ANNAMALAI UNIVERSITY

(Affiliated Colleges)

212 – B. Sc. Microbiology

Programme Structure and Scheme of Examination (under CBCS)

(Applicable to the candidates admitted from the academic year 2023 -2024 onwards)

Part	Course Code	Study Components & Course Title	Credit	Hours/ Week	Maximum Marks		
					CIA	ESE	Total
		SEMESTER – I					
I	23UTAML11/ 23UHINL11/ 23UFREL11	Language– I: nghJ jkpo; - I: தமிழிலக்கிய வரலாறு-1/ Hindi-I/ French-I	3	6	25	75	100
II	23UENGL12	General English – I	3	6	25	75	100
III	23UMICC13	Core – I: Fundamentals of Microbiology and Microbial Diversity	5	5	25	75	100
	23UMICP14	Core – II: Practical – I: Fundamentals of Microbiology and Microbial Diversity	5	5	25	75	100
	23UBCBE15	Elective – I Basic and Clinical Biochemistry	3	4	25	75	100
IV	23UTAMB16 23UTAMA16	Skill Enhancement Course – I* NME-I/ Basic Tamil – I / Advanced Tamil – I	2	2	25	75	100
	23UMICF17	Foundation Course: Basics of Microbiology	2	2	25	75	100
		Total	**23**	**30**			**700**
		SEMESTER – II					
I	23UTAML21 23UHINL21/ 23UFREL21	Language– II: nghJ jkpo; - II: தமிழிலக்கிய வரலாறு-2/ Hindi-II French-II	3	6	25	75	100
II	23UENCL22	General English – II	3	6	25	75	100
III	23UMICC23	Core – III: Microbial Physiology and Metabolism	5	5	25	75	100
	23UMICP24	Core – IV: Practical – II: Microbial Physiology and Metabolism Practical	5	5	25	75	100
	23UBINE25	Elective – II Bioinstrumentation	3	4	25	75	100
IV	23UTAMB26 23UTAMA26	Skill Enhancement Course – II* NME-II / Basic Tamil – II / Advanced Tamil - II	2	2	25	75	100
	23USECG27	Skill Enhancement Course – III Internet and its Applications (Common Paper)	2	2	25	75	100
	23UNMSD01	Language Proficiency for employability: Overview of English Communication**	2	-	25	75	100
		Total	**25**	**30**			**800**

Part	Course Code	Study Components & Course Title	Credit	Hours/ Week	Maximum Marks		
					CIA	ESE	Total
		SEMESTER – III					
I	23UTAML31/ 23UHINL31/ 23UFREL31	Language– III: பொது தமிழ் -III: தமிழக வரலாறும், பண்பாடும்/ Hindi-III/ French-III	3	6	25	75	100
II	23UENGL32	General English – III	3	6	25	75	100
III	23UMICC33	Core – V: Molecular Biology and Microbial Genetics	5	5	25	75	100
	23UMICP34	Core – VI: Practical – III: Molecular Biology and Microbial Genetics	5	5	25	75	100
	23UMICE35	Elective – III: Clinical Laboratory Technology	3	4	25	75	100
IV	23UMICS36	Skill Enhancement Course – IV: Organic Farming & Biofertilizer Technology	1	1	25	75	100
	23UMICS37	Skill Enhancement Course – V: Aquaculture	2	2	25	75	100
		Environmental Studies	-	1			
		Total	**22**	**30**			**700**
		SEMESTER – IV					
I	23UTAML41 23UHINL41/ 23UFREL41	Language– IV: பொது தமிழ் -IV: தமிழும் அறிவியலும்/ Hindi-IV French-IV	3	6	25	75	100
II	23UENGL42	General English – IV	3	6	25	75	100
III	23UMICC43	Core – VII: Immunology and Immunotechnology	5	5	25	75	100
	23UMICP44	Core – VIII: Practical – IV: Immunology and Immunotechnology	5	5	25	75	100
	23UMICE45	Elective – IV: Food Processing Technology	3	3	25	75	100
IV	23UMICS46	Skill Enhancement Course – VI Vaccine Technology	2	2	25	75	100
	23UMICS47	Skill Enhancement Course – VII Apiculture	2	2	25	75	100
	23UEVSG48	Environmental Studies	2	1	25	75	100
		Total	**25**	**30**			**800**

		SEMESTER – V					
III	23UMICC51	Core IX : Bacteriology and Mycology	4	5	25	75	100
	23UMICC52	Core X : Virology and Parasitology	4	5	25	75	100
	23UMICP53	Core XI : Practicals –V: Covering Core – IX & ,X	4	5	25	75	100
	23UMICD54	Core XII: Project with Viva-Voce	4	5	25	75	100
	23UMICE55	Elective V : Recombinant DNA Technology	3	4	25	75	100
	23UMICE56	Elective VI: Biosafety & Bioethics	3	4	25	75	100
IV	23 UVALG57	Value Education	2	2	25	75	100
	23UMICI58	Summer Internship^{++}	2	-	25	75	100
		Total	**26**	**30**			**800**
		SEMESTER –VI					
III	23UMICC61	Core XIII : Environmental and Agricultural Microbiology	4	6	25	75	100
	23UMICC62	Core XIV : Food, Dairy and Probiotic Microbiology	4	6	25	75	100
	23UMICP63	Core XV : Practical – VI : Covering Core – XIII & XIV	4	6	25	75	100
	23UMICE64	Elective – VII : Pharmaceutical Microbiology	3	5	25	75	100
	23UMICE65	Elective VIII : Entrepreneurship and Bio-Business	3	5	25	75	100
IV	23UMICF66	Professional Competency Skill : Microbial Quality Control and Testing	2	2	25	75	100
V	23UMICX67	Extension Activity	1	-	100	-	100
		Total	**21**	**30**			700
		Grand Total	**142**				**4500**

	NME offered to other Departments						
IV	23 UMICN16	Social and Preventive medicine	**2**	**2**	**25**	**75**	**100**
IV	23UMICN26	Nutrition & Health Hygiene	**2**	**2**	**25**	**75**	**100**

* PART-IV: NME / Basic Tamil / Advanced Tamil (Any one)

Students who have not studied Tamil upto 12th Standard and have taken any Language other than Tamil in Part-I, must choose Basic Tamil-I in First Semester & Basic Tamil-II in Second Semester.

Students who have studied Tamil upto 10th & 12th Standard and have taken any Language other than Tamil in Part-I, must choose Advanced Tamil-I in First Semester and Advanced Tamil-II in Second Semester.

** The course "23UNMSD01: Overview of English Communication" is to be taught by the experts from Naan Mudhalvan Scheme team. However, the faculty members of Department of English should coordinate with the Naan Mudhalvan Scheme team for smooth conduct of this course.

$^{++}$Students should complete two weeks of internship before the commencement of V semester.

Choice Based Credit System (CBCS), Learning Outcomes Based Curriculum Framework (LOCF) Guideline Based Credit and Hours Distribution System

for all UG courses including Lab Hours

First Year – Semester-I

Part	List of Courses	Credit	No. of Hours
Part I	Language – Tamil	3	6
Part II	English	3	6
Part III	Core Theory, Practical & Elective Courses	13	14
Part IV	Skill Enhancement Course SEC-1 (NME-I)	2	2
	Foundation Course	2	2
		23	**30**

Semester-II

Part	List of Courses	Credit	No. of Hours
Part I	Language – Tamil	3	6
Part II	English	3	6
Part III	Core Theory, Practical & Elective Courses	13	14
Part IV	Skill Enhancement Course -SEC-2 (NME-II)	2	2
	Skill Enhancement Course -SEC-3 (Discipline / Subject Specific)	2	2
		23	**30**

Second Year – Semester-III

Part	List of Courses	Credit	No. of Hours
Part I	Language - Tamil	3	6
Part II	English	3	6
Part III	Core Theory, Practical & Elective Courses	13	14
Part IV	Skill Enhancement Course -SEC-4 (Entrepreneurial Based)	1	1
	Skill Enhancement Course -SEC-5 (Discipline / Subject Specific)	2	2
	E.V.S	-	1
		22	**30**

Semester-IV

Part	List of Courses	Credit	No. of Hours
Part I	Language - Tamil	3	6
Part II	English	3	6
Part III	Core Theory, Practical & Elective Courses	13	13
Part IV	Skill Enhancement Course -SEC-6 (Discipline / Subject Specific)	2	2
	Skill Enhancement Course -SEC-7 (Discipline / Subject Specific)	2	2
	E.V.S	2	1
		25	**30**

Third Year

Semester-V

Part	List of Courses	Credit	No. of Hours
Part III	Core Theory, Practical, Project & Elective Courses	22	28
Part IV	Value Education	2	2
	Internship / Industrial Visit / Field Visit	2	-
		26	**30**

Semester-VI

Part	List of Courses	Credit	No. of Hours
Part III	Core Theory, Practical & Elective Courses	18	28
Part IV	Professional Competency Skill	2	2
Part V	Extension Activity	1	-
		21	**30**

Consolidated Semester wise and Component wise Credit distribution

Parts	Sem I	Sem II	Sem III	Sem IV	Sem V	Sem VI	Total Credits
Part I	3	3	3	3	-	-	12
Part II	3	3	3	3	-	-	12
Part III	13	13	13	13	22	18	92
Part IV	4	4	3	6	4	2	23
Part V	-	-	-	-	-	1	1
Total	23	23	22	25	26	21	**140**

