
<tr><td>Objectives of the course</td><td colspan="7">• To understand the biology of honey bees.
• To study on honey bee colony establishment.
• To develop knowledge on honey extraction.
• To understand the diseases of honey bees and their control.
• To gain information on financial assistance and funding agencies for bee keeping industry.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (6 hours) (K1, K2, K3 & K4)
Biology of Bees.
Biology of Bees: Honeybee – Systematic position – Species of Honey bees – Life history of Honey bee – behaviour – swarming – Pheromone.</td></tr>
<tr><td></td><td colspan="7">UNIT II (6 hours) (K1, K2, K3 & K4)
Social life in Bees.
Social life in Bees:Bee colony – Castes – natural colonies and their yield – Types of bee hives – Structure – location, care and management.</td></tr>
<tr><td></td><td colspan="7">UNIT III (6 hours) (K1, K2, K3 & K4)
Bee Rearing.
Bee Rearing: Apiary – Care and Management – Artificial bee hives – types – construction of spaceframes – Selection of sites – Handling – Maintenance – Instruments employed in Apiary – Extraction instruments.</td></tr>
<tr><td></td><td colspan="7">UNIT IV (6 hours) (K1, K2, K3 & K4)
Bee Economy.
Bee Economy: Honey – Composition – uses – Bee wax and its uses – yield in national and international market – Diseases of honey bees and their control methods. Economics of bee culture.</td></tr>
<tr><td></td><td colspan="7">UNIT V (6 hours) (K1, K2, K3 & K4)
Entrepreneurship.
Entrepreneurship: venture – Preparing proposals for financial assistance and funding agencies – Bee Keeping Industry – Recent Efforts, Modern Methods in employing artificial Beehives for cross pollination in horticultural gardens.</td></tr>
</table>

Text Books	1. Dewey M. Caron. (2013). Honey Bee Biology and Beekeeping. Revised Edition. Wicwas Press, Kalamazoo. ISBN 10: 1878075292. 2. Morse R. A. (1993). Rearing queen honey bees. Wicwas press, NY. ISBN-10: 1878075055. 3. Ted Hooper. (2010). Guide to Bees & Honey: The World's Best-Selling Guide to Beekeeping. Northern Bee Books. Oxford. ISBN 10: 1904846513. 4. Jayashree K. V., Tharadevi C.S. and Arumugam N. (2014) Apiculture. Saras Publication. 5. Raj H. (2020). Vinesh Text Book of Apiculture. S. Vinesh and Co.
Reference Books	1. Dewey M. Caron. (2020). The Complete Bee Handbook: History, Recipes, Beekeeping Basics, and More, Rockridge Press. ISBN-10: 1646119878 2. Joachim Petterson. (2016). Beekeeping: A Handbook on Honey, Hives & Helping the Bees, Weldon Owen. 3. Eva Crane. (1999). The World History of Beekeeping and Honey Hunting. Routledge. India.ISBN-10 : 0415924677 4. Pagar B. S. (2016). Textbook Of Apiculture. Sahitya Sagar. 5. Sehgal P.K. (2018). Text Book of Sericulture, Apiculture and Entomology.Kalayani.
Web resources	1. Bee Keeping Basics. Retrieved from: https://denton.agrilife.org/files/2013/08/beekeeping-basics.pdf 2. Beekeeping as an Entrepreneurship, Retrieved from: https://lupinepublishers.com/agriculture-journal/ pdf/ CIACR.MS.ID.000270.pdf 3. Raising Bumble Bees at Home: A Guide to Getting Started. Retrieved from: https://www.ars.usda.gov/ARSUserFiles/20800500/BumbleBeeRearingGuide.pdf 4. Apiculture – Biology for Everybody (homeomagnet.com) 5. Apiculture: Introduction to Apiculture (iasri.res.in)

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Understand the systematic position and life history of honey bee.
CO2	Reveal the different stages and types of bees and discuss about the care and management of apiculture.
CO3	Describe the practice of bee rearing process and analyze instruments employed in apiary.
CO4	Compare and contrast the composition of honey and bee wax and interpret the yield in National and International markets.
CO5	Clarify the proposal for financial assistance and funding agencies and reveal the modern methods employed in artificial bee hives.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	H	M	L	H
CO2	H	H	H	L	L	H
CO3	H	M	M	M	M	M
CO4	H	H	H	M	M	H
CO5	H	H	H	M	M	H

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	M	H	H
CO2	H	H	H	H	M	H
CO3	H	M	H	M	L	M
CO4	H	H	H	M	L	H
CO5	H	H	H	L	L	H

(HIGH - 3, MODERATE - 2, LOW - 1)

<table>
<tr><td>Title of the Course</td><td colspan="7">BACTERIOLOGY AND MYCOLOGY</td></tr>
<tr><td>Paper No.</td><td colspan="7">Core Course IX</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>III</td><td>Credits</td><td>5</td><td>Course Code</td><td>UCMBI24</td></tr>
<tr><td>Semester</td><td>V</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>5</td><td>-</td><td colspan="3">-</td><td colspan="2">5</td></tr>
<tr><td>Objectives of the course</td><td colspan="7">• Understand the role of normal flora and pathogenic microbes of various diseases and clinical microbiological techniques.
• Basic knowledge about Gram positive pathogenic bacteria and their epidemiology.
• Acquire knowledge about Gram negative pathogenic bacteria and nosocomial infections.
• Comprehensive knowledge about medically important, its classification and its significance.
• Gain knowledge about the general characteristics and mode of action of various antibacterial agents.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (15 hours) (K1, K2, K3 & K4)
Host Parasite interaction and collection of clinical specimens.
1.1 History, Classification of Medically Important Microbes.
1.2 Koch’s, and River’s postulates.
1.3 A brief account on the normal microbial flora of the healthy human body.
1.4 Host-pathogen interactions: Definitions of infection, invasion, primary and opportunistic pathogens, pathogenicity, virulence, toxigenicity, carriers.
1.5 Endemic, epidemic, pandemic diseases and epidemiology – putative virulence factors of human pathogens –infectious disease cycle.
1.6 Collection and transport of clinical specimens for bacterial and fungal infections.</td></tr>
<tr><td></td><td colspan="7">UNIT II (15 hours) (K1, K2, K3 & K4)
Medically important Gram-Positive infections.
Causative agent, clinical symptoms, pathogenesis, mode of transmission, prevention and treatment of the following bacterial diseases;
2.1 Streptococcal infections (Streptococcus pyogenes, Streptococcus faecalis).
2.2 Staphylococcal infections (Staphylococcus aureus).
2.3 Tetanus (Clostridium tetani).
2.4 Diphtheria (Corynebacterium diphtheriae).
2.5 Anthrax (Bacillus anthracis).
2.6 Tuberculosis (Mycobacterium tuberculosis) and Leprosy (Mycobacterium leprae).</td></tr>
<tr><td></td><td colspan="7">UNIT III (15 hours) (K1, K2, K3 & K4)
Medically important Gram-Negative infections.
Causative agent, clinical symptoms, pathogenesis, mode of transmission, prevention, and treatment of the following bacterial diseases;
3.1 Meningitis (Streptococcus pneumoniae, Neisseria meningitidis).
3.2 Typhoid (Salmonella typhi, Salmonella paratyphi).</td></tr>
</table>

	3.3 cholera (Vibrio cholerae). 3.4 bacillary dysentery (Shigella dysenteriae). 3.5 Sexually Transmitted disease (syphilis–Treponema pallidum, Gonorrhoea - Neisseria gonorrhoeae). 3.6 Nosocomial infections – definition, importance, and their control (Pseudomonas aeruginosa).
	UNIT IV (15 hours) (K1, K2, K3 & K4) **Medically important Fungi.** 4.1 Classification of medically important fungi. Superficial mycoses: Pityriasis versicolor; Tinea Nigra; Piedra. 4.2 Cutaneous mycoses: Microsporum spps . , Trichophyton spps., and Epidermophyton floccosum. 4.3 Subcutaneous mycoses: Chromoblastomycosis; Sporotrichosis. 4.4 Systemic Mycoses - Blastomycosis; Histoplasmosis. 4.5 Opportunistic Infections -Candidiasis; Cryptococcosis; Zygomycosis. 4.6 Mycotoxins: Aflatoxin.
	UNIT V (15 hours) (K1, K2, K3 & K4) **Antimicrobial agents.** 5.1 General characteristics and mode of action of Antibacterial agents: Modes of action with an example for each: Inhibitor of nucleic acid synthesis. 5.2 Inhibitor of cell wall synthesis. 5.3 Inhibitor of cell membrane function. 5.4 Inhibitor of protein synthesis. 5.5 Inhibitor of metabolism. 5.6 Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin.
Text Books	1. Tom Parker, M. Leslie H. Collier. (1990). Topley&Wilson's Principles of Bacteriology, Virology and Immunity,8th Edition. London: Edward Arnold. 2. Greenwood, D., Slack, R.B. and Peutherer, J.F. (2012) Medical Microbiology, 18thEdition. Churchill Livingstone, London. 3. Finegold, S.M. (2000) Diagnostic Microbiology, 10th Edition. C.V. Mosby Company, St. Louis. 4. Ananthanarayanan, R. and JayaramPanicker C.K. (2020) Text book of Microbiology. Orient Longman, Hyderabad. 5. JagdishChander (2018). Textbook of Medical Mycology, 4th edition, Jaypee brothers medical publishers.
Reference Books	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. Kevin Kavanagh, (2018). Fungi Biology and Applications 3rd Edition. Wiley Blackwell publishers. 3. C.J. Alexopoulos, C.W. Mims, M. Blackwell, (2007). Introductory Mycology, 4th edition. Wiley publishers. 4. A.J. Salle (2007). Fundamental principles of bacteriology, fourth edition, Tata McGraw-Hill Publications.

	5. Christopher C. Kibbler, Richard Barton,Neil A. R. Gow, Susan Howell,Donna M. MacCallum, Rohini J. Manuel (2017). Oxford Textbook of Medical Mycology. Oxford University Press.
Web 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	Course Outcomes
On completion of this course, students will be able to;	
CO1	Understand the importance of normal flora of human body and acquire knowledge on the process of infectious disease.
CO2	Explain the various bacterial pathological events during the progression of an infectious disease, and apply the underlying mechanisms of spread of disease and its control.
CO3	Compile a list of disease-causing bacteria and compare their modes of infection, symptoms, diagnosis and treatment.
CO4	Comprehend human-fungal interaction, which can be applied to obtain in-depth knowledge on fungal diseases and the mechanism behind the disease process.
CO5	Explain the types of mycoses caused in humans and categorize the modes of infection, pathogenesis, and treatment with introduction to mycotoxins.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	H	M	L	H
CO2	H	L	M	L	L	H
CO3	H	M	L	M	M	H
CO4	H	M	M	H	M	H
CO5	H	M	H	L	L	M

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	L	L	M
CO2	H	H	H	M	L	M
CO3	H	H	H	L	L	L
CO4	H	H	H	M	L	M
CO5	H	H	H	L	L	M

(HIGH - 3, MODERATE - 2, LOW - 1)

<table>
<tr><td>Title of the Course</td><td colspan="7">VIROLOGY AND PARASITOLOGY</td></tr>
<tr><td>Paper No.</td><td colspan="7">Core Course X</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>III</td><td>Credits</td><td>4</td><td>Course Code</td><td>UCMBJ24</td></tr>
<tr><td>Semester</td><td>V</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>5</td><td>-</td><td colspan="3">-</td><td colspan="2">5</td></tr>
<tr><td>Objectives of the course</td><td colspan="7">• To gain knowledge on properties and classification of viruses and collection of relevant clinical samples for diagnosing viral infections.
• To understand pathogenic microorganisms of viruses and the mechanisms by which they cause disease in the human body.
• To gain knowledge about reemerging viral infections and develop diagnostic skills, including the use and interpretation of laboratory test in the diagnosis of infectious diseases.
• Understand the types of parasites causing infections in the intestine.
• To develop skills in the diagnosis of parasitic infections.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (15 hours) (K1, K2, K3 & K4)
Classification and cultivation of virus.
1.1 General Properties.
1.2 Viral replication.
1.3 Classification of viruses (Baltimore classification).
1.4 Cultivation of viruses- in animals, embryonated eggs and tissue culture.
1.5 Virus purification assays.
1.6 Collection and transport of clinical specimens for viral infections.</td></tr>
<tr><td></td><td colspan="7">UNIT II (15 hours) (K1, K2, K3 & K4)
Common Viral diseases.
Viral diseases with reference to symptoms, pathogenesis, transmission, prophylaxis and control;
2.1 Arboviruses (Flavi virus), Picorna viruses (Polio virus and Rhinovirus).
2.2 Hepatitis viruses (HAV, HBV, HCV, HDV, HEV), Rabies virus.
2.3 Orthomyoviruses (Influenza virus) and Paramyxoviruses (Mumps and Measles virus).
2.4 Pox viruses (Variola, Vaccinia), Herpes viruses (Herpes simplex, Varicella zoster).
2.5 Adeno viruses, Rota viruses and HIV viruses.
2.6 Oncogenic viruses (Human Papilloma virus): Introduction, characteristics of transformed cells, mechanism of viral oncogenesis and clinical manifestations.</td></tr>
<tr><td></td><td colspan="7">UNIT III (15 hours) (K1, K2, K3 & K4)
Detection of Virus, Antiviral agents and viral vaccines.
3.1 Emerging and reemerging viral infections.
3.2 SARS, Swine flu, Ebola, Dengue.
3.3 Chikungunya and Corona – its causes, spread and preventive measures.
3.4 Detection of viruses in clinical specimens – Serological and Molecular diagnosis of virus infections.</td></tr>
</table>