***Part I. II, and Part III components will be separately taken into account for CGPA calculation and classification for the under graduate programme and the other components Part IV, V have to be completed during the duration of the programme as per the norms, to be eligible for obtaining the UG degree.**

CREDIT DISTRIBUTION FOR U.G. PROGRAMME

Part	Course Details	No. of Courses	Credit per course	Total Credits
Part I	Tamil	4	3	12
Part II	English	4	3	12
Part III	Core Courses	15	4/5	68
	Elective Courses: Generic / Discipline Specific (3 or 2+1 Credits)	8	3	24
Part I, II and III Credits				116
Part IV	Skill Enhancement Courses / NME / Language Courses	7	1/2	15
	Professional Competency Skill Course	1	2	2
	Environmental Science (EVS)	1	2	2
	Value Education	1	2	2
	Internship	1	2	2
Part IV Credits				**23**
Part V	Extension Activity (NSS / NCC / Physical Education)	1	1	1
Total Credits for the UG Programme				**140**

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods 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 off beat situations, Discussion, Debating or Presentations

Programme Outcomes:	**PO1: Disciplinary knowledge:** Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines that form a part of an undergraduate Programme of study **PO2: Communication Skills:** Ability to express thoughts and ideas effectively in writing and orally; Communicate with others using appropriate media; confidently share one's views and express herself/himself; demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner to different groups. **PO3: Critical thinking:** Capability to apply analytic thought to a body of knowledge; analyse and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories by following scientific approach to knowledge development. **PO4: Problem solving: Capacity** to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one's learning to real life situations. **PO5: Analytical reasoning**: Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyze and synthesize data from a variety of sources; draw valid conclusions and support them with evidence and examples, and addressing opposing viewpoints. **PO6: Research-related skills**: A sense of inquiry and capability for asking relevant/appropriate questions, problem arising, synthesising and articulating; Ability to recognise cause-and-effect relationships, define problems, formulate hypotheses, test hypotheses, analyse, interpret and draw conclusions from data, establish hypotheses, predict cause-and-effect relationships; ability to plan, execute and report the results of an experiment or investigation **PO7: Cooperation/Team work:** Ability to work effectively and respectfully with diverse teams; facilitate cooperative or coordinated effort on the part of a group, and act together as a group or a team in the interests of a common cause and work efficiently as a member of a team **PO8: Scientific reasoning**: Ability to analyse, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective. **PO9: Reflective thinking**: Critical sensibility to lived experiences, with self awareness and reflexivity of both self and society. **PO10 Information/digital literacy:** Capability to use ICT in a variety of learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources; and use appropriate software for analysis of data. **PO 11 Self-directed learning**: Ability to work independently, identify appropriate resources required for a project, and manage a project through to completion. **PO 12 Multicultural competence:** Possess knowledge of the values and beliefs of multiple cultures and a global perspective; and capability to effectively engage in a multicultural society and interact respectfully with diverse groups.

	PO 13: Moral and ethical awareness/reasoning: Ability toembrace moral/ethical values in conducting one's life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work. Capable of demonstratingthe ability to identify ethical issues related to one‟s work, avoid unethical behaviour such as fabrication, falsification or misrepresentation of data or committing plagiarism, not adhering to intellectual property rights; appreciating environmental and sustainability issues; and adopting objective, unbiased and truthful actions in all aspects of work. **PO 14: Leadership readiness/qualities:** Capability for mapping out the tasks of a team or an organization, and setting direction, formulating an inspiring vision, building a team who can help achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination, in a smooth and efficient way. **PO 15: Lifelong learning:** Ability to acquire knowledge and skills, including „learning how to learn‟, that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of work place through knowledge/skill development/reskilling.
Programme Specific Outcomes:	On successful completion of Bachelor of Physics with Computer Applications programme, the student should be able to: **PSO1: Disciplinary Knowledge:** Understand the fundamental principles, concepts, and theories related to physics and computer science. Also, exhibit proficiency in performing experiments in the laboratory. **PSO2: Critical Thinking:** Analyse complex problems, evaluate information, synthesize information, apply theoretical concepts to practical situations, identify assumptions and biases, make informed decisions and communicate effectively **PSO3: Problem Solving:** Employ theoretical concepts and critical reasoning ability with physical, mathematical and technical skills to solve problems, acquire data, analyze their physical significance and explore new design possibilities. **PSO4: Analytical & Scientific Reasoning:** Apply scientific methods, collect and analyse data, test hypotheses, evaluate evidence, apply statistical techniques and use computational models. **PSO5: Research related skills:** Formulate research questions, conduct literature reviews, design and execute research studies, communicate research findings and collaborate in research projects. **PSO6: Self-directed & Lifelong Learning:** Set learning goals, manage their own learning, reflect on their learning, adapt to new contexts, seek out new knowledge, collaborate with others and to continuously improve their skills and knowledge, through ongoing learning and professional development, and contribute to the growth and development of their field.

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

SEMESTER: I CORE - I PART - III	CORE – I : Fundamentals of Microbiology and Microbial Diversity (23UMICC13)	CREDIT: 5 HOURS: 5/W

Course Objectives

CO1	Learn the fundamental principles about different aspects of Microbiology including recent developments in the area.
CO2	Describe the structural organization, morphology and reproduction of microbes.
CO3	Explain the methods of cultivation of microbes and measurement of growth.
CO4	Understand the microscopy and other basic laboratory techniques – culturing, disinfection and sterilization in Microbiology.
CO5	Compare and contrast the different methods of sterilization.

UNIT	Details	No.of Hours	Course Objectives
I	History and Evolution of Microbiology, Classification – Three kingdom, five kingdom, six kingdom and eight kingdom. Microbial biodiversity: Introduction to microbial biodiversity- ecological niche. Basic concepts of Eubacteria, Archaebacteria and Eucarya. Conservation of Biodiversity.	12	CO1
II	General characteristics of cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) and acellular microorganisms - (Viruses, Viroids, Prions), Differences between prokaryotic and eukaryotic microorganisms. Structure of Bacterial cell wall, cell membrane, capsule, flagella, pili, mesosomes, chlorosomes, phycobilisomes, spores, and gas vesicles. Structure of fungi (Mold and Yeast), Structure of microalgae.	12	CO2
III	Bacterial culture media and pure culture techniques. Mode of cell division, Quantitative measurement of growth. Anaerobic culture techniques.	12	CO3
IV	Microscopy – Simple, bright field, dark field, phase contrast, fluorescent, electron microscope – TEM & SEM, Confocal microscopy, and Atomic Force Microscopy. Stains and staining methods.	12	CO4
V	Sterilization–moist heat - autoclaving, dry heat – Hot air oven, radiation – UV, Ionization, filtration – membrane filter and disinfection, antiseptic; Antimicrobial agents.	12	CO5
	Total	60	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Study the historical events that led to the discoveries and inventions and understand the Classification of Microorganisms.	PO5, PO6, PO10
CO2	Gain Knowledge of detailed structure and functions of prokaryotic cell organelles.	PO10
CO3	Understand the various microbiological techniques, different types of media, and techniques involved in culturing microorganisms.	PO11
CO4	Explain the principles and working mechanism of different microscopes/Microscope, their function and scope of application.	PO4, PO11
CO5	Understand the concept of asepsis and modes of sterilization and disinfectants**.**	PO4, PO11
Text Books		
1	Pelczar.M. J., Chan E.C.S. and Noel. R.K. (2007). Microbiology. 7th Edition.,McGraw –Hill, New York.	
2	Willey J., Sherwood L., and Woolverton C. J., (2017). Prescott's Microbiology. 10th Edition., McGraw-Hill International edition.	
3	Tortora, G.J., Funke, B.R., Case,C.L. (2013). Microbiology. An Introduction 11th Edition., A La Carte Pearson.	
4	Salle. A.J (1992). Fundamental Principles of Bacteriology. 7th Edition., McGraw Hill Inc.New York.	
5	Boyd, R.F. (1998). General Microbiology,2nd Edition., Times Mirror, Mosby CollegePublishing, St Louis.	
References Books		
1	Jeffrey C. Pommerville., Alcamo's Fundamentals of Microbiology (9th Edition). Jones &Bartlett learning 2010.	
2	Stanier R.Y, Ingraham J. L., Wheelis M. L., and Painter R. R. (2010). General Microbiology, 5th Edition., MacMillan Press Ltd	
3	Tortora, G.J., Funke, B.R. and, Case, C.L (2013). Microbiology-An Introduction, 11th Edition., Benjamin Cummings.	
4	Nester E., Anderson D., Roberts C. E., and Nester M. (2006). Microbiology-A Human Perspective, 5th Edition., McGraw Hill Publications.	
5	Madigan M.T., Martinko J.M., Stahl D.A, and Clark D. P. (2010). Brock - Biology of Microorganisms, 13th Edition Benjamin-Cummings Pub Co.	
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/bz-x/study/principle/structure.jsp	

3	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6604941/#
4	https://bio.libretexts.org/@go/page/9188
5	https://courses.lumenlearning.com/boundless-microbiology/chapter/microbial-nutrition/

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods 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

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1					M	M				M	
CO2										M	M
CO3											S
CO4				M							S
CO5				M							S

SEMESTER: I CORE Practical- I PART - III	CORE –II :Practical – 1 Fundamentals of Microbiology and Microbial Diversity (23UMICP14)	CREDIT: 5 HOURS: 5/W