	3.5 Antiviral agents, Interferons. 3.6 Viral Vaccines, Immunization schedules.
	UNIT IV (15 hours) (K1, K2, K3 & K4) **Medical Parasitology** 4.1 General introduction to Medical Parasitology, 4.2 Classification of medically important parasites. 4.3 Morphology, life cycle, pathogenesis, clinical features, laboratory diagnosis, prevention and treatment of diseases caused by the following organisms: Entameoba histolytica. 4.4 Flagellates - Giardia lamblia. 4.5 Leishmania donovani. 4.6 Sporozoa- Plasmodium spps.
	UNIT V (15 hours) (K1, K2, K3 & K4) **Helminths and Lab techniques in parasitology.** 5.1 Introduction to Helminthes. 5.2 Platyhelminthes – Taenia – Fasciola, Paragonimus, Schistosoma spps. 5.3 Nemathelminthes – Ascaris, Ankylostoma, Enterobius. 5.4 Trichuris, Trichinella,Wuchereria , Dracanculus. 5.5 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). 5.6 Examination of blood for parasites. Cultivation of parasites.
Text Books	1. Rajan. S. (2007). Medical microbiology, MJP publisher. 2. Jeyaram Paniker, C.K. (2006). Text Book of Parasitology. Jay Pee Brothers, New Delhi. 3. Arora D.R. and Arora B. (2002). Medical Parasitology, 1st Edition CBS Publishers & Distributors, New Delhi. 4. Chatterjee (1986). Medical Parasitology. Tata McGraw Hill, Calcutta. 5. Parija S. C. (1996). Text Book of Medical Parasitology.4th edition, Orient Longman, AllIndia Publishers & Distributors.
Reference Books	1. Jawetz, E., Melnick, J.L. and Adelberg, E.A. (2000). Review of Medical Microbiology, 19thEdition. Lange Medical Publications, U.S.A. 2. Ananthanarayan, R. and JeyaramPaniker, C.K. (2009). Text Book of Microbiology, 8th Edition. Orient Longman, Chennai. 3. Conrat H. F, 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.
Web resources	1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4047123/ 2. https://www.ncbi.nlm.nih.gov/pubmed/21722309 3. https://www.sciencedirect.com/science/article/pii/S2211753919300193 4. https://cmr.asm.org/content/30/3/811 5. https://www.nejm.org/doi/full/10.1056/NEJMoa1811400

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Understand the structure and properties of viruses, cultivation methods and diagnosis of viral diseases.
CO2	Knowledge of basic and general concepts of causation of disease by the pathogenic microorganisms and various parameters of assessment of their severity and the methods of diagnosis.
CO3	Insights to treatment options of viral diseases.
CO4	Knowledge about the importance of protozoans in the intestine.
CO5	Knowledge of Nematodes as infectious agent.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	H	M	L	H
CO2	H	H	H	L	L	H
CO3	H	M	M	M	M	M
CO4	H	H	H	M	M	H
CO5	H	H	H	M	M	H

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	H	H	L	M
CO2	H	L	H	M	L	M
CO3	H	M	H	L	L	M
CO4	H	H	H	M	L	L
CO5	H	L	H	L	L	M

(HIGH - 3, MODERATE - 2, LOW - 1)

<table>
<tr><td>Title of the Course</td><td colspan="7">PRACTICAL -V: MEDICAL MICROBIOLOGY</td></tr>
<tr><td>Paper No.</td><td colspan="7">Core Course XI</td></tr>
<tr><td rowspan="2">Category</td><td>Core Practical</td><td>Year</td><td>III</td><td>Credits</td><td>3</td><td>Course Code</td><td>UCMBK24</td></tr>
<tr><td></td><td>Semester</td><td>V</td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>-</td><td>-</td><td colspan="3">5</td><td colspan="2">5</td></tr>
<tr><td>Objectives of the course</td><td colspan="7">• To familiarize students with medical microbiology techniques and technical knowledge on collection and processing of clinical samples.
• To learn the techniques for isolation and identification of bacterial pathogens.
• To gain expertise in various techniques of clinically important viral pathogens and their identification.
• To get acquainted with medically important fungi and their metabolism.
• To categorize parasites and understand their role in infections.</td></tr>
<tr><td>Course Outline (Experiments)</td><td colspan="7">1. Collection and Transport of Clinical specimens.
2. Simple, Differential and Special staining of Clinical materials.
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. Cultivation of Viruses in Embryonated eggs – Amniotic, Allantoic, Yolk sac routes and Chorio - allantoic membrane (Demonstration).
7. Microscopic identification of medically important Fungi – KOH and Lactophenol cotton blue staining.
8. Slide culture techniques for fungal Identification.
9. Identification of Dermatophytes.
10. Germ tube test, Carbohydrate fermentation and assimilation tests for Yeasts.
11. Direct Examination of Faeces – wet mount and Iodine mount – Demonstration of Protozoan cysts and Helminthes eggs.
12. Concentration techniques of stool specimen – Floatation and Sedimentation methods.
13. Examination of blood for Malarial parasites – thin and thick smear preparations - (Demonstration).
14. Identification of Medically important parasites in slides / specimens as spotters.</td></tr>
<tr><td>Text Books</td><td colspan="7">1. Dubey, R.C. and Maheswari, D.K. (2020). 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.</td></tr>
</table>

	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.
Reference Books	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 Eckel Mizer (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.
Web 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	Course Outcomes
On completion of this course, students will be able to;	
CO1	Demonstrate methods to observe and measure microorganisms by standard microbiological techniques.
CO2	Identify pathogenic microorganisms in the laboratory set-up and interpret their sensitivity towards commonly administered antibiotics.
CO3	Understand experimental tools used to cultivate and characterize clinically important viruses and bacteriophages.
CO4	Elucidate clinically important fungi.
CO5	Investigate Parasites of medical importance and identify them from clinical specimens.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	H	M	L	H
CO2	H	H	H	L	L	M
CO3	H	H	H	H	M	H
CO4	H	H	H	H	M	H
CO5	H	H	H	M	L	H

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	L	L	M
CO2	H	H	H	M	L	M
CO3	H	H	H	L	L	H
CO4	H	H	H	M	L	H
CO5	H	H	H	M	L	M

(HIGH - 3, MODERATE - 2, LOW - 1)

<table>
<tr><td>Title of the Course</td><td colspan="7">ELECTIVE: RECOMBINANT DNA TECHNOLOGY</td></tr>
<tr><td>Paper No.</td><td colspan="7">Elective -I</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Discipline specific Elective</td><td>Year</td><td>III</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">UEMBA24</td></tr>
<tr><td>Semester</td><td>V</td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>5</td><td>-</td><td colspan="3">-</td><td colspan="2">5</td></tr>
<tr><td>Objectives of the course</td><td colspan="7">Understand the principles of rDNA technology.
Illustrate the molecular tools employed in gene cloning.
Discuss the importance of various molecular techniques and their importance in Biotechnology.
Acquire knowledge about the concepts of tissue culture methods and transgenic organisms.
Examine recent trends in genetic engineering and its application in human welfare.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (12 hours) (K1, K2, K3 & K4)
Steps involved in Gene manipulation.
1.1 Milestones in rDNA Technology.
1.2 Gene Manipulation-Steps involved in Gene Cloning.
1.3 Isolation of Chromosomal and Plasmid DNA.
1.4 Restriction endonuclease - Discovery, Types, Mode of action.
1.5 Application of Ligase, DNA Polymerase, DNA
1.6 Modifying enzymes and Topoisomerases. Use of Linkers and Adapters.</td></tr>
<tr><td></td><td colspan="7">UNIT II (12 hours) (K1, K2, K3 & K4)
Gene transfer methods, Cloning Vectors & Gene libraries.
2.1 Artificial GeneTransfer methods -Calcium Chloride Induction, Electroporation, Microinjection, Biolistic method, Liposome and Viral-mediated delivery.
2.2 Cloning vectors –Properties and Applications - Plasmid Based Vectors- Natural Vectors-pSC101 and pMB1.
2.3 Artificial Vectors- pBR322 and pUC. Phage Based Vectors- Lambda phage.
2.4 Hybrid Vectors- Phagemid, Cosmid, BAC and YAC.
2.5 Screening of Recombinants.
2.6 Genomic DNA and cDNA library-Construction and Screening.</td></tr>
<tr><td></td><td colspan="7">UNIT III (12 hours) (K1, K2, K3 & K4)
Molecular tools.
3.1 Molecular Tools- PCR- Types.
3.2 Gel Electrophoresis - AGE and PAGE
3.3 Blotting Techniques-Southern, Western & Northern.
3.4 DNA sequencing methods - Sanger’s and Automated method.
3.5 Recent Trends in Genetic Engineering- Targeted Genome Editing- ZFNs, TALENs, CRISPRs. Gene Targeting- Knock-in & Knock-outs.</td></tr>
</table>

	3.6 DNA Finger Printing.
	UNIT IV (12 hours) (K1, K2, K3 & K4) **Plant and Animal Biotechnology** 4.1 Plant Biotechnology – Media, Growth Regulators and Equipment for Plant Tissue Culture. 4.2 Explant Culture- Micropropagation- Callus and Protoplast Culture. 4.3 Production of Bio-Active Secondary Metabolites by Plant Tissue Culture - Agrobacterium and Crown Gall Tumors, Ti Plasmid and Ri Plasmid. 4.4 Animal Biotechnology-Principles of Animal Cell Culture, Media and Equipment for Animal Cell Culture. 4.5 Primary and Secondary Cultures- Cell Lines- Types. 4.6 Establishment and Maintenance of Cell Lines.
	UNIT V (12 hours) (K1, K2, K3 & K4) **Application of Genetic Engineering.** 5.1 Applications of Genetic Engineering - Transgenic Animals – Mice and Sheep. 5.2 Recombinant Cytokines and their use in the Treatment of Animal infections. 5.3 Monoclonal Antibodies in Therapy. 5.4 Vaccines and their Applications in Animal Infections. 5.5 Human Gene Therapy-Germline and Somatic Cell Therapy-Ex-vivo Gene Therapy-SCID (Severe Combined Immuno Deficiency) – In-vivo Gene Therapy- CFTR (Cystic Fibrosis Transmembrane Regulator) –Vectors in Gene Therapy-Viral and Non-Viral Vectors. 5.6 Transgenic Plants– Bt Cotton, Bt Corn, Round Ready soy bean, Flavr Savr Tomato and GoldenRice.
Text Books	1. Brown T.A. (2016). Gene Cloning and DNA Analysis. 7th 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 Wileys and Sons Ltd. 3. Keya Chaudhuri (2013). Recombinant DNA technology. The Energy and Resources Institute 4. Siddra Ijaz, Imran UlHaq (2019). Recombinant DNA Technology. Cambridge Scholars Publishing. 5. Monika Jain (2012). Recombinant DNA Techniques: A Textbook, 1st Edition, Alpha Science International Ltd
Reference Books	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. Synder L., Peters J. E., Henkin T.M. and Champness W. (2013). Molecular Genetics of Bacteria,4th Edition. ASM Press Washington-D.C. ASM Press.

	5. James D.Watson, Michael Gilman, Jan Witkowski, Mark Zoller (1992). Recombinant DNA. Scientific American Books.
Web resources	1. https://www.britannica.com/recombinant-DNA-technology 2. https://www.byjus.com/recombinant-dna-technology 3. https://www.rpi.edu 4. https://www.ncbi.nlm.nih.gov 5. https://www.le.ac.uk/recombinant-dna-and-genetic-techniques

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Illustrate the steps involved in introduction and expression of foreign DNA into bacteria, animal and plants cells and their screening.
CO2	Discuss the various cloning vectors and their applications.
CO3	Assess the usage and advantages of molecular tools.
CO4	Explain plant and animal tissue culture protocols and gene transfer mechanism.
CO5	Elucidate and understand the application of genetic engineering and gene therapy.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	H	M	L	M
CO2	H	H	H	L	L	M
CO3	H	H	H	M	M	L
CO4	H	H	H	H	M	M
CO5	H	H	H	L	L	M

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	L	L	H
CO2	H	H	H	L	M	H
CO3	H	H	H	L	M	M
CO4	H	H	H	M	L	H
CO5	H	H	H	L	M	M

(HIGH - 3, MODERATE - 2, LOW - 1)

<table>
<tr><td>Title of the Course</td><td colspan="7">ELECTIVE: FUNDAMENTALS OF CELL BIOLOGY</td></tr>
<tr><td>Paper No.</td><td colspan="7">Elective -I</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Discipline specific Elective</td><td>Year</td><td>III</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">UEMBB24</td></tr>
<tr><td>Semester</td><td>V</td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="2">Lab Practice</td><td colspan="3">Total</td></tr>
<tr><td>5</td><td>-</td><td colspan="2">-</td><td colspan="3">5</td></tr>
<tr><td>Objectives of the course</td><td colspan="7">• To compare the difference between plant cell and animal cell.
• To analyze the basic components of prokaryotic and eukaryotic cells and the chemistry of its macromolecules and differentiate the roles of each cell organelles with its functions.
• To compile the ultrastructure and function of nucleus and nucleolus.
• To discuss on the different stages of cell division in prokaryotic and eukaryotic cells.
• To outline the basic principles of osmosis, cell signaling and signal transduction.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (12 hours) (K1, K2, K3 & K4)
Cell organization.
1.1 Overview of Cell organization and types of cell.
1.2 Structural organization of prokaryotic cell.
1.3 Structural organization of eukaryotic cell.
1.4 Structure of plant cell.
1.5 Structure of animal cell.
1.6 Structure of Virus cell.</td></tr>
<tr><td></td><td colspan="7">UNIT II (12 hours) (K1, K2, K3 & K4)
Components and functions of organelles.
2.1 Structure and function of mitochondria.
2.2 Structure and function of endoplasmic reticulum- rough and smooth.
2.3 Structure and function of ribosomes and golgi vesicles.
2.4 Lysosomes, chloroplast, peroxisomes and glyoxysomes.
2.5 Extracellular matrix- collagen, microtubules, microfilaments.
2.6 Centrioles, basal bodies, cilia and flagella.</td></tr>
<tr><td></td><td colspan="7">UNIT III (12 hours) (K1, K2, K3 & K4)
Cytogenetics.
3.1 Nucleus- Nuclear membrane, Nucleolus, Nuclear pore and annulus.
3.2 Cytogenetics- an overview.
3.3 Structure of chromosomes.
3.4 Nucleosomes - Gaint chromosomes.
3.5 Polytene Chromosomes.
3.6 Lamp brush chromosomes. (K1, K2)</td></tr>
</table>

	UNIT IV (12 hours) (K1, K2, K3 & K4) **Mitosis and Meiosis I and II.** 4.1 Overview of Cell cycle. 4.2 Cell division- Mitosis. 4.3 Meiosis I and II. 4.4 Cytoplasmic matrix- compounds of matrix- inorganic compound-water. 4.5 Organic compound- carbohydrates, lipids and proteins. 4.6 Protein structure and synthesis.
	UNIT V (12 hours) (K1, K2, K3 & K4) **Molecular organization of animal cell membrane.** 5.1 Cell biology- Overview on molecular organization of animal cell membrane. 5.2 Membrane lipids,proteins and carbohydrates. 5.3 The fluid mosaic model and artificial membranes. 5.4 Mitochondrial membrane. 5.5 Red cell membrane. 5.6 Cell wall components and role of cell wall.
Text Books	1. De Robertis E.D.P (2010). Cell and Molecular Biology.8th edition, Lippincott Williams, Philadelphia. 2. Powar.C.B (2006) .Cell biology. 1st edition , Himalaya publishing house, New Delhi 3. Verma.P.S and Agarwal.V.K.(2005). Cell biology, Genetics, Molecular Biology, Evolution and Ecology.1st edition. S.Chand and company Ltd, Chennai 4. Stephen R. Bolsover, Elizabeth A. Shephard, Hugh A. White, Jeremy S. Hyams (2011). Cell Biology: A Short course. 3rd edition, Wiley Blackwell publishers, United States. 5. John K.Young (2010).Introduction to Cell Biology.1st edition, World Scientific publishing company, Singapore.
Reference Books	1. Gerald Karp (2013). Cell Biology. 7th edition, Wiley Blackwell publishers, United States. 2. George Plopper (2014). Principles of Cell Biology.2nd edition, John and Bartlett publishers, London. 3. Graur D & Li W-H (1999). Fundamentals of Molecular Evolution, 2nd edn. Sunderland, MA: Sinauer Associates. 4. Alberts B, Bray D, Johnson A et al. (1997) Essential Cell Biology. London: Garland Publishing. 5. Margulis L & Schwartz KV (1998) Five Kingdoms: An Illustrated Guide to the Phyla of Life on Earth, 3rd edn. New York: Freeman.
Web resources	1. www.gutenberg.org 2. www.free-ebooks.net 3. www.e-booksdirectory.com 4. https://www.byjus.com/cell-biology 5. https://www.adelaide.edu.au/cellbiology/

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Compare the difference between plant cell and animal cell.
CO2	Analyze the basic components of prokaryotic and eukaryotic cells and the chemistry of its macromolecules and differentiate the roles of each cell organelles with its functions.
CO3	Compile the ultrastructure and function of nucleus and nucleolus.
CO4	Discuss on the different stages of cell division in prokaryotic and eukaryotic cells.
CO5	Outline the basic principles of osmosis, cell signaling and signal transduction.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	H	M	L	M
CO2	H	H	H	L	L	M
CO3	H	H	H	M	M	L
CO4	H	H	H	M	M	M
CO5	H	H	H	M	M	M

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	H	H	L	M
CO2	H	M	H	M	L	M
CO3	H	M	H	L	L	L
CO4	H	M	H	L	L	L
CO5	H	M	H	L	L	L

(HIGH - 3, MODERATE - 2, LOW - 1)

<table>
<tr><td>Title of the Course</td><td colspan="7">ELECTIVE: CLINICAL LABORATORY TECHNOLOGY</td></tr>
<tr><td>Paper No.</td><td colspan="7">Elective -II</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Discipline specific Elective</td><td>Year</td><td>III</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">UEMBC24</td></tr>
<tr><td>Semester</td><td>V</td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="2">Lab Practice</td><td colspan="3">Total</td></tr>
<tr><td>4</td><td>-</td><td colspan="2">-</td><td colspan="3">4</td></tr>
<tr><td>Objectives of the course</td><td colspan="7">• Demonstrate ethical and professional conduct with patients, laboratory personnel, health - care professionals, and the public.
• Explain how accurate and reliable information might be obtained about proper procurement, storage, and handling of laboratory specimens.
• Develop a sound scientific knowledge foundation that prepares them to interpret, analyze and evaluate scientific knowledge in clinical practice.
• Perform a full range of laboratory tests with accuracy and precision.
• Establish quality assurance principles and practices to ensure the accuracy and reliability of laboratory information.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (12 hours) (K1, K2, K3 & K4)
Introduction to Clinical Laboratory Science.
1.1 Basic laboratory principles.
1.2 Code of conduct for medical laboratory personnel.
1.3 Organization of clinical laboratory and role of medical laboratory technician - Safety measures.
1.4 Assessment of a patient and brief history of collection.
1.5 Maintenance of Hygiene.
1.6 Infection Control Practices.</td></tr>
<tr><td></td><td colspan="7">UNIT II (12 hours) (K1, K2, K3 & K4)
Specimen collection and processing.
2.1 Blood, urine, stool, sputum, CSF, amniotic fluid and bile.
2.2 Separation of serum and plasma.
2.3 Handling of specimens for testing.
2.4 Preservation of specimens.
2.5 Transport of specimens.
2.6 Factors affecting the clinical results.</td></tr>
<tr><td></td><td colspan="7">UNIT III (12 hours) (K1, K2, K3 & K4)
Introduction to histopathology.
3.1 Methods of examination of tissues and cells.
3.2 Fixation of tissues: Classification and properties of fixatives.
3.3 Tissue processing - Collection of specimens.
3.4 Labeling and fixation, Dehydration, Clearing.
3.5 Impregnation, Embedding - Paraffin block making, Section Cutting.
3.6 Microtomes – types and mounting of sections.</td></tr>
</table>

	UNIT IV (12 hours) (K1, K2, K3 & K4) **Haematology.** 4.1 Introduction to Haematology. 4.2 Laboratory methods used in the investigation of coagulation disorders - coagulation tests. 4.3 Routine coagulation tests, (prothrombin time, plasma recalcification time, partial thromboplastin tim , activated partial thromboplastin time, thrombin time), 4.4 Laboratory diagnosis of bleeding disorders. 4.5 Estimation of fibrinogen. 4.6 Assay of coagulation factors.
	UNIT V (12 hours) (K1, K2, K3 & K4) **Quality Standards in Health Laboratories.** 5.1 Development and implementation of standards. 5.2 Accreditation Boards –NABL, ISO, CAP, COLA. 5.3 Performing quality assessment. 5.4 Pre-analytical assessment. 5.5 Analytical Assessment. 5.6 Post-analytical phases of testing.
Text Books	1. Mukharji,K.L. (2000).Medical Laboratory Techniques, Vol - I, II & III, 5th Edition. Tata Mc Graw 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.
Reference Books	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 Rana Shinde. (2008). Textbook of Medical Biochemistry, 7th Edition, Jaypee Brothers Medical Publishers Pvt. Limited. 5. James G Cappucino. and Natalie Sherman. (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	Course Outcomes
On completion of this course, students will be able to;	
CO1	Describe characteristics of laboratory organizations and demonstrate professionalism by displaying professional conduct, model ethical behavior and operate as a vital member of the medical lab team. Practice safety or infection control procedures in the clinical laboratory, properly use safety equipment and maintain a clean, safe work environment.
CO2	Accurately collect specimens for various purposes. Determine appropriate tests based on test request, maintain standard and transmission-based precautions, engage in the scientific process by understanding the principles and practices of clinical study design, implementation, and dissemination of results.
CO3	Identify the basic structure of cells, tissues and organs and describe their contribution to normal function. Interpret light and electron microscopic histological images and identify the tissue source and structures. Relate and recognize the histological appearance of affected tissues to the underlying pathology.
CO4	Recognize the pathologies behind benign and malignant disorders of erythrocytes, leucocytes, thrombocytes and familiar with the diagnosis, evaluation, and management of hematologic malignancies.
CO5	Interpret, implement, and complying with laws, regulations and accrediting standards and guidelines of relevant governmental and non-governmental agencies.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	H	M	L	H
CO2	H	H	H	L	L	M
CO3	H	H	H	H	M	H
CO4	H	H	H	H	M	H
CO5	H	H	H	M	L	H

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	L	L	M
CO2	H	H	H	M	L	M
CO3	H	H	H	L	L	H
CO4	H	H	H	M	L	H
CO5	H	H	H	M	L	M

(HIGH - 3, MODERATE - 2, LOW - 1)

<table>
<tr><td>Title of the Course</td><td colspan="7">ELECTIVE: MARINE MICROBIOLOGY</td></tr>
<tr><td>Paper No.</td><td colspan="7">Elective -II</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Discipline specific Elective</td><td>Year</td><td>III</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">UEMBD24</td></tr>
<tr><td>Semester</td><td>V</td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>4</td><td>-</td><td colspan="3">-</td><td colspan="2">4</td></tr>
<tr><td>Objectives of the course</td><td colspan="7">• To outline about the different marine environment and compare the microbial communities in the aquatic environment.
• To discuss adaptations strategies of various extremophilic microorganisms, extremozymes and their importance in biotechnology.
• To identify the kinetics of aquatic microbial population and microbial interactions – symbiosis and antagonism.
• To describe about the marine food borne and water borne pathogens.
• To explain the production and biotechnological applications of novel marine microbial products.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (12 hours) (K1, K2, K3 & K4)
The marine environment.
1.1 Marine environment - sea-benthic & littoral zone.
1.2 Saltpan.
1.3 Mangroves.
1.4 Estuarine microbes.
1.5 Microbial loop.
1.6 Marine microbial community - planktons, bacteria, fungi, protozoa.</td></tr>
<tr><td></td><td colspan="7">UNIT II (12 hours) (K1, K2, K3 & K4)
Extremophiles and their growth environment.
2.1 Survival at extreme environments – starvation.
2.2 Adaptive mechanisms in thermophilic, psychrophilic microorganisms.
2.3 Alkalophilic microorganisms.
2.4 Barophilic microorganisms and Osmophilic microorganisms.
2.5 Hyperthermophiles microorganisms.
2.6 Halophiles - importance in biotechnology.</td></tr>
<tr><td></td><td colspan="7">UNIT III (12 hours) (K1, K2, K3 & K4)
Microbe- Microbe interactions.
3.1 Microbe-microbe interactions – Lichens.
3.2 Antagonistic interactions - amensalism, mycoparasitism.
3.3 Animal-microbe interaction - Ectosymbiosis of Protozoa, Ruminant symbiosis.
3.4 Plant-microbe interaction – Rhizobium.
3.5 Plant-microbe interaction – Mycorrhizae.
3.6 Anabaena - sponge.</td></tr>
</table>