Course Objectives			
CO1	Acquire knowledge on Cleaning of glass wares, GLP and sterilization.		
CO2	Gain knowledge on media preparation and cultural characteristics.		
CO3	Learn the pure culture technique		
CO4	Learn the microscopic techniques and staining methods.		
CO5	Acquire knowledge on stain and staining methods		
UNIT	**Details**	**No.of Hours**	**Course Objectives**
I	Cleaning of glass wares, Microbiological good laboratory practice and safety. Sterilization and assessment of sterility– Autoclave, hot air oven, and membrane filtration.	12	CO1
II	Media preparation: liquid media, solid media, semi-solid media, agar slants, agar deeps, agar plates.	12	CO2
III	Preparation of basal, differential, enriched, enrichment, transport, and selective media preparation- quality control of media, growth supporting properties, sterility check of media. Pure culture techniques: streak plate, pour plate, decimal dilution.	12	CO3
IV	Culture characteristics of microorganisms: growth on different media, growth characteristics, and description. Demonstration of pigment production. Microscopy: light microscopy and bright field microscopy.	12	CO4
V	Staining techniques: smear preparation, simple staining, Gram's staining and endospore staining. Study on Microbial Diversity using Hay Infusion Broth-Wet mount to show different types of microbes, hanging drop.	12	CO5
	Total	60	
Course Outcomes			
Course Outcomes	On completion of this course, students will;		
CO1	Practice sterilization methods; learn to prepare media and their quality		PO4, PO7,

	control.	PO8, PO9, PO11
CO2	Learn streak plate, pour plate and serial dilution and pigment production of microbes.	PO4, PO7, PO8, PO9
CO3	Understand Microscopy methods, different Staining techniques and motility test.	PO4, PO7, PO8, PO9, PO11
CO4	Observe culture characteristics of microorganisms.	PO4, PO7, PO8, PO9
CO5	Study on Microbial Diversity using Hay Infusion Broth-Wet mount	PO4, PO7, PO8, PO9
Text Books		
1	James G Cappucino and N. Sherman MB(1996). A lab manual Benjamin Cummins, New York 1996.	
2	Kannan. N (1996). Laboratory manual in General Microbiology. Palani Publications.	
3	Sundararaj T (2005). Microbiology Lab Manual (1st edition) publications.	
4	Gunasekaran, P. (1996). Laboratory manual in Microbiology. New Age International Ld., Publishers, New Delhi.	
5	R C Dubey and D K Maheswari (2002). Practical Microbiology. S. Chand Publishing.	
References Books		
1	Atlas.R (1997). Principles of Microbiology, 2nd Edition, Wm.C.Brown publishers.	
2	Amita J, Jyotsna A and Vimala V (2018). Microbiology Practical Manual. (1st Edition). Elsevier India	
3	Talib VH (2019). Handbook Medical Laboratory Technology. (2nd Edition). CBS	
4	Wheelis M, (2010). Principles of Modern Microbiology, 1st Edition. Jones and Bartlett Publication.	
5	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	
Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	

	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks
Methods 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	

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1				M			L	M	L		M
CO2				S			L	L	L		
CO3				S			M	M	L		M
CO4				S			M	L	L		
CO5				S			M	L	L		

SEMESTER: I Elecvtive-1 PART - III	Elective – 1 BASIC AND CLINICAL BIOCHEMISTRY (23UBCBE15)	CREDIT: 3 HOURS: 4/W

Course Objectives			
CO1	Attain thorough knowledge on carbohydrates and lipids, their characteristic properties and organization in carrying out all the living functions which constitute the life.		
CO2	Explain the biological activity of amino acids and proteins.		
CO3	Identify the metabolic errors in enzymes of carbohydrates and lipids.		
CO4	Describe the disorders in amino acid metabolism.		
CO5	Interpret the consequences, biochemical, clinical features, diagnosis and treatment of metabolic diseases of day today life.		
UNIT	**Details**	**No.of Hours**	**Course Objectives**
I	Biomolecules -Carbohydrate – General properties, function, structure, classification– monosaccharides (Glucose, Fructose, Galactose), Oligoaccharides (Sucrose, Maltose, Lactose) and polysaccharides (Starch, Glycogen,) and biological significance. Lipids – General properties, functions, structure, classification (Simple, Derived and Complex), Cholesterol, LDL, HDL – biological significance.	12	CO1
II	Biomolecules - Amino acids – General properties, functions, structure, classification and biological significance. Proteins– General structure, Properties, functions, classification and biological significance.	12	CO2
III	Disorders of Metabolism: Disorders of carbohydrate metabolism: diabetes mellitus,ketoacidosis, hypoglycemia, glycogen storage diseases, galactosemia and lactose intolerance. Disorders of lipid metabolism: hyperlipidemia, hyperlipoproteinemia, hypercholesterolemia, hypertriglyceridemia,sphingolipidosis.	12	CO3
IV	Disorders of Metabolism: Disorders of amino acid metabolism:alkaptonuria, phenylketonuria, phenylalaninemia, homocystineuria, tyrosinemia, aminoacidurias.	12	CO4
V	Evaluation of organ function tests: Assessment and clinical manifestations of renal, hepatic, pancreatic, gastric and intestinal functions. Diagnostic enzymes: Principles of diagnostic enzymology. Clinical significance of aspartate aminotransferase, alanine aminotransferase, creatine kinase, aldolase and lactate dehydrogenase.	12	CO5

	Total	60	
Course Outcomes			
Course Outcomes	On completion of this course, students will;		
CO1	Explain the structure, classification , biochemical functions and significance of carbohydrates and lipids	PO1	
CO2	Differentiate essential and non-essential amino acids, biologically important modified amino acids and their functions, Illustrate the role, classification of Proteins and recognize the structural level organization of proteins, its functions and denaturation.	PO1	
CO3	Assess defective enzymes and Inborn errors. Recognize diseases related to carbohydrate and lipid metabolism.	PO4, PO5, PO6	
CO4	Discuss and evaluate the pathology of aminoacid metabolic disorders.	PO4, PO5, PO6	
CO5	Appraise the imbalances of enzymes in organ function and relate the role of Clinical Biochemistry in screening and diagnosis.	PO5, PO6, PO9	
Text Books			
1	Satyanarayana, U. and Chakrapani, U(2014).Biochemistry,4th Edition, Made Simple Publisher.		
2	Jain J L, Sunjay Jain and Nitin Jain (2016).Fundamentals of Biochemistry, 7th Edition, S Chand Company.		
3	AmbikaShanmugam's (2016). Fundamentals of Biochemistry for Medical Students, 8th Edition. Wolters Kluwer India Pvt Ltd.		
4	Vasudevan. D.M.Sreekumari.S, Kannan Vaidyanathan (2019). Textbook Of Biochemistry For Medical Students. Kindle edition, Jaypee Brothers Medical Publishers		
5	Jeremy M. Berg,LubertStryer, John L. Tymoczko, Gregory J. Gatto (2015). Biochemistry, 8th edition. WH Freeman publisher.		
References Books			
1	AmitKessel&Nir Ben-Tal (2018). Introduction to Proteins: structure, function and motion. 2ndEdition, Chapman and Hall.		
2	David L. Nelson and Michael M. Cox (2017).Lehninger Principles of Biochemistry, 7thEdition W.H. Freeman and Co., NY.		
3	LupertStyrer, Jeremy M. Berg, John L. Tymaczko, Gatto Jr., Gregory J (2019). Biochemistry. 9thEdition ,W.H.Freeman& Co. New York.		
4.	Donald Voet, Judith Voet, Charlotte Pratt (2016). Fundamentals of Biochemistry: Life at the Molecular Level, 5th Edition, Wiley.		
5.	Joy PP, Surya S. and AswathyC (2015). Laboratory Manual of Biochemistry, Edition 1.,Publisher:Kerala agricultural university.		
Web Resources			

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

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods 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

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	M										
CO2	M										
CO3				S	S	S					
CO4				S	S	S					
CO5					S	S			S		

SEMESTER: I Foundation Course PART - IV	**Foundation Course : Basics of Microbiology** **(23UMICF17)**	**CREDIT: 2** **HOURS: 2/W**

Learning Objectives			
CO1	To become familiar with the concepts of microorganisms in soil		
CO2	To understand the microbial populations in water		
CO3	To gain the knowledge of microorganisms in air		
CO4	To understand the relationship between microorganisms and food		
CO5	To know the applications of microorganisms		
UNIT	**Details**	**No. of Hours**	**Course Objectives**
I	**Microbiology of Soil** Soil as an environment as a culture medium-Micro biota of soil-Rhizosphere- Definition: Rhizosphere and non rhizosphere microflora-R:S ratio, interactions between plant and rhizophere flora- microbes used as biofertilizers.	12	CO1
II	**Microbiology of Water** Microbial communities in natural water-Ponds, lakes, streams-Marine habits-estuaries, mangroves, deep sea-zonation-Eutrophication. Indicator bacteria.	12	CO2
III	**Microbiology of Air** Composition of air-Number and kinds of microorganisms in air (indoor, outdoor)-Distribution and sources of air borne microorganisms-Air as a carrier of microorganisms-Droplet, droplet nuclei, dispersal of microorganisms in air. Air sanitation- dust control, UV radiation, bacter/icidal vapors, filtration, laminar air flow system (HEPA filters).	12	CO3
IV	**Microbiology of Food** Food as a substrate for microorganisms-sources of contamination of food-importance of *Lactobacillus* in food fermentation- spoilage of foods-Food preservation-pasteurization-canning.	12	CO4
V	**Economic importance of microorganisms** Applications of bacteria- Bio fertilizer-Eg. Rhizobium, fungi-Eg. Penicillin production, algae-Eg.SCP- Spirulina and virus- Bio pesticides-CPV, NPV	12	CO5