	UNIT IV (12 hours) (K1, K2, K3 & K4) **Marine pathogens.** 4.1 Marine food borne pathogens & Water borne pathogens – An overview. 4.2 *Aeromonas.* 4.3 *Vibrio.* 4.4 *Salmonella.* 4.5 *Pseudomonas.* 4.6 *Leptospira.*
	UNIT V (12 hours) (K1, K2, K3 & K4) **Marine microbial products.** 5.1 Production and applications of marine microbial products - pigments – Astaxanthin. 5.2 Production and applications of marine microbial products - β carotene. 5.3 Production and applications of marine microbial products – enzymes. 5.4 Production and applications of marine microbial products – antibiotics. 5.5 Production and applications of marine microbial products – polysaccharide. 5.6 Sea food preservation methods.
Text Books	1. Munn C. B. (2019). Marine Microbiology: Ecology and Applications. (3rd Edition). CRC Press. ISBN:9780367183561. 2. Bhakuni, D.S. and Rawat D. S. (2005). Bioactive Marine Natural Products. Anamaya Publishers, New Delhi. ISBN:1-4020-3472-5. 3. Brock T. D. (2011). Thermophilic Microorganisms and Life at High Temperatures. Springer. ISBN-13:978-1461262862 / ISBN-10:1461262860. 4. Nybakken, J.W. (2001). Marine Biology. (5th Edition). Benjamin Cummings. ISBN:0321030761. 5. Veena. (2003) Understanding marine biology. Discovery Publishing.
Reference Books	1. Maier R. M., Pepper I. L. and Gerba C. P. (2006). Environmental Microbiology. (2nd Edition). Academic Press. ISBN:978-0-12-370519-8. 2. Belkin S. and Colwell R. R. (2005). Oceans and Health: Pathogens in the Marine Environment. Springer. ISBN:978-0-387-23708-4. 3. Scheper T. (2009). Advances in Biochemical Engineering/Biotechnology Marine Biotechnology. Springer. ISBN:978-3-540-69356-7. E-ISBN:978-3-540 69357-4. 4. Gasol J. M. and Kirchman D. L. (Eds.). (2018). Microbial Ecology of the Oceans. (3rd Edition). Wiley-Blackwell. ISBN:978-1-119-10718-7. 5. Kim S. K. (2019). Essentials of Marine Biotechnology. Springer.
Web resources	1. https://link.springer.com/content/pdf/bfm%3A978-0-387-23709-1%2F1 2. https://www.researchgate.net/publication/285931262_Bioactive_Marine_Natural_Products 3. http://link.springer.com/content/pdf/bfm%3A978-3-642-03470-1%2F1.pdf 4. https://link.springer.com/book/10.1007/b102184 5. https://www.wiley.com/enbs/Microbial+Ecology+of+the+Oceans%2C+3rd+Edition p-9781119107187

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Outline about the different marine environment and compare the microbial communities in the aquatic environment.
CO2	Discuss adaptations strategies of various extremophilic microorganisms, extremozymes and their importance in biotechnology.
CO3	Identify the kinetics of aquatic microbial population and microbial interactions – symbiosis and antagonism.
CO4	Describe about the marine food borne and water borne pathogens.
CO5	Explain the production and biotechnological applications of novel marine microbial products.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	M	M	L	M
CO2	H	H	H	L	L	M
CO3	H	M	M	H	H	M
CO4	H	M	H	H	H	M
CO5	H	L	M	M	M	M

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	H	L	L
CO2	H	M	H	M	L	L
CO3	H	M	H	H	L	L
CO4	H	M	H	M	L	L
CO5	H	H	H	H	L	H

(HIGH - 3, MODERATE - 2, LOW - 1)

<table>
<tr><td>Title of the Course</td><td colspan="7">ENVIRONMENTAL AND AGRICULTURE MICROBIOLOGY</td></tr>
<tr><td>Paper No.</td><td colspan="7">Core Course XIII</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>III</td><td>Credits</td><td>3</td><td>Course Code</td><td>UCMBM24</td></tr>
<tr><td>Semester</td><td>VI</td><td colspan="3"></td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>5</td><td>-</td><td colspan="3">-</td><td colspan="2">5</td></tr>
<tr><td>Objectives of the course</td><td colspan="7">• To discuss the distribution and association of microorganism in various ecosystems. and to know about the role of microorganism in water pollution and water quality.
• To acquire knowledge about the role of microorganism in water pollution and water quality.
• Gain knowledge about microbes as biofertilizers and the aspects of application.
• To learn about the process of solid waste management and sewage water treatment.
• Gain knowledge on various plant diseases and pathogens.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (15 hours) (K1, K2, K3 & K4)
Microorganisms and their Habitats.
1.1 Structure and function of ecosystems.
1.2 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.
1.3 Aquatic Environment: Microflora of fresh water and marine habitats, factors influencing microbial growth in the aquatic environments.
1.4 Atmosphere: Aeromicroflora and dispersal of microbes, Assessment of air quality, Enumeration of microorganism in air, Air sanitation.
1.5 Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels.
1.6 Predisposing factors for Environmental diseases – infectious (water and air borne) and pollution related, spread and control of these diseases. Environmental Protection Agency (EPA) - role in environmental protection.</td></tr>
<tr><td></td><td colspan="7">UNIT II (15 hours) (K1, K2, K3 & K4)
Water Microbiology.
2.1 Water potability: Sources and types of water surface, ground, stored, distilled, mineral and de-mineralized water.
2.2 Water pollution, biological indicators of water pollution, eutrophication. BOD, COD.
2.3 Conventional Bacteriological standards of Water Quality, MPN index, coliform test, Membrane filtration.
2.4 Advanced molecular methods for water analysis.
2.5 Water borne diseases.
2.6 Central Pollution Control Board (CPCB) standards.</td></tr>
</table>

	UNIT III (15 hours) (K1, K2, K3 & K4) **Microbial interactions.** 3.1 Microbial Interactions: Rhizosphere microflora. 3.2 Concepts of Nitrogen fixation – Symbiotic and asymbiotic nitrogen fixers. 3.3 Brief account of microbial interactions: Symbiosis, neutralism, commensalism, competition, Ammensalism, Synergism, parasitism, and predation. 3.4 General account and Significance of Biofertilizers and biocontrol agents – Bacterial, cyanobacterial, VAM. 3.5 Mass production of Rhizobial biofertilizer. 3.6 Biocontrol agents – Bacterial, viral, fungal.
	UNIT IV (15 hours) (K1, K2, K3 & K4) **Waste treatment and bioremediation.** 4.1 Solid waste management: Sources and types of solid waste, composting, vermin composting, production of biogas. 4.2 Liquid waste management: Primary, secondary, and tertiary sewage treatment. 4.3 Bioremediation and waste management: Need and scope of bioremediation. 4.4 Degradation of hydrocarbons and oil spills. 4.5 Degradation of heavy metals – Chromium and lead. 4.6 xenobiotics – PCB.
	UNIT V (15 hours) (K1, K2, K3 & K4) **Plant pathology:** 1.7 Mode of entry of pathogens, 1.8 Microbial enzymes, toxins, growth regulators and suppressor of plant defense in plant diseases. 1.9 Plant defense mechanisms. 1.10 Bacterial diseases – Citrus canker, Blight of paddy. Viral disease – TMV, CMV. 1.11 Fungal disease- red rot of sugarcane, Tikka disease. 1.12 Plant disease management.
Text Books	1. Joseph C. Daniel. (2006). Environmental aspects of Microbiology 2nd Edition. Bright Sun 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. Vijaya Ramesh. K. (2004). Environmental Microbiology. 1st Edition. MJP Publishers. 5. SubbaRao N.S. (2017). Soil Microbiology.4th Edition. Oxford and IBH Publishing Pvt. Ltd.
Reference Books	1. Dirk, J. Elasas, V., Trevors, J.T., Wellington, E.M.H. (1997). Modern Soil Microbiology, Marcel Dekker INC, New York, Hong Kong. 2. EcEldowney S, Hardman D.J., Waite D.J., Waite S. (1993). Pollution: Ecology and Biotreatment – Longman Scientific Technical publishers.

	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, 20thEdition. 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.
Web 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	Course Outcomes
On completion of this course, students will be able to;	
CO1	Describe about the structure and function of ecosystems and understand the role of microbes in various environments.
CO2	Identify the cause of water pollution, and perform methods to assess the quality of water.
CO3	Explain the production of biofertilizers and biopesticides.
CO4	Explain about waste treatment process and microbial decomposition and bio-remediation process.
CO5	Describe about plant diseases caused by microbes and acquire a clear idea on plant pathogenic interaction.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	H	M	L	M
CO2	H	H	H	L	L	M
CO3	H	M	M	H	M	M
CO4	H	M	H	H	M	M
CO5	H	M	H	M	M	M

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	H	H	L	M
CO2	H	L	H	M	L	M
CO3	H	M	H	L	L	M
CO4	H	H	H	M	L	L
CO5	H	L	H	L	L	M

(HIGH - 3, MODERATE - 2, LOW - 1)

<table>
<tr><td>Title of the Course</td><td colspan="7">FOOD, DAIRY AND PROBIOTIC MICROBIOLOGY</td></tr>
<tr><td>Paper No.</td><td colspan="7">Core Course XIV</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>III</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">UCMBN24</td></tr>
<tr><td>Semester</td><td>VI</td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="2">Lab Practice</td><td colspan="3">Total</td></tr>
<tr><td>5</td><td>-</td><td colspan="2">-</td><td colspan="3">5</td></tr>
<tr><td>Objectives of the course</td><td colspan="7">• To impart current knowledge of basic and applied microbiological aspects of fluid milks and dairy products for improved quality and food safety.
• Gives an insight into various types of food borne diseases and their prevention.
• To gain information about microflora of milk and production of fermented dairy products.
• To impart current knowledge of probiotics, prebiotics and functional dairy foods for the health benefits.
• To create a sustainable environmentally and technologically advanced dairy farm.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (15 hours) (K1, K2, K3 & K4)
Food as a substrate for microorganism & food preservation.
1.1 Food as a substrate for microorganisms.
1.2 Microorganisms important in food microbiology; Molds, yeasts and bacteria - General Characteristics - Classification and importance.
1.3 Principles of food preservation - Asepsis - Removal of microorganisms.
1.4 Use of High temperature & Low temperature.
1.5 Drying & Food additives.
1.6 Nanoscience in food preservation; microencapsulation.</td></tr>
<tr><td></td><td colspan="7">UNIT II (15 hours) (K1, K2, K3 & K4)
Food borne illness and Food Sanitation.
2.1 Contamination and spoilage of food products.
2.2 Food borne infections (Bacillus cereus, Salmonellosis, Shigellosis, Listeria monocytogenes and Campylobacter jejuni).
2.3 Food intoxications – (Staphylococcus aureus, Clostridium botulinum, Clostridium perfringens and mycotoxins).
2.4 Foodborne disease outbreaks - newly emerging pathogens. Conventional and Novel technology in control of food borne pathogens and preventive measures.
2.5 Food sanitation - plant sanitation - Employees' health standards.
2.6 Regulatory Agencies & criteria for food safety.</td></tr>
<tr><td></td><td colspan="7">UNIT III (15 hours) (K1, K2, K3 & K4)
Dairy Microbiology
3.1 Microflora of raw milk.
3.2 Sources of contamination.</td></tr>
</table>

	3.3 Spoilage of milk and milk products. 3.4 Preservation of milk and milk products. 3.5 Antimicrobial systems in raw milk. 3.6 Importance of biofilms, their role in transmission of pathogens in dairy products and preventive strategies.
	UNIT IV (15 hours) (K1, K2, K3 & K4) **Fermented foods.** 4.1 Food fermentations: Indian Pickles Bread, vinegar, fermented vegetables (sauerkraut). 4.2 Fermented dairy products (yoghurt, cheese, Acidophilus Milk, Kefir, Koumiss). 4.3 Oriental fermented foods - Miso –Tempeh, Ontjom, Natto, Idli. 4.4 Spoilage and defects of fermented dairy products. 4.5 Functional fermented foods and nutraceuticals. 4.6 Bioactive proteins and bioactive peptides, genetically modified foods.
	UNIT V (15 hours) (K1, K2, K3 & K4) **Probiotic and Prebiotics.** 5.1 Probiotic microorganisms, concept, definition safety of probiotic microorganisms, legal status of probiotics. 5.2 Characteristics of Probiotics for selection: stability maintenance of probiotic microorganisms. 5.3 Role of probiotics in health and disease: Mechanism of probiotics. 5.4 Application of bacteriocins in foods. Biopreservation. 5.5 Prebiotics: concept, definition, criteria, types and sources of prebiotics, prebiotics and gut microflora – 5.6 Prebiotics and health benefits: mineral absorption, immune response, cancer prevention, elderly health and infant health, prebiotics in foods.
Text Books	1. Frazier WC and West off DC. (2017). Food microbiology. 5th Edition TATA McGraw Hill Publishing Company Ltd. New Delhi. 2. Adams, M.R., Moss, M.O. (2018). Food Microbiology 1stedition. New Age Publishers by New Age International (P) Ltd., Publishers. 3. R.C. Dubey. (2014). Advanced Biotechnology. S. Chand publishers. 4. Banwart GJ. (1989). Basic food microbiology, Chapman & Hall, New York. 5. Sugumar D. (1997). Outlines of dairy technology, Oxford University press.
Reference Books	1. Jay JM, Loessner MJ and Golden DA. (2 2. 005). Modern Food Microbiology. 7th Edition. CBS Publishers and Distributors, Delhi, India. 3. Prescott, Harley and Klein Wim. (2008). Microbiology, 7th Edition McGraw Hill Publications. 4. Robinson, R. K. (2002). Dairy Microbiology Handbook - The Microbiology of Milk and Milk Products (Third Edition), A John Wiley & Sons, Inc., New York. 5. Yuankunlee, Sepposalminen. (2008). Handbook of probiotics and prebiotics Second Edition. A John Wiley & Sons publication Inc.