	Total	**60**	
Course Outcomes			
Course Outcomes	On completion of this course, students will;		
CO1	To understand relevance of microorganismsin agriculture	PO1	
CO2	To understand the marine habitat and microbial community in water	PO1, PO2	
CO3	To gain knowledge of distributions and sources of microorganisms in air	PO4, PO6	
CO4	To understand the spoilage and contamination of food and food products	PO4, PO5, PO6	
CO5	To learn about the biofertilizer, biopesticide and its applications	PO3, PO8	
Text Books (Latest Editions)			
1.	Atlas R.M., Microbiology – fundamentals and applications, Macmillan Publishing Company, New York.		
2	Pelczar .J. Chan E.C.S. and Krieg N.R., Microbiology, McGraw Hill Book Company, New York.		
3.	Stanier R.Y., Ingraham J.L., General Microbiology, Prentice Hall of India Private Limited, New Delhi.		
4	Brock T.D. and Madigan M.T., Biology of Microorganisms, Prentice Hall of India Private Limited.		
5	RavindraNath, Fundamentals of Biology Courses for Biotechnology, - Vol.1, Special Bangalore University edition, Kalayani Publishers.		
References Books (Latest editions, and the style as given below must be strictly adhered to)			
1.	Alexopoulos C.J. and Mims C.W., Introductory Mycology, New Age International, New Delhi.		
2.	Thomas M. Bell, 1965. An Introduction to General Virology, William Heinemann Medical books, London.		
3.	Stanier R.Y., Ingraham J.L., General Microbiology, Prentice Hall of India Private Limited, New Delhi.		
4.	Salle A.J., Fundamental Principles of Bacteriology, Tata McGraw – Hill Publishing Company Limited, New Delhi.		
5	Benson Harold J, Microbiological Applications, WCB McGraw – Hill, New York.		
6	Collins CH, Patricia M, and Lyne JM (1995). Collins and Lynes Microbiological Methods 7th edition. Grange, Butter Worth, Oxford.		
7	Cappucino JG and Sherman N (1996). Microbiology, A Laboratory Manual 4th edition. Benjamin Cumings Inc. California.		
8	Pelczar MJ, Chan ECS and Krieg NR (1993). Microbiology 5th edition, Tata McGraw Hill.		
9	Madigan MT, Martinko JM and Parker J (2012). Brock Biology of		

	Microorganism, 11th edition Prentice Hall International Inc. London.	
Web Resources		
1.	https://vlab.amrita.edu/?sub=3&brch=73	
2.	https://learn.chm.msu.edu/vibl/	
3.	https://mvi-au.vlabs.ac.in/	
4.	https://virtuallab.tlc.ontariotechu.ca/intro.php	
5.	https://www.merlot.org/merlot/viewMaterial.htm?id=79694	
Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks
Methods 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	

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S				S	S					
CO2	S	S		M	S	S			M		
CO3				M	S	S					
CO4	S			S	S	M					
CO5	S				S	S					

SEMESTER: I Core-III PART - III	MICROBIAL PHYSIOLOGY AND METABOLISM (23UMICC23)	CREDIT: 5 HOURS: 5/W

Course Objectives			
CO1	Study the basic principles of microbial growth.		
CO2	Understand the basic concepts of aerobic and anaerobic metabolic pathways.		
CO3	Analyze the role of individual components in overall cell function.		
CO4	Provide information on sources of energy and its utilization by microorganisms.		
CO5	Study the different types of metabolic strategies.		
Unit	**Details**	**No.of Hours**	**Course Objectives**
I	Physiology of microbial growth: Batch – continuous - synchronous cultures; Growth Curve and measurement method (turbidity, biomass, and cell count). Control of microbial growth.	12	CO1
II	Nutrition requirements - Photoautotrophs, Photoorganotrophs, Chemolithotrophs (Ammonia, Nitrite, Sulfur, Hydrogen, Iron oxidizing Bacteria), Chemoorganotrophs. Nutrition transport mechanisms – Passive diffusion and Active transport. Factors affecting microbial growth.	12	CO2
III	An overview of Metabolism - Embden Meyerhof Pathway, Entner-Doudoroff Pathway, Pentose Phosphate Pathway, Tricarboxylic Acid Cycle. Electron Transport Chain and Oxidative Phosphorylation. ATP synthesis. Fermentation-Homolactic Fermentation, Heterolactic Fermentation, Mixed Acid Fermentation, Butanediol Fermentation.	12	CO3
IV	Photosynthesis - An Overview of chloroplast structure. Photosynthetic Pigments, Light Reaction-Cyclic and non-cyclic Photophosphorylation. Dark Reaction - Calvin Cycle.	12	CO4
V	Bacterial reproduction - Binary fission, Budding, Reproduction through conidia, cyst formation, endospore formation. Fungi asexual and sexual reproduction, Microalgae reproduction. Asexual and sexual reproduction of protozoa.	12	CO5
	Total	60	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Describe microorganisms based on nutrition.	PO6, PO9
CO2	Know the concept of microbial growth and identify the factors affecting bacterial growth.	PO6, PO7, PO9
CO3	Explain the methods of nutrient uptake.	PO6, PO9
CO4	Describe anaerobic and aerobic energy production.	PO6, PO9
CO5	Elaborate on the process of bacterial photosynthesis and reproduction.	PO6, PO9
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.	
References Books		
1	Robert K. Poole (2004). Advances in Microbial Physiology, Elsevier Academic Press, New York, Volume 49.	
2	Kim B.H., Gadd G.M. (2008). Bacterial Physiology and Metabolism. Cambridge University Press, Cambridge.	
3	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	BhanuShrivastava. (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/boundless-microbiology/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

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods 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

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1						M			M		
CO2						M	L		M		
CO3						M			M		
CO4						M			M		
CO5						M			M		

SEMESTER: I Core-IV PART - III	PRACTICAL-II: MICROBIAL PHYSIOLOGY AND METABOLISM (23UMICP24)	CREDIT: 5 HOURS: 5/W

Course Objectives			
CO1	Understand the principles of motility test.		
CO2	Understand the basic concepts of staining methods.		
CO3	Learn the bacterial count using different methods and anaerobic culture.		
CO4	Study the morphological demonstration of microorganisms and identification.		
CO5	Study the biochemical identification of the bacteria.		
UNIT	**Details**	**No.of Hours**	**Course Objectives**
I	Motility demonstration: hanging drop, wet mount preparation, semi-solid agar, Craigie's tube method. Staining techniques: Smear preparation, permanent specimen preparation, Capsular, and Acid-fast staining	12	CO1
II	Direct counts – Direct cell count (Petroff-Hausser counting chamber), Turbidometry. Viable count - pour plate, spread plate. Bacterial growth curve.	12	CO2
III	Anaerobic culture methods. Antibiotic sensitivity testing: Disc diffusion test- quality control with standard strains.	12	CO3
IV	Morphological variations in algae, fungi and protozoa. Micrometry: Demonstration of the size of yeast, fungal filaments and protozoa.	12	CO4
V	Methods of bacterial identification- morphological, physiological, and biochemical methods - IMViC test, H2S, TSI, Oxidase, catalase, urease test, and Carbohydrate fermentation test.Maintenance of pure culture, paraffin method, stab culture, maintenance of mold culture.	12	CO5
	Total	60	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Describe hanging drop, wet mount preparation, semi-solid agar, Craigie's tube method.	PO6, PO7, PO8, PO9, PO11
CO2	Demonstrate Smear preparation, permanent specimen preparation, Capsular, and Acid-fast staining.	PO6, PO7, PO8, PO9, PO11
CO3	Explain antibiotic sensitivity testing: Disc diffusion test- quality control with standard strains.	PO6, PO7, PO8, PO9, PO11
CO4	Describe demonstration of the size of yeast, fungal filaments and protozoa.	PO6, PO7, PO8, PO9, PO11
CO5	Elaborate on the bacterial identification- morphological, physiological, and biochemical methods.	PO6, PO7, PO8, PO9, PO11
Text Books		
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) 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.	
References Books		
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.	
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

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	40 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	60 Marks
	Total	100 Marks

Methods 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.

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1						M	L	M	L		M
CO2						M	M	L	M		L
CO3						L	M	M	L		M
CO4						L	M	M	M		M
CO5						M	M	M	M		M

SEMESTER: I Elective-II PART - III	Elective-II: BIOINSTRUMENTATION (23UBINE25)	CREDIT: 3 HOURS: 4/W

Course Objectives			
CO1	Understand the analytical instruments and study the basic principles in the field of sciences.		
CO2	To gain knowledge about principles of spectroscopy		
CO3	Understand the analytical techniques of Chromatography and electrophoresis		
CO4	To understand the principle of different types of scans used in medical diagnosis		
CO5	To gain information about the principles of radioactivity and its measurements		
Unit	**Details**	**No.of Hours**	**Course Objectives**
I	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.	12	CO1
II	Spectroscopic Techniques: Spectroscopic Techniques: Colorimeter, Ultraviolet and visible, Infra red and Mass Spectroscopy.	12	CO2
III	Chromatographic and Electrophoresis Techniques: Chromatographic Techniques: Paper, Thin Layer, Column, HPLC and GC. Electrophoresis Techniques: Starch Gel, AGE, PAGE.	12	CO3
IV	Imaging techniques: Principle, Instrumentation and application of ECG, EEG, EMG, MRI, CT and PET scan radioisotopes.	12	CO4
V	Fluorescence and radiation based techniques: Spectr of luorimeter, Flame photometer, Scintillation counter, Geiger Muller counter, Autoradiography.	12	CO5
	Total	60	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Gain knowledge about the basics of instrumentation.	PO1,PO4,PO11
CO2	Exemplify the structure of atoms and molecules by using the principles of spectroscopy.	PO4,PO10,PO11
CO3	Evaluate by separating and purifying the components.	PO4,PO7,PO11
CO4	Understand the need and applications of imaging techniques.	PO7,PO8,PO11
CO5	Categorize the working principle and applications of fluorescence and radiation.	PO10,PO11
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.1stEdition. MJP publishers.	
3	Veerakumari, L (2009).Bioinstrumentation- 5 thEdition -.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. S.Himalaya Publishing House, Mumbai.	
References 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	

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks
Methods 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	

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	L			M							S
CO2				L						M	S
CO3				L			M				S
CO4							S	S			S
CO5										M	S

Elective papers Offered by Department of Microbiology to other programmes

Elective Paper I FUNDAMENTALS OF MICROBIOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
	3	1			3	4	25	75	100

Course Outcomes	
CO1	Understand the classification of Microorganisms and structure of bacteria
CO2	Understand the various microbiological techniques, different types of media, and techniques involved in culturing microorganisms.
CO3	Categorize the methods of sterilization and identify the significance of culture media in the growth of different microbes.
CO4	Understand the skills in working procedures of Microscopes.
CO5	Understand about the nutritional requirements of Microorganisms.

UNIT	Contents	No.of Hours
I	History and scope of Microbiology, Classification of bacteria, fungi, virus, protozoa and algae – classical and molecular approaches. Scope of microbiology – Role of microbes in biotechnology.	15
II	Structure of bacteria - Bacterial growth and measurement of growth, Media – types and preparation- plating methods - staining methods (Gram's, capsule, spore, LCB mount)- methods of preservation and storage of microbes. Culture of fungi, virus and algae.	15
III	Sterilization methods - physical and chemical methods- Mode of action – Antibiotic in clinical use - Resistance to antibacterial agents - MRSA, ESBL.	15
IV	Microscopy: Principle and applications of Bright field, Dark field, Phase contrast, Fluorescent Microscope, Electron microscope-TEM and SEM.	15

V	Microbial metabolism: Nutritional requirements - macro and micro nutrients - Nutritional groups-Nutrient Transport: Active, passive and facilitated- Microbial Growth-Growth curve - Factors affecting growth (temperature, acidity, alkalinity, water availability and oxygen requirement) -measurement of growth,-Bacterial growth kinetics-Batch, continuous culture and synchronous growth.	15
Total		**75**

Text Books	
1	Pelczar.M. J., Chan E.C.S. and Noel. R.K. (2007). Microbiology. 7th Edition.,McGraw –Hill, New York.
2	Dubey R.C. and Maheswari, S. (2003). A textbook of Microbiology, New Delhi: S. Chand & Co.
3	Prescott, Harley, Klein, Microbiology, 10th Edition, McGraw – Hill, 2016.
4	Gerhardt, P., Murray, R.G., Wood, W.A. and Kreig, N.R. (Editions) (1994) Methods for General and Molecular Bacteriology. ASM Press, Washington, DC
Reference Books	
1	Madigan, Martinko, Bender, Buckley, Stahl, Brock Biology of Microorganisms, 14th edition, 2017.
2	Boyd, R.F. (1998). General Microbiology,2nd Edition., Times Mirror, Mosby CollegePublishing, St Louis.
3	Dr. C.B.Powar (Author), Dr.H.F. Daginawala. January 2010.General Microbiology Vol. I Vol.II. Himalalya Publishing home.
4	Tortora, G.J., Funke, B.R., Case,C.L. (2013). Microbiology. An Introduction 11th Edition., A La Carte Pearson.

Web Resources	
1	Horst W. Doelle (2004). Microbial Metabolism and Biotechnology. Proceedings of an E-seminar organized by the International organization for Biotechnology and Bioengineering (IOBB)
2	http://www ejb.org/content.
3	www. Biotech.kth.se Electronic Journal of biotechnology
4	https://www.cliffsnotes.com/study guides/biology/microbiology/introduction-to-microbiology/a-brief-history-of-microbiology
5	https://bio.libretexts.org/@go/page/9188

MAPPING WITH PROGRAMME OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1				M			L	M	L		M
CO2				S			L	L	L		
CO3				S			M	M	L		M
CO4				S			M	L	L		
CO5				S			M	L	L		

ELECTIVE PRACTICAL I -FUNDAMENTALS OF MICROBIOLOGY

Subject Code	L	T	P	S	Credits	Hours/W	Marks		
							CIA	External	Total
			4		2	4	25	75	100

Course Outcomes	
CO1	Describe the general Laboratory safety & Sterilization Techniques
CO2	Develop Skills in Media Preparation, Isolation & Serial Dilution Techniques and Pure Culture Techniques
CO3	Microscopically analyze the morphological features of Bacteria and fungi and define various Staining Techniques.
CO4	Perform the Motility of organisms.
CO5	Able to characterize and identify bacteria using Biochemical tests.

UNIT	Contents	No.of Hours
I	Sterilization techniques – Preparation of Media	9
II	Inoculation techniques- Pour plate, spread plate Isolation of bacteria from various sources and dilution techniques.	9
III	Staining techniques: Simple, Gram's, Capsule (Negative), Spores, Preparation of temporary mounts- Lacto phenol cotton blue staining.	9
IV	Motility tests: Hanging drop technique.	9
V	Biochemical characterization - catalase, oxidase, IMVIC test and TSI.Antibiotic sensitivity test (demonstration).	9

Total	**45**
Text Books	
1	James G Cappucino and N. Sherman MB(1996). A lab manual Benjamin Cummins, New York 1996.
2	Kannan. N (1996). Laboratory manual in General Microbiology. Palani Publications.
3	Sundararaj T (2005). Microbiology Lab Manual (1st edition) publications.
4	Gunasekaran, P. (1996). Laboratory manual in Microbiology. New Age International Ld., Publishers, New Delhi.
5	R C Dubey and D K Maheswari (2002). Practical Microbiology. S. Chand Publishing.
Reference Books	
1	Atlas.R (1997). Principles of Microbiology, 2nd Edition, Wm.C.Brown publishers.
2	Amita J, Jyotsna A and Vimala V (2018). Microbiology Practical Manual. (1st Edition). Elsevier India.
3	Talib VH (2019). Handbook Medical Laboratory Technology. (2nd Edition). CBS.
4	Wheelis M, (2010). Principles of Modern Microbiology, 1st Edition. Jones and Bartlett Publication.
5	Lim D. (1998). Microbiology, 2nd Edition, 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://www.cliffsnotes.com/studyguides/biology/microbiology/introduction-to-microbiology/a-brief-history-of-microbiology

MAPPING WITH PROGRAMME OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	M										
CO2	M										
CO3				S	S	S					
CO4				S	S	S					
CO5					S	S			S		

Elective Paper II APPLIED MICROBIOLOGY

Subject Code	L	T	P	S	Credits	Hours/W	Marks		
							CIA	External	Total
	3	1			3	4	25	75	100

Course Outcomes	
CO1	Understand beneficial role of microorganisms in dairy and food products.
CO2	Understand the various microbiological techniques, different types of media, and techniques involved in culturing microorganisms.
CO3	Categorize the methods of sterilization and identify the significance of culture media in the growth of different microbes.
CO4	Exhibit knowledge in analyzing the importance ofBio insecticides, Bio fertilizersprebiotics and probiotics.
CO5	Distinguish between normal flora and pathogens and describe the role of microbes in food intoxications.

UNIT	Contents	No.of Hours
I	Microorganisms as food and feed: SCP, Mushroom-Oyster (Pleurotus) and Button (Agaricus) mushroom. Dairy products-cheese, yoghurt; Beverages-Beer and Wine. Probiotics.	15
II	Microorganisms in Agriculture: Bacterial Biofertilizers, Phosphate solubilizers, Vasicular Arbusucular Mycorrhizae, Algal Biofertilizers.	15
III	Biocontrol of microbial pathogens-Bio pesticide-Bactericide-*Bacillus thuringiensis*; Fungicide-*Trichoderma viridae*-Viral Biopesticides-CPV and NPV	15
IV	Microorganisms and Environment: liquid waste and solid waste-liquid waste management-water recycling- Industrial effluent treatment (sugar mill effluent, tannery effluent)- Solid waste management -Composting and vermicomposting.	15
V	Microbial Disease- host -pathogen interaction, clinical features, lab diagnosis and treatment of Airborne disease (Pneumonia, Chicken pox), food borne disease (Typhoid, Aspergillosis), Water borne disease (Cholera, Amoebiasis), Sexually transmitted disease (AIDS, Trichomoniasis), Vector	15

	borne disease (Dengue, Malaria).	
Total		**75**
Text Books		
1	Rangaswami G and Bagyaraj DJ (2002). Agricultural Microbiology. Second edition, PHI Learning (P) Ltd., New Delhi	
2	Dubey R.C. and Maheswari, S. (2003). A textbook of Microbiology, New Delhi: S. Chand & Co.	
3	Prescott, Harley, Klein, Microbiology, 10th Edition, McGraw – Hill, 2016.	
Reference Books		
1	. Adams, M.R and M.O. Moss (2005). Food Microbiology. 1st edition. Reprinted, Published byNew Age International (P) Ltd, Publishers-New Delhi.	
2	Gillespie, Bamford, Medical Microbiology and Infection at a Glance, 4th edition, 2012.	
3	Maier, R.M., Pepper, I.L. & Gerba, C.P. (2009). Environmental Microbiology. 2nd Ed. Academic Press.	
4	Ananthanarayanan, Paniker, Kapil, Textbook book of Microbiology, 9th edition, Orient BlackSwan, 2013.	