	6. Dharumadurai Dhansekaran, Alwarappan Sankaranarayanan. (2021). Advances in Probiotics Microorganisms in Food and Health 1st Edition. eBook ISBN:9780128230916.
Web resources	1. https://www.researchgate.net/publication/15326559_A_Dynamic_Approach_to_Predicting_BacterialGrowth_in_Food/link/5a1d2e02aca2726120b28eba/download 2. https://www.fda.gov/ food/ laboratory – methods – food / bam - food sampling preparation- sample-homogenate 3. https://www.researchgate.net/publication/243462186_Foodborne_diseases_in_India_-_A_review 4. https://www.researchgate.net/publication/228662659_Fermented_Dairy_Products_Starter_Cultures_and_Potential_Nutritional_Benefits/link/000084160cf23f86393d5764/ download 5. https://www.fda.gov/food

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Gain knowledge about food as a substrate for various microbes and Understand about the principles of food preservation technique.
CO2	Acquire a thorough understanding of food borne diseases, testing methods, and preventive technique.
CO3	Gain information about spoilage of milk and its products and its antimicrobial properties.
CO4	Learn about the various fermented product and its various stage spoilage.
CO5	Impart current knowledge of probiotics, prebiotics and functional dairy foods for the health benefits.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	H	M	L	H
CO2	H	L	M	L	L	H
CO3	H	M	L	M	M	H
CO4	H	M	M	H	M	H
CO5	H	M	H	L	L	M

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	M	L	H
CO2	H	M	H	L	L	H
CO3	H	H	M	L	L	H
CO4	H	M	M	L	L	H
CO5	H	H	H	L	M	M

(HIGH - 3, MODERATE - 2, LOW - 1)

<table>
<tr><td>Title of the Course</td><td colspan="8">PRACTICAL -VI: APPLIED MICROBIOLOGY</td></tr>
<tr><td>Paper No.</td><td colspan="8">Core Course XV</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core Practical</td><td>Year</td><td>III</td><td>Credits</td><td>4</td><td>Course Code</td><td colspan="2">UCMBO24</td></tr>
<tr><td>Semester</td><td>VI</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="4">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>-</td><td>-</td><td colspan="4">5</td><td colspan="2">5</td></tr>
<tr><td>Objectives of the course</td><td colspan="8">• To assess the water quality and potability.
• To acquire knowledge on enumeration of bacteria from milk and milk quality analysis
• To investigate various extracellular enzyme producers in soil and to gain knowledge on preparation of biofertilizers
• Improve knowledge on plant pathogens
• To acquire knowledge on preparation of probiotics and prebiotics</td></tr>
<tr><td>Course Outline (Experiments)</td><td colspan="8">1. Microbiological assessment of water quality- 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 and vegetables.
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. Microbiological assay of antibiotics by cup plate method.
9. Isolation of Rhizobium/ Azotobacter/ phosphate solubilizing organisms.
10. Preparation of biofertilizers – Demonstration
11. Study of plant pathogens- Tikka Disease, Red rot of sugarcane, Citrus canker, Blight of paddy - Spotters.
12. Study of fungi - Mucor, Fusarium, Alternaria, Rhizopus, Aspergillus, Penicillium.
13. Isolation of constituent flora of fermented milk.
14. Preparation of probiotic fermented milks like dahi, yoghurt, lassi and whey drink.
15. Effect of prebiotics on the growth of LAB in milk and broth.
16. Survivability of probiotic organisms in fermented milks.
17. Antimicrobial potential of the functional dairy products.</td></tr>
<tr><td>Text Books</td><td colspan="8">1. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th Edition. Pearson Education Limited.
2. Kannan. N. (1996). Laboratory manual in General Microbiology. Palani Publications.
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.</td></tr>
</table>

	5. Aneja, K R. (2010). Experiments in Microbiology, Plant pathology and Biotechnology.New Age International (P) Limited.
Reference Books	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. 4thEdition. 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 MicrobiologyA Laboratory Manual, 2nd Edition. Lippincott Williams & Wilkins Inc. 5. Ian Pepper, Charles Gerba, Jeffrey Brendecke (2004). Environmental Microbiology-A laboratory manual, Elsevier.
Web 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	Course Outcomes
On completion of this course, students will be able to;	
CO1	Assess the microbial quality of water and relate the experimental results to the prescribed standards by the statutory bodies.
CO2	Evaluate the quality of milk and enumerate bacteria in milk by standard plate count method.
CO3	Identify extracellular enzyme producing and nitrogen fixing microorganism form soil and to prepare a biofertilizer.
CO4	Identify various plant pathogenic bacteria.
CO5	Synthesize probiotic fermented milks using microorganisms.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	H	L	L	H
CO2	H	H	H	M	L	M
CO3	H	H	H	M	L	M
CO4	H	H	H	M	L	H
CO5	H	H	H	H	M	M

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	L	L	H
CO2	H	H	H	M	L	M
CO3	H	H	H	M	L	M
CO4	H	H	H	M	L	H
CO5	H	H	H	H	M	M

(HIGH - 3, MODERATE - 2, LOW - 1)

<table>
<tr><td>Title of the Course</td><td colspan="7">BIOSAFETY AND BIOETHICS</td></tr>
<tr><td>Paper No.</td><td colspan="7">Core Course XVI</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>III</td><td rowspan="2">Credits</td><td rowspan="2">2</td><td rowspan="2">Course Code</td><td rowspan="2">UCMBP24</td></tr>
<tr><td>Semester</td><td>VI</td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="2">Lab Practice</td><td colspan="3">Total</td></tr>
<tr><td>3</td><td>-</td><td colspan="2">-</td><td colspan="3">3</td></tr>
<tr><td>Objectives of the course</td><td colspan="7">• To create a research environment - encourage investigation, analysis and studying the bioethical principles, values, concepts, and social and juridical implications contained in the Universal Declaration on Bioethics and Human
• Rights in order to assist their application and promotion in the areas of science, biotechnology and medicine.
• To discuss about various aspects of biosafety regulations, IPR and bioethics concerns arising from the commercialization of biotech products.
• To introduce fundamental aspects of Intellectual property Rights to students who are going to play a major role in development and management of innovative projects in industries.
• To understand the importance of IPR, Patents and Patent laws.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (12 hours) (K1, K2, K3 & K4)
Basics of Biosafety.
1.1 Basics of Biosafety - Laboratory Hazards and Hazard symbols.
1.2 Definitions on Biohazard, Biosafety and Biosecurity- Biohazard- LAI, BP.
1.3 Biohazard Classification.
1.4 Biological Risk Groups. Need and application of biosafety.
1.5 Good Laboratory Practices (GLP).
1.6 Good Manufacturing Practices (GMP).</td></tr>
<tr><td></td><td colspan="7">UNIT II (12 hours) (K1, K2, K3 & K4)
Biohazardous waste.
2.1 Hazardous materials in Biotechnology.
2.2 Categories of Waste in the Biotechnology Laboratories.
2.3 Biohazardous waste and their disposal and treatments.
2.4 Issues in use of GMO’s.
2.5 Risk for animal/human/ agriculture and environment owing to GMO.
2.6 Hazardous materials, Emergency response/ first aids in Laboratories.</td></tr>
<tr><td></td><td colspan="7">UNIT III (12 hours) (K1, K2, K3 & K4)
Biological Safety Containment.
3.1 Biological Safety Containment in Laboratory - Primary and secondary containments.
3.2 Physical and biological containment.
3.3 Types of biosafety containments (level I, II, III).
3.4 PPE.
3.5 Biosafety guidelines in India.
3.6 Roles of Institutional Biosafety Committee, RCGM, GEAC.</td></tr>
</table>

	UNIT IV (12 hours) (K1, K2, K3 & K4) **Bioethics.** 4.1 Introduction and need of Bioethics - its relationship with other branches. 4.2 Ethical implications of biotechnological products and techniques. 4.3 Ethical Issues involving human cloning. 4.4 Human genome project, prenatal diagnosis. 4.5 Agriculture and Animal rights. 4.6 Social and ethical implications of biological weapons.
	UNIT V (12 hours) (K1, K2, K3 & K4) **Intellectual Property Rights.** 5.1 IPR, Patents and Patent laws - Intellectual property rights-TRIP- GATT International conventions patents. 5.2 Methods of application of patents, Legal implications. 5.3 Biodiversity and farmer rights. 5.4 Objectives of the patent system, Basic principles and general requirements of patent law, Biotechnological inventions, and patent law. 5.5 Legal development-Patentable subjects and protection in biotechnology. 5.6 The patenting of living organisms.
Text Books	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. DeepaGoel and ShominiParashar, (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. I.K. International pvt, Ltd.
Reference Books	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. Charles Oluwaseun Adetunji, Abdulrazak B. Ibrahim, Benjamin Ewa Ubi (2022). Biosafety and Bioethics in Biotechnology-Policy, Advocacy, and Capacity Building,1st edition. CRC Press 5. Sree Krishna. V (2007). Bioethics and Biosafety in Biotechnology. New age international publishers.

Web resources	1. Subramanian, N., &Sundararaman, M. (2018). Intellectual Property Rights – An Overview. Retrieved from http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf. 2. World Intellectual Property Organisation. (2004). WIPO Intellectual property Handbook. Retrieved from https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub_489.pdf. 3. https://www.niehs.nih.gov/bioethics 4. https://www.sist.sathyabama.ac.in 5. https://www.longdom.org/bioethics-and-biosafety

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Understand the control measures of laboratory hazards (chemical, biological and physical) and to practice safety strategies and personal protective equipment.
CO2	Develop stratagems for the use of genetically modified organisms and Hazardous materials
CO3	Develop skills of critical ethical analysis of contemporary moral problems in medicine and health care.
CO4	Analyze and respond to the comments of other students regarding philosophical issues.
CO5	Pave the way to catch up Intellectual Property (IP) as a career option.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	M	M	M	H
CO2	H	H	M	L	L	H
CO3	H	M	L	H	M	H
CO4	H	M	L	H	M	H
CO5	H	H	M	M	H	H

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	L	H	H
CO2	H	H	H	M	L	H
CO3	H	H	H	L	M	H
CO4	H	M	H	L	M	H
CO5	H	H	H	L	H	H

(HIGH - 3, MODERATE - 2, LOW - 1)

<table>
<tr><td>Title of the Course</td><td colspan="7">ELECTIVE: PHARMACEUTICAL MICROBIOLOGY</td></tr>
<tr><td>Paper No.</td><td colspan="7">Elective -III</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Discipline specific Elective</td><td>Year</td><td>III</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">UEMBE24</td></tr>
<tr><td>Semester</td><td>VI</td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>5</td><td>-</td><td colspan="3">-</td><td colspan="2">5</td></tr>
<tr><td>Objectives of the course</td><td colspan="7">• To provide the knowledge on basics of chemotherapy.
• To learn the assays and testing methods of antibiotics.
• To gain information about spoilage of pharmaceutical products.
• To provide the knowledge on drug discovery and clinical trials.
• To learn about regulations in pharmaceutical industry.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (12 hours) (K1, K2, K3 & K4)
Introduction to Pharmaceutical microbiology:
1.1 Ecology of microorganisms in pharmaceutical industry: Atmosphere.
1.2 Ecology of microorganisms in pharmaceutical industry: Water.
1.3 skin and respiratory flora of workers.
1.4 Raw materials.
1.5 Packaging, building and equipments and their control measures.
1.6 Design and layout of sterile manufacturing.</td></tr>
<tr><td></td><td colspan="7">UNIT II (12 hours) (K1, K2, K3 & K4)
Microbial contamination and spoilage of pharmaceutical products.
2.1 Microbial aspects of pharmaceutical products.
2.2 Sterilization of pharmaceutical products: Heat, gaseous,
2.3 Sterilization of pharmaceutical products: radiation and filtration;
2.4 Contamination and Spoilage of Pharmaceutical products: sterile injectable and
2.5 Contamination and Spoilage of Pharmaceutical products: non-injectable,
2.6 Contamination and Spoilage of Pharmaceutical products: ophthalmologic preparation, implants.</td></tr>
<tr><td></td><td colspan="7">UNIT III (12 hours) (K1, K2, K3 & K4)
Production of antibiotics.
3.1 Production of antibacterial – Penicillin, Tetracycline.
3.2 Antifungal – Griseofulvin, Amphotericin.
3.3 Antiparasitic agents – Artemesin, Metronidazole.
3.4 Semi-synthetic antibiotics and anticancerous agents.
3.5 Additional application of microorganisms in pharmaceutical sciences: Enzymes-Streptokinase, Streptodornase and clinical dextrin;
3.6 Immobilization procedures for pharmaceutical applications (liposomes); Biosensors in pharmaceuticals.</td></tr>
</table>

	UNIT IV (12 hours) (K1, K2, K3 & K4) **Production of immunological products and their quality control.** 4.1 Vaccines - DNA vaccines. 4.2 Synthetic peptide vaccines, multivalent vaccines. 4.3 Vaccine clinical trials. 4.4 Immunodiagnostics - immuno sera and immunoglobulin. 4.5 Quality control in Pharmaceutical: In – Process and Final Product Control. 4.6 Sterility tests.
	UNIT V (12 hours) (K1, K2, K3 & K4) **Quality Assurance and Validation.** 5.1 Good Manufacturing Practices (GMP). 5.2 Good Laboratory Practices (GLP) in pharmaceutical industry. 5.3 Regulatory aspects of quality control. 5.4 Quality assurance and quality management in pharmaceuticals – An overview. 5.5 BIS (IS), ISI, ISO 5.6 WHO and US certification.
Text Books	1. Chand Pasha Kedernath. (2021). Text book of Pharmaceutical Microbiology. Ramnath Publisher. 2. Hugo WB and Russell AD. (2004). Pharmaceutical Microbiology 7th edition. Blackwell Scientific Publication, Oxford. 3. Franklin, D J. and Snow, GA. (2013). Biochemistry of antimicrobial action. Chapman & Hall. 4. Kuntal Das (2019). Pharmaceutical Microbiology, 2nd edition, Nirali Prakashan. 5. Priyatama Powar, Shital Nimbargi, VaijayantiSapre (2020). Pharmaceutical Microbiology, 1st edition, Technical publications.
Reference Books	1. Handa, S. S. and Kapoor, V. K. (2022). Pharamcognosy. 4th Edition. Vallabh Prakashan Publishers, New Delhi. 2. Kokate, C.K., Durohit, A.P. and Gokhale, S.R. (2002). Pharmacognosy. 12th edition 3. Nirali Prakasham Publishers, Pune. 4. Vyas, S. P. & Dixit, V. K. (2003). Pharmaceutical Biotechnology. CBS Publishers & Distributors, New Delhi. 5. Wallis, T.E. (2005). Text book of Pharmacognosy. 5th edition. CBS publishers and distributors, New Delhi. 6. Garrod, L.P., Lambert, H. P. And C'Grady, F. (1973). Antibiotics and Chemotherapy. Churchill Livingstone.
Web resources	1. https://www.pharmapproach.com/introduction-to-pharmaceutical-microbiology/ 2. https://www.iptsalipur.org/wp-content/ 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	Course Outcomes
On completion of this course, students will be able to;	
CO1	Learn the basics of chemotherapy and action of antibiotics.
CO2	Carry out the microbiological assay of antibiotics.
CO3	Analyse Microbiological standardization of Pharmaceuticals, sterility testing of pharmaceutical products and apply sterilization in pharmaceutical industry.
CO4	Evaluate the process and develop new strategies for rational drug design.
CO5	Learn the Regulatory guidelines in pharmaceuticals product.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	H	H	M	H
CO2	H	M	M	L	H	H
CO3	H	M	M	L	H	H
CO4	H	M	M	L	H	H
CO5	H	H	H	L	H	H

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	H	M	H
CO2	H	M	M	H	H	H
CO3	H	M	M	H	H	H
CO4	H	M	M	H	H	H
CO5	H	H	H	H	H	H

(HIGH - 3, MODERATE - 2, LOW - 1)

<table>
<tr><td>Title of the Course</td><td colspan="7">ELECTIVE: MICROBIAL NANOTECHNOLOGY</td></tr>
<tr><td>Paper No.</td><td colspan="7">Elective -III</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Discipline specific Elective</td><td>Year</td><td>III</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">UEMBF24</td></tr>
<tr><td>Semester</td><td>VI</td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>5</td><td>-</td><td colspan="3">-</td><td colspan="2">5</td></tr>
<tr><td>Objectives of the course</td><td colspan="7">• To outline evolution of nanoscience and hurdles in the development of nanotechnology.
• To understand the use spectroscopy for nanotechnology research.
• To discuss the role of microscopy in nanotechnology research.
• To utilize nano materials for drug development and its application in nuclear medicine.
• To apply nanotechnology for air and water treatment and become familiar with nanoscience education in India and abroad.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (12 hours) (K1, K2, K3 & K4)
History and evolution of Nano Science.
1.1 Definition – Evolution of Nano science.
1.2 Need of Nano technology.
1.3 Hurdles for Nanotechnology development.
1.4 Factors affecting the manufacturing process of nano materials.
1.5 Role of physicists, chemists, computer scientists, engineers in nanotechnology.
1.6 Role of Medical doctors, biologists in nano technology.</td></tr>
<tr><td></td><td colspan="7">UNIT II (12 hours) (K1, K2, K3 & K4)
Spectroscopy in nanotechnology research.
2.1 Spectroscopy- An overview.
2.2 Importance of spectroscopy in nano technology research.
2.3 Mass spectroscopy.
2.4 Infra-red spectroscopy.
2.5 Raman spectroscopy.
2.6 Ultra violet-visible spectroscopy.</td></tr>
<tr><td></td><td colspan="7">UNIT III (12 hours) (K1, K2, K3 & K4)
Microscopy in nanotechnology research.
3.1 Microscopy in nanotechnology research- An over view.
3.2 Atomic force microscope.
3.3 Scanning electron microscope.
3.4 Transmission electron microscope.
3.5 Magnetic resonance force microscopy.
3.6 Nano probes for nucleic and hybridization detection.</td></tr>
</table>

	UNIT IV (12 hours) (K1, K2, K3 & K4) **Nanotechnology for drug development and medical applications.** 4.1 Nanotechnology for drug development and medical applications. 4.2 Nanotechnology for drug solubilization and drug delivery. 4.3 Diagnosis using nanomaterials. 4.4 Nanotherapy for cancer treatment. 4.5 Nanotherapy for interior artery embolisms. 4.6 Radioactive tuberene cages in Nuclear medicine.
	UNIT V (12 hours) (K1, K2, K3 & K4) **Cleaning the air with nanotechnology.** 5.1 Cleaner environment with Nanotech. Cleaning the air with Nanotechnology. 5.2 Nanotechnology for water treatment. 5.3 Microbial nanoparticles used in cleaning air. 5.4 Nanocarbon ball as deodorizer in fermentation process. 5.5 Possible harm from Nanomaterials. 5.6 Nanoscience in India – Nanoscience education abroad – ethics and society.
Text Books	1. Brydson R. M., Hammond, C. (2005). Generic Methodologies for Nanotechnology: Characterization. In Nanoscale Science and Technology. John Wiley & Sons, Ltd. 2. Leggett G. J., Jones R. A. L. (2005). Bionanotechnology. In Nanoscale Science and Technology. John Wiley & Sons, Ltd. 3. Mohan Kumar G. (2016). Nanotechnology: Nanomaterials and nanodevices. Narosa Publishing House. 4. Goodsell D. S. (2004). Bionanotechnology. John Wiley & Sons, Inc. 5. Pradeep T. (2007). Nano: The Essentials-Understanding nanoscience and nanotechnology. Tata McGraw-Hill.
Reference Books	1. Nouailhat A. (2008). An Introduction to Nanoscience and Nanotechnology, Wiley & Sons. 2. Sharon M. and Maheshwar (2012). Bio-Nanotechnology: Concepts and Applications. New Delhi. Ane books Pvt Ltd. 3. Niemeyer C.M. and Mirkin C. A. (2005). Nanobiotechnology. Wiley Interscience. 4. Rehm, B. (2006). Microbial Bionanotechnology: Biological Self Assembly Systems and Biopolymer-Based Nanostructures. Horizon Scientific Press. 5. Reisner, D.E. (2009). Bionanotechnology: Global Prospects. CRC Press.
Web resources	1. https://www.gale.com/nanotechnology 2. https://www.understandingnano.com/resources.html 3. http://dbtnanobiotech.com/index2.php 4. http://www.istl.org/11-winter/internet1.html 5. https://www.cdc.gov/niosh/topics/nanotech/default.html

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Outline evolution of nanoscience and hurdles in the development of nanotechnology.
CO2	Understand the use spectroscopy for nanotechnology research.
CO3	Discuss the role of microscopy in nanotechnology research.
CO4	Utilize nano materials for drug development and its application in nuclear medicine.
CO5	Apply nanotechnology for air and water treatment and become familiar with nanoscience education in India and abroad.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	M	M	M	H
CO2	H	H	H	L	L	M
CO3	H	M	M	H	L	M
CO4	H	M	H	H	M	M
CO5	H	L	M	M	H	H

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	L	M	H
CO2	H	H	H	L	L	M
CO3	H	H	H	L	L	M
CO4	H	H	H	M	M	M
CO5	H	H	H	M	H	H

(HIGH - 3, MODERATE - 2, LOW - 1)

<table>
<tr><td>Title of the Course</td><td colspan="7">ELECTIVE: ENTREPRENEURSHIP AND BIO-BUSINESS</td></tr>
<tr><td>Paper No.</td><td colspan="7">Elective -IV</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Discipline specific Elective</td><td>Year</td><td>III</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">UEMBG24</td></tr>
<tr><td>Semester</td><td>VI</td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="2">Lab Practice</td><td colspan="3">Total</td></tr>
<tr><td>4</td><td>-</td><td colspan="2">-</td><td colspan="3">4</td></tr>
<tr><td>Objectives of the course</td><td colspan="7">• Understanding basic concepts in the area of entrepreneurship, the role and importance of entrepreneurship for economic development.
• Developing personal creativity and entrepreneurial initiative, adopting the key steps in the elaboration of business idea.
• Understanding the stages of the entrepreneurial process and the resources needed for the successful development of entrepreneurial ventures.
• Explain the central components of successful business strategies in biotechnology, and create a business plan.
• Understand the various funding resources and develop as Entrepreneur.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (12 hours) (K1, K2, K3 & K4)
Bio Entrepreneurship.
1.1 Introduction to bio-business.
1.2 SWOT analysis of bio-business.
1.3 Ownership, Development of Entrepreneurship.
1.4 Stages in entrepreneurial process.
1.5 Government schemes and funding.
1.6 Small scale industries: Definition; Characteristics; Need and rationale.</td></tr>
<tr><td></td><td colspan="7">UNIT II (12 hours) (K1, K2, K3 & K4)
Entrepreneurship Opportunity in Agricultural Biotechnology.
2.1 Business opportunity, Essential requirement, marketing, strategies, schemes, challenges and scope.
2.2 Case study on Plant cell and tissue culture technique, polyhouse culture.
2.3 Herbal bulk drug production, Nutraceuticals, value added herbal products.
2.4 Bioethanol production using Agricultural waste, Algal source.
2.5 Integration of system biology for agricultural applications.
2.6 Biosensor development in Agriculture management.</td></tr>
<tr><td></td><td colspan="7">UNIT III (12 hours) (K1, K2, K3 & K4)
Entrepreneurship Opportunity in Industrial Biotechnology.
3.1 Business opportunity, Essential requirement, marketing strategies, schemes, challenges and scope.
3.2 Pollution monitoring and Bioremediation for Industrial pollutants.
3.3 Integrated compost production- microbe enriched compost.
3.4 Bio pesticide/ insecticide production.
3.5 Biofertilizer.
3.6 Single cell protein.</td></tr>
</table>

	UNIT IV (12 hours) (K1, K2, K3 & K4) **Therapeutic and Fermented products.** 4.1 Stem cell production. 4.2 Stem cell bank. 4.3 Production of monoclonal/polyclonal antibodies. 4.4 Secondary metabolite production – antibiotics. 4.5 Probiotic. 4.6 Prebiotics.
	UNIT V (12 hours) (K1, K2, K3 & K4) **Project Management, Technology Management and Startup Schemes.** 5.1 Building Biotech business challenges in Indian context. 5.2 Biotech partners (BIRAC, DBT, Incubation centers. etc.,). 5.3 Operational biotech parks in India. 5.4 Indian Company act for Bio business-schemes and subsidies. 5.5 Project proposal preparation. 5.6 Successful start-ups-case study.
Text Books	1. Craig Shimasaki. (2014). Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies. Academic Press. 2. Ashton Acton, O. (2012). Biological Pigments – Advances in Research and Application Scholarly Editions: Atlanta, Georgia. 3. Jennifer Merritt, Jason Feifer (2018). Start Your Own Business, 7th edition, Entrepreneur Press publisher. 4. Peter F. Drucker (2006). Innovation and Entrepreneurship. Harper Business publisher. 5. Leah Cannon (2017). How to Start a Life Science Company: A Comprehensive Guide for First-Time Entrepreneurs. International Kindle paperwhite.
Reference Books	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 Asia World 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.
Web 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	Course Outcomes
On completion of this course, students will be able to;	
CO1	Describe and apply several entrepreneurial ideas and business theories in practical framework.
CO2	Analyse the business environment in order to identify business opportunities, identify the elements of success of entrepreneurial ventures, evaluate the effectiveness of different entrepreneurial strategies and interpret their own business plan.
CO3	Express the mass production of microbial inoculants used as Biofertilizers and Bioinsecticides in response with field application and crop response.
CO4	Analyze the application and commercial production of Monoclonal antibodies, Cytokines. TPH and teaching kits.
CO5	Integrate and apply knowledge of the regulation of biotechnology industries, utilize effective team work skills within an effective management team with a common objective, and gain effective team work skills, with an awareness of cultural diversity and social inclusiveness.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	M	M	M	H
CO2	H	H	M	L	L	H
CO3	H	M	L	H	M	H
CO4	H	M	L	H	M	H
CO5	H	H	M	M	H	H