Web Resources	
1	http://www ejb.org/content.
2	www. Biotech.kth.se Electronic Journal of biotechnology
3	https://bio.libretexts.org/@go/page/9188

MAPPING WITH PROGRAMME OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1				M			L	M	L		M
CO2				S			L	L	L		
CO3				S			M	M	L		M
CO4				S			M	L	L		
CO5				S			M	L	L		

ELECTIVE PRACTICAL II –APPLIED MICROBIOLOGY

Subject Code	L	T	P	S	Credits	Instructional Hours	Marks		
							CIA	External	Total
			4		2	4	25	75	100

Course Outcomes	
CO1	Describe the techniques to estimate the quality of dairy products
CO2	Develop Skills in enzyme production
CO3	Microscopically analyze the morphological features of algae and root nodules bacteria
CO4	Learn the methods available to check the water quality
CO5	Understand the pathogenic bacteria in various sample

UNIT	Contents	No.of Hours
I	Detection of bacteria in milk by SPC, Methylene Blue reduction test, Microscopic observation of curd	9
II	Demonstration of enzymes producing bacteria (lipase, amylase, protease)	9
III	Azolla- morphological study, Isolation of Rhizobium from root nodules,	9
IV	Enumeration of bacteria from water sample, test for coliforms by MPN method	9
V	Isolation of pathogenic bacteria from air, water, and food specimens	9
Total		**45**

Text Books	
1	James G Cappucino and N. Sherman MB(1996). A lab manual Benjamin Cummins, New York 1996.
2	Kannan. N (1996). Laboratory manual in General Microbiology. Palani Publications.
3	Sundararaj T (2005). Microbiology Lab Manual (1st edition) publications.
4	Gunasekaran, P. (1996). Laboratory manual in Microbiology. New Age International Ld., Publishers, New Delhi.
5.	Rajan. S and Selvi Christy (2015). Experiments Procedure in Life Science, Anjanaa book House Publisers, Chennai
6	R C Dubey and D K Maheswari (2002). Practical Microbiology. S. Chand Publishing.
Reference Books	
1	Atlas.R (1997). Principles of Microbiology, 2nd Edition, Wm.C.Brown publishers.
2	Amita J, Jyotsna A and Vimala V (2018). Microbiology Practical Manual. (1st Edition). Elsevier India.
3	Talib VH (2019). Handbook Medical Laboratory Technology. (2nd Edition). CBS.
4	Wheelis M, (2010). Principles of Modern Microbiology, 1st Edition. Jones and Bartlett Publication.
5	Lim D. (1998). Microbiology, 2nd Edition, 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://www.cliffsnotes.com/studyguides/biology/microbiology/introduction-to-microbiology/a-brief-history-of-microbiology

MAPPING WITH PROGRAMME OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	M										
CO2	M										
CO3				S	S	S					
CO4				S	S	S					
CO5					S	S			S		

NME offered to other Departments

SEMESTER: I Skill Enhancement Course-1(NME-1) PART-IV	**Social and Preventive medicine (23 UMICS16)**	CREDIT:2 HOURS:2/W

Course Objectives			
CO1	Describe the concepts of health and disease and their social determinants		
CO2	Summarize the health management system		
CO3	Know about the various health care services		
CO4	Outline the goals of preventive medicine		
CO5	Gain knowledge about alternate medicine		
UNIT	**Details**	**No.of Hours**	**Course Objectives**
I	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.	6	CO1
II	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 and occupational hazards and their control.	6	CO2
III	Health care and services:	6	CO3

	Health care of the community-information, education, communication and training in health-maternal & child health-school health services- Geriatrics-care and welfare of the aged-mental health-health services through general practitioners.		
IV	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.	6	CO4
V	Prevention through alternate medicine: Unani, Ayurveda, Homeopathy, Naturopathy systems in epidemic and pandemic outbreaks. International health regulations. Infectious disease outbreak case studies and precautionary response during SARS and MERS coronavirus, Ebola and novel SARS-COV2 outbreaks.	6	CO5
	Total	30	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Identify the health information system	PO1,PO5, PO6
CO2	Associate various factors with health management system	PO1,PO2, PO3,PO5, PO6, PO9
CO3	Choose the appropriate health care services	PO1,PO5, PO6
CO4	Appraise the role of preventive medicine in community setting	PO4,PO5, PO6
CO5	Recommend the usage of	PO1,PO5, PO6

	alternate medicine during outbreaks	
Text Books		
1.	Park.K (2021). Textbook of preventive and social medicine, 26th edition. BanarsidasBhanot publishers.	
2.	Mahajan& Gupta (2013). Text book of preventive and social medicine, 4thedition. Jaypeebrothers 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.	
References 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 BehavioralMedicine.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	
Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	

	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks
Methods 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	

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S				S	S					
CO2	S	S		M	S	S			M		
CO3				M	S	S					
CO4	S			S	S	M					
CO5	S				S	S					

SEMESTER: II Skill Enhancement Course-2(NME-2) PART-IV	Nutrition & Health Hygiene (23UMICN26)	CREDIT:2 HOURS:2/W

Course Objectives			
CO1	Learn about nutrition and their importance		
CO2	Make student understand thenutritional facts fora better life.		
CO3	Learn information to optimize our diet		
CO4	Impart knowledge on different health care programs taken up by India		
CO5	Learn knowledge on different health indicators and types of hygiene methods		
Unit	**Details**	**No.of Hours**	**Course Objectives**
I	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	5	CO1
II	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.	5	CO2
III	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.	5	CO3
IV	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.	5	CO4
V	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.	5	CO5

	Total	25	
Course Outcomes			
Course Outcomes	On completion of this course, students will;		
CO1	Learn the importance of nutrition for a healthy life	PO5, PO6, PO7, PO8, PO10	
CO2	Study the nutrition for life cycle	PO5, PO6, PO7, PO8, PO10	
CO3	Know the health care programmes of India	PO5, PO6, PO7, PO8, PO10	
CO4	Learn the importance of community and personal health & hygiene measures	PO5, PO6, PO7, PO10	
CO5	Create awareness on community health and hygiene	PO5, PO6, PO7, PO10	

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
References 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

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods of Assessment	
Recall (KI)	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
Analyse (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

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1					S	M	M	M		S	
CO2					S	M	M	M		S	
CO3					S	M	M	M		S	
CO4					S	S	L			S	
CO5					S	S	M			S	

SEMESTER III

SEMESTER: III CORE - V PART - III	23UMICC33 - CORE – V : Molecular Biology and Microbial Genetics		CREDIT: 5 HOURS: 5/W
Learning Objectives			
CO1	Provide knowledge on structure and replication of DNA.		
CO2	Illustrate the significance and functions of RNA in protein synthesis.		
CO3	Explain the cause and types of DNA mutation and DNA repair mechanisms.		
CO4	Outline the role of plasmids and phages in genetics.		
CO5	Examine mechanisms of gene transfer and recombination.		
Unit	**Details**	**No. of Hours**	**Course Objectives**
I	DNA Structure - Salient features of double helix, forms of DNA. Denaturation and renaturation. DNA topology – Supercoiling, topoisomerases. DNA organization in prokaryotes, eukaryotes. Replication of DNA in prokaryotes and eukaryotes - Bidirectional and unidirectional replication, semi-conservative and semi-discontinuous replication. Mechanism of DNA replication – enzymes involved – DNA polymerases, DNA ligase, primase. DNA replication modes - rolling circle, D-loop modes.	15	CO1
II	Transcription in Prokaryotes. Concept of transcription. RNA Polymerases - prokaryotic and eukaryotic. General transcription factors in eukaryotes. Distinction between transcription processes in prokaryotes versus eukaryotes. Translation in prokaryotes and eukaryotes - Translational machinery - ribosome structure in prokaryotes and eukaryotes, tRNA structure and processing. Inhibitors of protein synthesis in prokaryotes and eukaryotes. Overview of regulation of gene expression - *lac*, *trp* as examples. Regulation of gene expression by DNA methylation.	15	CO2
III	Mutation - Definition and types - base substitutions, frame shifts, deletions, insertions, duplications, inversions. Silent, conditional, and lethal mutations. Physical and chemical mutagens. Reversion and suppression. Uses of mutations. Repair Mechanisms - Photoreactivation, Nucleotide Repair, Base Excision Repair, Methyl Directed Mismatch Repair and SOS Repair.	15	CO3
IV	Plasmid replication and partitioning, host range, plasmid incompatibility, plasmid amplification, regulation of plasmid copy number- Types of plasmids – R Plasmids, F plasmids, colicinogenic plasmids, metal resistance plasmids, Ti plasmid, linear plasmids, yeast 2µ plasmid.	15	CO4
V	Gene Transfer Mechanisms- Conjugation and its uses. Transduction - Generalized and Specialized, Transformation -	15	CO5

	Natural Competence and Transformation. Transposable elements - Prokaryotic transposable elements – insertion sequences, composite, and non-composite transposons. Uses of transposons.		
	Total	75	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Analyze the significance of DNA and elucidate the replication mechanism.	PO4, PO5, PO7,PO9
CO2	Illustrate the types of RNA and protein synthesis machinery.	PO4, PO7,PO9
CO3	Infer the causes and types of DNA mutation and summarize the DNA repair mechanisms.	PO5, PO7,PO9
CO4	Evaluate the importance of plasmids and phages in genetics.	PO7,PO9
CO5	Analyze gene transfer and recombination methods.	PO5, PO6, PO7,PO9

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 SnustedD.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.
References 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). iGenetics - A Molecular Approach, 3rd Edition., Pearson New International edn.
3.	Nelson, D.L. and Cox, M.M. Lehninger(2017). Principles of Biochemistry. 7th Edition, W.H. Freeman.
4.	Synder L., Peters J. E., Henkin T.M. and Champness W. (2013). Molecular Genetics of Bacteria, 4th Edition, ASM Press Washington-D.C. ASM Press.
5.	Primrose S.B. and Twyman R. M. (2006). Principles of Gene Manipulation and Genomics. (7th Edition). Blackwell Publishing
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	
Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks
Methods 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	

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1				S	S	M	S	M	S	M	
CO2				S	M	M	S	M	S	L	
CO3				M	S	M	S	M	S	L	
CO4				M	M	M	S	M	S	L	
CO5				M	S	S	S	M	S	L	

SEMESTER: III CORE - VI PART - III	23UMICP34 - CORE – VI : Practical – III: Molecular Biology and Microbial Genetics	CREDIT: 5 HOURS: 5/W

Learning Objectives	
CO1	Provide knowledge on structure and replication of DNA.
CO2	Elucidate the methods of Genomic and Plasmid DNA isolation.
CO3	Explain methods of protein separation.
CO4	Explain artificial transformation method.
CO5	Outline the role of phages in genetics.

Unit	Details	No. of Hours	Course Objectives
I	Study of different types of DNA and RNA using micrographs and model / schematic representations. Study of semi-conservative replication of DNA through micrographs / schematic representations.	15	CO1
II	Isolation of Genomic and Plasmid DNA from *E. coli* and Analysis by Agarose gel electrophoresis. Estimation of DNA using colorimeter (diphenylamine reagent).	15	CO2
III	Resolution and visualization of proteins by polyacrylamide gel electrophoresis (SDS-PAGE) – Demonstration. UV induced auxotrophic mutant production and isolation of mutants by replica plating technique – Demonstration.	15	CO3
IV	Isolation of antibiotic resistant mutants by gradient plate method. - Demonstration	15	CO4
V	Screening and isolation of phages from sewage. Perform RNA isolation. Industrial visit and Submission of Report - Biofertilizer production Centers, Clinical, Health care Research Institute, Water and soil testing center, Aquaculture pond visit.	15	CO5
	Total	75	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Illustrate different types of DNA and RNA.	PO4, PO7, PO9, PO11
CO2	Utilize hands-on training in isolation of genomic and plasmid DNA.	PO4, PO7, PO9, PO11
CO3	Analyze importance of experimental microbial genetics.	PO4, PO7, PO9, PO11
CO4	Apply the knowledge of molecular techniques in various fields.	PO4, PO7,

		PO9, PO11
CO5	Investigate the significance of Phages.	PO4, PO7, PO9, PO11

Text Books	
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.
References Books	
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). iGenetics - A Molecular Approach, 3rd Edition., Pearson New International edn.
3	Nelson, D.L. and Cox, M.M. Lehninger(2017). Principles of Biochemistry. 7th Edition, W.H. Freeman.
4	Synder L., Peters J. E., Henkin T.M. and Champness W. (2013). Molecular Genetics of Bacteria, 4th edition, ASM Press Washington-D.C. ASM Press.
5	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

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods 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

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1				S	L	M	S	M	S	M	S
CO2				S	L	M	S	M	S	M	S
CO3				S	L	M	S	M	S	M	S
CO4				S	L	M	S	M	S	M	S
CO5				S	L	M	S	M	S	M	S

SEMESTER – III ELECTIVE –III PART - III	23UMICE35 - ELECTIVE –III: Clinical Laboratory Technology	CREDIT: 3 HOURS: 4/W

Learning Objectives	
CO1	Demonstrate ethical and professional conduct with patients, laboratory personnel, health- care professionals, and the public.
CO2	Explain how accurate and reliable information might be obtained about proper procurement, storage, and *handling* of laboratory *specimens*.
CO3	Develop a sound scientific knowledge foundation that prepares them to interpret, analyze and evaluate scientific knowledge in clinical practice.
CO4	Perform a full range of laboratory tests with accuracy and precision.
CO5	Establish quality assurance principles and practices to ensure the accuracy and reliability of laboratory information.

Unit	Details	No.of Hours	Course Objectives
I	**Introduction to Clinical Laboratory Science**: Basic laboratory principles - Code of conduct for medical laboratory personnel - Organization of clinical laboratory and role of medical laboratory technician - Safety measures. Assessment of a patient and brief history of collection. Maintenance of Hygiene & Infection Control Practices.	12	CO1
II	**Specimen collection and processing** - Blood, urine, stool, sputum CSF, amniotic fluid and bile. Separation of serum and plasma, Handling of specimens for testing, preservation of specimens, transport of specimens and factors affecting the clinical results.	12	CO2
III	**Introduction to histopathology**-Methods of examination of tissues and cells, Fixation of tissues: Classification and properties of fixatives. Tissue processing - Collection of specimens, Labeling and fixation, Dehydration, Clearing, Impregnation, Embedding - Paraffin block making, Section Cutting, Microtomes – types and mounting of sections.	12	CO3
IV	**Introduction to Haematology**- Laboratory methods used in the investigation of coagulation disorders - coagulation tests , Routine coagulation tests, (prothrombin time , plasma recalcification time,partial thromboplastin time , activated partial thromboplastin time, thrombin time), Laboratory diagnosis of bleeding disorders. Estimation of fibrinogen, Assay of coagulation factors.	12	CO4
V	**Quality Standards in Health Laboratories** – Development and implementation of standards, Accreditation Boards –NABL, ISO, CAP, COLA, Performing quality assessment - pre-analytical, analytical, and post-analytical phases of testing.	12	CO5
	Total	60	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Describe characteristics of laboratory organizations, 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.	PO3, PO11
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.	PO5, PO6, PO11
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.	PO6, PO8, PO9, PO11
CO4	Recognize the pathologies behind benign and malignant disorders of erythrocytes, leucocytes, thrombocytes and familiar with the diagnosis, evaluation, and management of hematologic malignancies.	PO5, PO6, PO9, PO11
CO5	Interpret, implement, and complying with laws, regulations and accrediting standards and guidelines of relevant governmental and non-governmental agencies.	PO1,PO10
Text Books		
1.	Mukharji,K.L. (2000).Medical Laboratory Techniques, Vol - I, II & III, 5th Edition. Tata McGrawHill, Delhi.	
2.	Ochei,A., Kolhatkar.A. (2000).Medical Laboratory Science: Theory and Practice, McGraw Hill Education.	
3	RamnikSood (2015).Concise Book of Medical Laboratory Technology: Methods and Interpretation, 2ndEdition, Jaypee Brothers Medical Publishers, NewDelhi.	
4.	S. Ramakrishnan, KN Sulochana (2012). Manual of Medical Laboratory Techniques, Jaypee Brothers Medical Publishers Pvt. Ltd	
5.	Talib V.H. (2019). Handbook Medical Laboratory Technology, 2nd*Edition*, Directorate of health services, Government of India.	
References 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, 7thEdition, CBS Publishers and Distributors Pvt. Ltd.	
3	Godkar (2021).Textbook of Medical Laboratory Technology, 3rdEdition,Bhalani Publishing House.	
4	M.N.Chatterjee and Rana Shinde.(2008). Textbook of Medical Biochemistry, 7thEdition, 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	
Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks
Methods 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	

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1			M								S
CO2					M	S					S
CO3						S		S		S	S
CO4					M	S			S		S
CO5	M									M	

SEMESTER – III SEC – IV PART – IV	23UMICS36 - SKILL ENHANCEMENT COURSE – IV: ORGANIC FARMING & BIOFERTILISER TECHNOLOGY ()	CREDIT: 1 HOUR: 1/W

Learning Objectives	
CO1	Impart knowledge about the significance of organic farming and strategies to increase the yield to conserve environment.
CO2	To encourage organic farming in urban areas.
CO3	Comprehensive knowledge about bacterial biofertilizers, its advantages and future perspective.
CO4	Structure and characteristic features of Cyanobacterial and fungal biofertilizer
CO5	Develop the knowledge and skill to produce, analyze the quality of packaging, storage and assess the shelf life and bioefficacy of biofertilizers.