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	L	H	H
CO2	H	H	H	M	L	H
CO3	H	H	H	L	M	H
CO4	H	M	H	L	M	H
CO5	H	H	H	L	H	H

(HIGH - 3, MODERATE - 2, LOW - 1)

<table>
<tr><td>Title of the Course</td><td colspan="7">ELECTIVE: ADVANCED MICROBIOLOGY</td></tr>
<tr><td>Paper No.</td><td colspan="7">Elective -IV</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Discipline specific Elective</td><td>Year</td><td>III</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">UEMBH24</td></tr>
<tr><td>Semester</td><td>VI</td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="2">Lab Practice</td><td colspan="3">Total</td></tr>
<tr><td>4</td><td>-</td><td colspan="2">-</td><td colspan="3">4</td></tr>
<tr><td>Objectives of the course</td><td colspan="7">• To provide knowledge on utilizing microorganisms in the preparation of cosmetics.
• To facilitate evaluating the biological potential in samples return from satellites and solar system.
• To discuss the role of antimicrobial fabrics, carpets, tiles, colorants and produce bacteriostatic sanitary napkins and towels.
• To comprehend on paper, rubber and plastic Microbiology.
• To analyze the methods for producing its antimicrobial products.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (12 hours) (K1, K2, K3 & K4)
Cosmetic Microbiology.
1.1 Definition; Preparations of Skin whitening compositions from microbes like Ascomycetes and Black yeast.
1.2 Preparations of Skin whitening compositions- enzymes.
1.3 Preparations of Skin whitening compositions- Mineral yeast ferments.
1.4 Microbial Production of Alpha Arbutin.
1.5 Microbial production of Hyaluronic acid.
1.6 Kojic acid and their use in Cosmetics preparations.</td></tr>
<tr><td></td><td colspan="7">UNIT II (12 hours) (K1, K2, K3 & K4)
Space Microbiology.
2.1 Introduction to Space Microbiology.
2.2 Monitoring of astronauts microbial flora.
2.3 Alterations in the load of medically important microorganisms.
2.4 ESA STONE experiment.
2.5 Evaluating the Biological Potential in Samples Returned from Planetary Satellites.
2.6 Evaluating the Biological Potential of Small Solar System Bodies.</td></tr>
<tr><td></td><td colspan="7">UNIT III (12 hours) (K1, K2, K3 & K4)
Textile Microbiology.
3.1 Introduction to Textile Microbiology.
3.2 Antimicrobial fabrics.
3.3 Antimicrobial garments.
3.4 Antimicrobial carpets.
3.5 Antimicrobial colorants.
3.6 Bacteriostatic sanitary napkins and towels.</td></tr>
</table>

	UNIT IV (12 hours) (K1, K2, K3 & K4) **Paper and Rubber Microbiology.** 4.1 Paper Microbiology- Introduction & Definition. 4.2 Antimicrobial papers and its production. 4.3 Antimicrobial currency. 4.4 Rubber Microbiology – Introduction & Definition. 4.5 Note on Antimicrobial rubbers. 4.6 Antimicrobial rubber compositions.
	UNIT V (12 hours) (K1, K2, K3 & K4) **Plastic Microbiology**. 5.1 Definition- Bacteriostatic plastics. 5.2 Antimicrobial plastic composition and production. 5.3 Antiseptic plastics. Fungistatic plastics: Definition and production. 5.4 Production of plastics materials from microorganisms. 5.5 Methods for producing anti-microbial plastic product. 5.6 Plastic article containing a metallic bactericidal agent. Casein plastic**.**
Text Books	1. Vimaladevi M (2015) Text book of Herbal Cosmetics.1st edition, CBS Publishers and Distributors, New Delhi. 2. Alfonso F Davila (2010). Astromicrobiology.1st edition, John Wiley & Sons, Inc. New Delhi. 3. Srikanth Pilla (2011). Handbook of Bioplastics and Biocomposites Engineering and Applications.1st edition, John Wiley and Sons Inc., New Delhi. 4. Nierstrasz V and Cavaco Paulo A (2010). Advances in Textile Biotechnology. 1st edition, Elsevier, London. 5. Chen, George Guo- Qiang (2010). Plastics from Bacteria: Natural Functions and Applications. 1st edition, Springers, United States.
Reference Books	1. Philip A. Geis (2006) Cosmetic Microbiology: A Practical Approach. 2nd edition, CRC Press, Taylor and Francis Group, New York, London. 2. David M. Klaus (2003). Space Microbiology: Microgravity and Microorganisms. 1st edition, John Wiley & Sons, Inc. New Delhi 3. Ashish Kumar Sen (2007). Coated Textiles: Principles and Applications. 2nd edition, CRC Press, New Delhi 4. Tappi (2007). Monograph on Microbiology of Papermaking systems. Tappi publishers, New York. 5. Roberts A.D (1988). Natural Rubber Science and Technology. 1st edition, Oxford University Press.UK.
Web resources	1. http://www.loc.gov/ 2. http://library.clark.edu/ 3. http://www.dli.ernet.in/ 4. http://www.loc.gov/education/ 5. https://www.springer.com

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Utilize microorganisms in the preparation of cosmetics**.**
CO2	Evaluate the biological potential in samples return from satellites and solar system.
CO3	Discuss the role of antimicrobial fabrics, carpets, tiles, colourants and produce bacteriostatic sanitary napkins and towels.
CO4	Comprehend on paper, rubber and plastic Microbiology.
CO5	Analyze the methods for producing its antimicrobial products.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	M	M	M	H
CO2	H	H	M	L	L	M
CO3	H	M	L	H	M	H
CO4	H	M	L	H	M	H
CO5	H	H	M	M	H	H

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	L	H	H
CO2	H	H	H	M	L	L
CO3	H	H	H	L	M	H
CO4	H	M	H	L	M	H
CO5	H	H	H	L	H	H

(HIGH - 3, MODERATE - 2, LOW - 1)

<table>
<tr><td>Title of the Course</td><td colspan="7">MICROBIAL QUALITY CONTROL AND TESTING</td></tr>
<tr><td>Paper No.</td><td colspan="7">SEC VIII</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Professional Competency Skill</td><td>Year</td><td>III</td><td>Credits</td><td>2</td><td>Course Code</td><td>UPMB24</td></tr>
<tr><td>Semester</td><td>VI</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>2</td><td>-</td><td colspan="3">-</td><td colspan="2">2</td></tr>
<tr><td>Objectives of the course</td><td colspan="7">• To understand the use of various advanced techniques for application in the field of quality control and quality assurance.
• To cultivate skills involved execution of microbiological techniques and to develop the good laboratory practices.
• To ensure the food safety regulations and its standards.
• To acquire knowledge on laboratory testing, Control & safety process.
• To analyze microbial standards to establish the quality of food products.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (6 hours) (K1, K2, K3 & K4)
Microbial Quality Control.
Microbial quality control: definition, history and introduction. Standard Methods involved in assessment of microbial quality control. Q. A and Q.C definitions and importance. Traditional Microbiological Quality Controlling methods: Sampling methods, TVC, APC and serial dilution techniques. Good laboratory practices, Good microbiological practices.</td></tr>
<tr><td></td><td colspan="7">UNIT II (6 hours) (K1, K2, K3 & K4)
Instruments associated in QC & QA.
Principle involved, working conditions, uses and precautions of Laminar Air Flow (LAF). Autoclave, Incubator, pH meter. Colony counter, Hot air oven, Centrifuges. Colorimeter/ spectrophotometer. ELISA and storage devices. Methodology of Disinfection, Autoclaving & Incineration.</td></tr>
<tr><td></td><td colspan="7">UNIT III (6 hours) (K1, K2, K3 & K4)
Culture media used in QC and QA.
Design of specialized media for identification of pathogens. Good laboratory practices in culture media preparation: raw material, water, pH. Uses of media. Enrichment culture technique. Detection of specific microorganisms - on XLD agar, Salmonella Shigella Agar, Mannitol salt agar, EMB agar, MacConkey Agar, Sabouraud Dextrose Agar.</td></tr>
</table>

	UNIT IV (6 hours) (K1, K2, K3 & K4) **Determining Microbes in Pharmaceutical Samples:** Sterility testing for pharmaceutical products, Bioburden, pyrogen test- in process and final process control, Safety and sterility test.
	UNIT V (6 hours) (K1, K2, K3 & K4) **HACCP for Food Safety and Microbial Standards.** Hazard analysis of critical control point (HACCP) - Principles, flow diagrams, limitations. Microbial Standards for Different Foods and Water – BIS standards for common foods and drinking water. Ascertaining microbial quality of milk by MBRT, Rapid detection methods of microbiological quality of milk at milk collection centers.
Text Books	1. Hugo, W. B. & Russell, A. D. (1998). Pharmaceutical Microbiology. 6th Edition. Blackwell scientific Publications. 2. Kulkarni A. K. Bewoor V. A. (2018). Quality Control, Wiley India Pvt. Ltd. 3. Chandrakant Kokare (2016). Pharmaceutical Microbiology, 1st Edition, Nirali Publication. 4. Brown, M. R. W. (2017). Microbiological Quality Assurance: A Guide Towards Relevance and Reproducibility of Inocula,1st Edition. CRC press. 5. Dev Raj Rakesh Sharma and Joshi, V. K. (2011). Quality Control for Value Addition in Food Processing, New India Publishing Agency.
Reference Books	1. Rosamund M. Baird, Norman A. Hodges, Stephen P. Denyer. (2000). Handbook of Microbiological Quality Control in Pharmaceuticals and Medical Devices. 1st Edition, CRC Press. 2. Konieczka, (2012). Quality Assurance and Quality Control in the Analytical Chemical Laboratory A Practical Approach (Hb), Routledge, Taylor and Francis group. 3. Singh Gajjar, Budhrani, Usman. (2021). Quality Control And Quality Assurance (M.Pharm) S Vikas And Company. 4. David Roesti, Marcel Goverde (2019). Pharmaceutical Microbiological Quality Assurance and Control: Practical Guide for Non-Sterile Manufacturing, Wiley publication. 5. Amihud Kramer Bernard A. Twigg (2017). Quality Control for the Food Industry- Fundamentals & Applications (Vol.1) 3rd Edition, MEDTEC publication.
Web resources	1. https://www.study.com/microbiology-quality-control-testing-definition-procedures. 2. https://www.sigmaaldrich.com 3. https://www.coursera.org 4. https://www.atcc.org 5. https://www.fao.org

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Understand the theoretical assessment of microbial quality methods and its good laboratory practices.
CO2	Describe the microbiological aspects of quality control of food and pharmaceutical products.
CO3	Explain the identification of pathogenic microorganisms and good laboratory practices.
CO4	Acquire the knowledge of different sterility test for the pharmaceutical products.
CO5	Illustrate the safety concern management and regulations of food and pharmaceutical industry and learn the basic standard methods and procedures for the microbiological analysis of food.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	M	M	M	H
CO2	H	H	H	L	L	M
CO3	H	M	M	H	L	M
CO4	H	M	H	H	M	M
CO5	H	L	M	M	H	H

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	L	M	H
CO2	H	H	H	L	L	M
CO3	H	H	H	L	L	M
CO4	H	H	H	M	M	M
CO5	H	H	H	M	H	H

(HIGH - 3, MODERATE - 2, LOW - 1)

<table>
<tr><td>Title of the Course</td><td colspan="7">GENERIC ELECTIVE III: MICROBIOLOGY-I</td></tr>
<tr><td>Paper No.</td><td colspan="7">Generic Elective III</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Allied (II B.Sc. Biochemistry)</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2">UGEMBA24</td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="2">Lab Practice</td><td colspan="3">Total</td></tr>
<tr><td>4</td><td>-</td><td colspan="2">-</td><td colspan="3">4</td></tr>
<tr><td>Objectives of the course</td><td colspan="7">• To provide in-depth understanding on the history, recent developments and microscopy.
• To Utilize techniques of sterilization, pure culture and staining.
• To Outline classification and anatomy of bacteria.
• To Compare the structural characteristics of algae, fungi and protozoa.
• To Demonstrate measurement of microbial growth and explain classification of antibiotics with its mode of action.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (12 hours) (K1, K2, K3 & K4)
History of Microbiology and Microscopy.
1.1 Definition and scope of Microbiology-History and recent Developments, Spontaneous generation and Biogenesis.
1.2 Contribution of Louis Pasteur, Antony Van Leuwenhoek, Joseph Lister, Robert Koch.
1.3 Edward Jenner, Emil Christian Hansen, Hans Christian Gram, Alexander Fleming.
1.4 Microscopy – Bright field Microscopy, Dark field Microscopy.
1.5 Phase contrast Microscope and Fluorescence Microscope.
1.6 Electron Microscopy – TEM & SEM.</td></tr>
<tr><td></td><td colspan="7">UNIT II (12 hours) (K1, K2, K3 & K4)
Basic techniques in Microbiology.
2.1 Sterilization of glass wares.
2.2 Culture media and its types.
2.3 Preparation of basal media.
2.4 Pure culture techniques – spread plate, pour plate and streak plate techniques.
2.5 Serial dilution and Standard plate count methods.
2.6 Staining techniques – simple and differential (Gram’s staining and Acid fast staining).</td></tr>
<tr><td></td><td colspan="7">UNIT III (12 hours) (K1, K2, K3 & K4)
Binomial nomenclature and Anatomy of bacteria.
3.1 Brief outline on bacterial classification- Binomial Nomenclature of Microbes.
3.2 Morphology of bacteria - size, shape and arrangement of bacteria.
3.3 Anatomy of Bacteria – Cell wall (Gram positive and Gram negative).
3.4 Cytoplasmic membrane.
3.5 Flagella –structure and arrangement, capsule, pili.
3.6 Spore and sporulation.</td></tr>
</table>

	UNIT IV (12 hours) (K1, K2, K3 & K4) **Structural characteristics of algae, fungi and protozoa.** 4.1 Structural characteristics of Microalgae- An overview. 4.2 Oscillatoria, Volvox, Chlorella. 4.3 Structural characteristics of fungi – An overview. 4.4 Yeast- Saccharomyces and its reproduction. 4.5 Molds - Aspergillus, Penicillium, Rhizopus, Mucor. 4.6 Protozoa (Entamoeba and Plasmodium).
	UNIT V (12 hours) (K1, K2, K3 & K4) **Growth of Microorganism and their control.** 5.1 Measurement of microbial growth (turbidity, biomass,cell count). 5.2 Growth curve. 5.3 Preservation of culture (Lyophilization, Liquid N2). 5.4 Antibiotics – Definition, classification and mode of action. 5.5 Antibiotics inhibiting cell wall and cell membrane synthesis. 5.6 Antibiotics inhibiting nucleic acid and protein synthesis.
Text Books	1. Pelczar. M. J., Chan E.C.S. and Noel. R.K. (2007). Microbiology. 7thEdition., Mc Graw –Hill, New York. 2. Willey J., Sherwood L., and Woolverton C. J., (2017). Prescott's Microbiology. 10th Edition., McGraw-Hill International. 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. 7thEdition., McGraw Hill Inc. New York. 5. Boyd, R.F. (1998). General Microbiology,2nd Edition., Times Mirror, Mosby College Publishing, St Louis.
Reference Books	1. Jeffrey C. Pommerville. (2010). Alcamo's Fundamentals of Microbiology 9th Edition. Jones &Bartlett learning publishers. 2. Stanier R.Y, Ingraham J. L., Wheelis M. L., and Painter R. R. (2010). General Microbiology, 5thEdition., MacMillan Press Ltd 3. Tortora, G.J., Funke, B.R. and, Case, C.L (2011). Microbiology -An Introduction, 10th Edition., Benjamin Cummings. 4. Nester E., Anderson D., Roberts C. E., and Nester M. (2006). Microbiology-A Human Perspective, 5thEdition., 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.
Web resources	1. www.gutenberg.org 2. www.free-ebooks.net 3. www.e-booksdirectory.com 4. www.webcast.berkeley.edu 5. www.cosmolearning.org

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Discuss history, recent developments and microscopy.
CO2	Utilize techniques of sterilization, pure culture and staining.
CO3	Outline classification and anatomy of bacteria.
CO4	Compare structural characteristics of algae, fungi and protozoa.
CO5	Demonstrate measurement of microbial growth and explain classification of antibiotics with its mode of action.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	M	H	L	L	M
CO2	H	H	H	L	L	M
CO3	H	L	H	H	L	M
CO4	H	L	M	H	M	M
CO5	H	M	M	M	L	H

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	H	L	L	M
CO2	H	H	H	L	L	M
CO3	H	L	H	H	L	M
CO4	H	L	M	H	M	M
CO5	H	M	M	M	L	H

(HIGH - 3, MODERATE - 2, LOW - 1)

<table>
<tr><td>Title of the Course</td><td colspan="7">GENERIC ELECTIVE IV: MICROBIOLOGY-II</td></tr>
<tr><td>Paper No.</td><td colspan="7">Generic Elective IV</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Allied (II B.Sc. Biochemistry)</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2">UGEMBB24</td></tr>
<tr><td>Semester</td><td>IV</td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="2">Lab Practice</td><td colspan="3">Total</td></tr>
<tr><td>4</td><td>-</td><td colspan="2">-</td><td colspan="3">4</td></tr>
<tr><td>Objectives of the course</td><td colspan="7">To discuss on the role of microorganisms in soil and biogeochemical cycles.
To disseminate knowledge on the potability of water, purification of municipal water supplies and sewage treatment process
For Communicating sources of airborne pathogens and the diseases caused.
To elaborate on Food borne diseases and outline on the contamination, spoilage and preservation of food.
For Compiling on different types of fermentation and fermented microbial product.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (12 hours) (K1, K2, K3 & K4)
Microbiology of soil and Biogeo chemical cycle.

1.1 Microbiology of soil - Microbes in soil.
1.2 Rhizosphere, rhizoplane and phylloplane.
1.3 Nitrogen fixation (symbiotic and non-symbiotic) - nitrifying and denitrifying bacteria.
1.4 Biogeo chemical cycle – Carbon cycle, Nitrogen cycle.
1.5 Sulphur cycle and phosphorus cycle.
1.6 Phosphate solubilizers and sulphur bacteria -Bacterial Biofertilizers.</td></tr>
<tr><td></td><td colspan="7">UNIT II (12 hours) (K1, K2, K3 & K4)

Microbiology of water.
2.1 Microbiology of water – types of water – potable water.
2.2 Municipal water purification.
2.3 Sewage treatment process – An overview.
2.4 Primary, Secondary and tertiary treatment process.
2.5 Sewage disinfection and disposal.
2.6 Water borne diseases.</td></tr>
<tr><td></td><td colspan="7">UNIT III (12 hours) (K1, K2, K3 & K4)

Aero Microbiology.
3.1 Microbiology of air- An overview.
3.2 Indoor and outdoor microflora.
3.3 Distribution and source of airborne organisms – Droplet, Droplet nuclei and Infectious dust.
3.4 Assessment of air quality.
3.5 Air sanitation.
3.6 Airborne diseases.</td></tr>
</table>

	UNIT IV (12 hours) (K1, K2, K3 & K4) **Food Microbiology.** 4.1 Food Microbiology – An introduction. 4.2 Food preservation techniques- asepsis, high temperature and low temperature. 4.3 Food preservation techniques – drying, radiation and food additives. 4.4 Microbial spoilage of food - vegetables and fruits, cereal and cereal products. 4.5 Microbial spoilage of food – meat and meat products, milk and milk products. 4.6 Food borne diseases.
	UNIT V (12 hours) (K1, K2, K3 & K4) **Fermentation and Industrial production.** 5.1 Fermentation- types of fermentation. 5.2 Bioreactor - structure and types. 5.3 Industrial production – Antibiotic (Penicillin). 5.4 Industrial production - alcohol (Ethanol). 5.5 Industrial production - organic acid (acetic acid). 5.6 Industrial production - Vitamin (B12).
Text Books	1. Joseph C. Daniel. (2006). Environmental aspects of Microbiology 2nd Edition. Bright Sun Publications. 2. Vijaya Ramesh. K. (2004). Environmental Microbiology. 1st Edition. MJP Publishers. 3. SubbaRao N.S. (2017). Soil Microbiology.4th Edition. Oxford and IBH Publishing Pvt. Ltd. 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 1stedition. New Age Publishers by New Age International (P) Ltd., Publishers.
Reference Books	1. Dirk, J. Elasas, V., Trevors, J.T., Wellington, E.M.H. (1997). Modern Soil Microbiology, Marcel Dekker INC, New York, Hong Kong. 2. Mitchel, R. (1992). Environmental Microbiology. Wiley –John Wiley and Sons. Inc. Publications, New York. 3. Atlas, R.M. and Bartha, R. (1992). Microbial Ecology: Fundamentals and Applications, 2nd Edition. The Benjamin / Cummings Publishing Co., Redwood City, CA. 4. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th Edition. CBS Publishers and Distributors, Delhi, India. 5. R.C. Dubey. (2014). Advanced Biotechnology. S. Chand publishers.
Web resources	1. www.gutenberg.org 2. www.free-ebooks.net 3. www.e-booksdirectory.com 4. www.webcast.berkeley.edu 5. www.cosmolearning.org

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Discuss the role of microorganisms in soil and biogeochemical cycles.
CO2	Disseminate knowledge on the potability of water, purification of municipal water supplies and sewage treatment process
CO3	Communicate sources of airborne pathogens and the diseases caused.
CO4	Explain Food borne diseases and outline on the contamination, spoilage and preservation of food.
CO5	Compile on different types of fermentation and fermented microbial product.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	M	H	H	L	M
CO2	H	H	H	M	L	M
CO3	H	H	H	L	L	M
CO4	H	H	H	L	L	M
CO5	H	H	H	L	L	H

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	H	H	L	M
CO2	H	H	H	M	L	M
CO3	H	H	H	L	L	M
CO4	H	H	H	L	L	M
CO5	H	H	H	L	L	H

(HIGH - 3, MODERATE - 2, LOW - 1)

<table>
<tr><td>Title of the Course</td><td colspan="7">GENERIC ELECTIVE PRACTICAL: MICROBIOLOGY</td></tr>
<tr><td>Paper No.</td><td colspan="7">Generic Elective</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Allied Practical</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">2</td><td rowspan="2">Course Code</td><td rowspan="2">UGEMBC24</td></tr>
<tr><td>Semester</td><td>III & IV</td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>-</td><td>-</td><td colspan="3">2 (III & IV SEM)</td><td colspan="2">2</td></tr>
<tr><td>Objectives of the course</td><td colspan="7">• To Perform cleaning & sterilization of glasswares.
• To analyse the concept of simple and differential staining method and prepare basal media for the cultivation of bacteria.
• To assess and enumerate microorganisms present in different environment.
• To examine the quality of milk sample.
• To demonstrate the morphology of algae and fungi.</td></tr>
<tr><td>Course Outline (Experiments)</td><td colspan="7">1. Cleaning of glasswares.
2. Sterilization of Glassware and culture media.
3. Microscopy- Bright field compound Microscope.
4. Preparation of bacterial smear and simple staining.
5. Grams staining Technique.
6. Hanging drop method for testing motility of bacteria.
7. Preparation of culture media – Nutrient agar, Nutrient broth, Agar slant.
8. Enumeration of microorganism in air by open plate count method.
9. Enumeration of bacteria from soil and water samples by standard plant count method.
10. Assessment of quality of milk by MBRT test.
11. Morphology of Fungi- Lacto phenol cotton blue wet mount preparation.
12. Observation of pond water for the presence of microorganism.</td></tr>
<tr><td>Text Books</td><td colspan="7">1. James G Cappucino and N. Sherman M B (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) Sundarraraj publications.
4. Gunasekaran, P. (1996). Laboratory manual in Microbiology. New Age International Ltd., Publishers, New Delhi.
5. R C Dubey and D K Maheswari (2002). Practical Microbiology. S. Chand Publishers.</td></tr>
<tr><td>Reference Books</td><td colspan="7">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.</td></tr>
</table>

	4. Wheelis M, (2010). Principles of Modern Microbiology, 1st Edition. Jones and Bartlett Publication. 5. Lim D. (1998). Microbiology, 2ndEdition, WCB McGraw Hill Publications.
Web resources	1. http://www.biologydiscussion.com/micro-biology/sterilisation-and-disinfection methods-and-principles-microbiology/24403. 2. https://www.ebooks.cambridge.org/ebook.jsf?bid=CBO9781139170635 3. https://www.grsmu.by/files/file/university/cafedry//files/essential_microbiology.pdf 4. https://microbiologyinfo.com/top-and-best-microbiology-books/ 5. https://www.cliffsnotes.com/studyguides/biology/microbiology/introduction-to-microbiology/a-brief-history-of-microbiology

CO	**Course Outcomes**
On completion of this course, students will be able to;	
CO1	Perform cleaning & sterilization of glasswares.
CO2	Analyse the concept of simple and differential staining method and Prepare basal media for the cultivation of bacteria.
CO3	Assess and enumerate microorganisms present in different environment.
CO4	Examine the quality of milk sample.
CO5	Demonstrate the morphology of algae and fungi.

CO/PSO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	H	L	H	L	L	M
CO2	H	H	H	L	L	M
CO3	H	H	H	H	L	M
CO4	H	M	H	L	L	M
CO5	H	L	H	H	L	M

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	L	H	L	L	M
CO2	H	H	H	L	L	M
CO3	H	H	H	H	L	M
CO4	H	M	H	L	L	M
CO5	H	L	H	H	L	M

(HIGH - 3, MODERATE - 2, LOW - 1)