Unit	Details	No.of Hours	Course Objectives
I	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.	6	CO1
II	Organic farming for urban space; Create a Sustainable Organic Garden (Backyard- Square Foot Gardening, Small Space Gardening, Mini Farming) Composting, Vermicomposting	6	CO2
III	Biofertilizers: Introduction, advantages and future perspective. Structure and characteristic features of bacterial biofertilizers- *Azospirillum, Azotobacter, Bacillus, Pseudomonas, Rhizobium* and *Frankia*	6	CO3
IV	Structure and characteristic features of Cyanobacterial biofertilizers- *Anabaena, Nostoc* ;Structure and characteristic features offungal biofertilizers- AM mycorrhiza	6	CO4
V	Production of *Rhizobium, Azotobacter, Anabena*;Biofertilizers - Storage, shelf life, quality control and marketing	6	CO5
	Total	30	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Become an Entrepreneur with wide knowledge about farming and sustainable resources.	PO1, PO2, PO7, PO8, PO10
CO2	Implement organic farming in urban areas with knowledge on compost.	PO1, PO5, PO10
CO3	Gain knowledge about the bacterial biofertilizers and its advantages	PO1, PO5, PO7, PO8, PO10
CO4	Understand the significance of Cyanobacterial and fungal biofertilizers	PO1, PO5, PO7, PO8, PO10
CO5	Understand and implement the use of bio fertilizers.	PO1, PO5, PO7, PO8, PO10

Text Books	
1.	A.K. Sharma (2006). Hand book of Organic Farming
2.	A.C.Gaur (2017). Hand book of Organic Farming and Biofertilizers
3.	N.S. Subbarao (2017). Bio-fertilizers in Agriculture and Forestry (4th Edition) Med tech publisher
4.	SubbaRao, N. S. (2002). Soil Microbiology. Soil Microorganisms and Plant Growth. (4th Edition), Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
5.	Dubey, R. C. (2008). A Textbook of Biotechnology. S. Chand & Co., New Delhi.
References Books	
1	Masanobu Fukuoka, Frances Moore Lappe Wendell Berry (2009). The One-Straw Revolution: An Introduction to Natural Farming, 1st edition, YRB Classics.
2	SujitChakrabarty(2018). Organic Home Gardening Made Easy, 1st Edition,
3	Singh and Purohit (2008). Biofertilizer technology. Agrobios, India.
4	Bansal M (2019). Basics of Organic Farming CBS Publisher.
5	Hurst, C.J., Crawford R.L., Garland J.L., Lipson D.A., Mills A.L. and Stetzenbach L.D. (2007). Manual of Environmental Microbiology. (3rd Edition). American Society for Microbiology.
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

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods 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

Mapping with Programme Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S	S					S	S		S	
CO2	S				S					S	
CO3	S				S		S	S		S	
CO4	S				S		S	S		S	
CO5	S				S		S	S		S	

SEMESTER – III SEC – IV PART – IV	23UMICS37 - SKILL ENHANCEMENT COURSE – V: AQUACULTURE	CREDIT: 2 HOUR: 2/W

Learning Objectives	
CO1	Provide a deeper knowledge in aquaculture systems and methods.
CO2	Explain the significance and functions of design, types and construction of aquaculture ponds.
CO3	Demonstrate the biological characteristics of various aquaculture species.
CO4	Discuss the methods involved in post stocking management.
CO5	Illustrate major cultivatable species for aquaculture.

Unit	Details	No. of Hours	Course Objectives
I	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.	6	CO1
II	Aquaculture Engineering - Design and construction of pond, lay-out and design of aquaculture farm, construction, water intake system, drainage system - aeration and aerators. Ponds - Types of ponds.	6	CO2
III	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.	6	CO3
IV	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.	6	CO4
V	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, *Penaeus monodon* and *Litopenaeus Vannamei*. Culture of pearl oysters. Culture of sea weeds. Methods of Crab culture. Culture of ornamental fishes. Culture of Molluscs.	6	CO5
	Total	30	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Analyze the significance and importance of aquaculture	PO4, PO5, PO7,PO9

CO2	Illustrate the types and construction of aquaculture ponds	PO4, PO7,PO9
CO3	Analyze the biological characteristics of species and choose the best species for aquaculture.	PO5, PO7,PO9
CO4	Follow methods involved for optimal growth of aquaculture species	PO7,PO9
CO5	Summarize major species suitable for aquaculture in a particular environment	PO5, PO6, PO7,PO9

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.
5.	Akpaniteaku R.C. (2018).Basic Handbook of Fisheries and Aquaculture.AkiNik Publications.
References 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)

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods of Assessment	
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand/	MCQ, True/False, Short essays, Concept explanations, Short summary or

Comprehend (K2)	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

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1				S	S	M	S	M	S	M	
CO2				S	M	M	S	M	S	L	
CO3				M	S	M	S	M	S	L	
CO4				M	M	M	S	M	S	L	
CO5				M	S	S	S	M	S	L	

SEMESTER IV

SEMESTER: IV CORE - VII PART - III	23UMICC43 - CORE – VII : IMMUNOLOGY AND IMMUNOTECHNOLOGY		CREDIT: 5 HOURS: 5/W
Course Objectives			
CO1	To gain knowledge about immune system, organs of immunity and cells involved.		
CO2	To distinguish the types of antigens and antibodies; their properties.		
CO3	To provide in-depth knowledge on immuno-techniques.		
CO4	To discuss the role of MHC system in transplantation; functions of Tumor specific antigens.		
CO5	To impart knowledge on immunological disorders.		
Unit	**Details**	**No.of Hours**	**Course Objectives**
I	Organs and Cells in Immune System and Immune Response:Primary lymphoid organs, secondary lymphoid organs, and lymphoid tissues; T – cell and B –cell membrane bound receptors – apoptosis; T - cell processing, presentation and regulation; T –cell subpopulation, properties, functions and T – cell suppression; Physiology of immune response- innate, humoral and cell mediated immunity; Immunohematology.	12	CO1
II	Antigen and Antibody:Antigens - Properties of haptens, epitopes, adjuvants, and cross reactivity; Antibodies- structure, properties, classes; Antigen and Antibody Reactions: precipitation, agglutination, complement fixation, opsonization, neutralization; Vaccines – active and passive immunization; Classification of vaccines; Other approaches to new vaccines; Types of vaccine - antibacterial, antiviral; Vaccination schedule.	12	CO2
III	Immunoassay and Immunotechniques - Preparation and standardization of bacterial antigens; Raising of monoclonal and polyclonal antibodies; Purification of antibodies. Immunotechniques - RIA, RAST, ELISA, Immuno fluorescence techniques and Flow cytometry	12	CO3
IV	Transplantation and TumorImmunology - MHC Antigens - structure and function; HLA system - Regulation and response to immune system; Transplantation immunology - tissue transplantation and grafting; Mechanism of graft acceptance and rejection; HLA typing; Tumor specific antigens; Immune response to tumors; Immune diagnosis; cancer immune therapy.	12	CO4
V	Immunological disorders and diseases - Hypersensitivity reactions (Type I, II, III and IV); acquired immunodeficiency syndrome; Auto immune disorders and diseases: organ specific and non-organ specific.	12	CO5
	Total	60	
Course Outcomes			

Course Outcomes	On completion of this course, students will;	
CO1	Assess the fundamental concepts of immunity, contributions of the organs and cells in immune responses.	PO1, PO4, PO6, PO9,
CO2	Investigate the structures of Ag and Ab; Immunization.	PO1, PO4, PO5, PO9
CO3	Justify the Immunoassay and Immunotechniques.	PO1, PO4, PO5, PO7
CO4	Explain about the immunologic processes governing graft rejection and therapeutic modalities for immunosuppression in transplantation	PO1, PO3, PO4, PO5, PO9
CO5	Analyze the overreaction by our immune system leading to hypersensitive conditions and its consequences.	PO1, PO4, PO5, PO6

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.
References 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

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External	End Semester Examination	75 Marks

Evaluation		
	Total	100 Marks
Methods 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	

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	S			M		S			M
CO2	S			M	M				M
CO3	S			S	S		S		
CO4	S		M	S	S				M
CO5	S			S	M	M			

SEMESTER: IV CORE - VIII PART - III	23UMICP44 - CORE – VIII : PRACTICAL – IV : IMMUNOLOGY AND IMMUNOTECHNOLOGY	CREDIT: 5 HOURS: 5/W

Course Objectives

CO1	To gain hands-on knowledge to identify Blood group and typing.
CO2	To acquire adequate skill to perform latex agglutination reactions.
CO3	To analyze precipitation reactions in gels.
CO4	To investigate the antigen & antibody reactions in electrophoresis.
CO5	To familiarize with Separation of Lymphocytes.

Unit	Details	No.of Hours	Course Objectives
I	Identification of blood group and typing. Coomb's test. TPHA	12	CO1
II	T cell identification (Demonstration). Latex Agglutination reactions- RF, ASO, CRP	12	CO2
III	Ouchterlony's Double Diffusion Method (antigen pattern). Single Radial Immuno Diffusion Method.	12	CO3
IV	Electrophoresis - Serum, Counter and Immuno.	12	CO4
V	Separation of Lymphocytes by gradient centrifugation method. ELISA: Hepatitis/ HIV. Industrial visit and Submission of Report - International Vaccination Centre, The King Institute of Preventive Medicine and Research, Guindy, Chennai or Blood banking, Multispeciality Hospitals any others.	12	CO5
	Total	60	

Course Outcomes

Course Outcomes	On completion of this course, students will;	
CO1	Assess the blood groups and types	PO1,PO5, PO6, PO7, PO8
CO2	Competently perform serological diagnostic tests such as RF, ASO, CRP	PO4, PO5, PO6, PO7, PO8
CO3	Illustrate the antigen antibody reactions in gel.	PO5, PO6, PO7, PO8, PO9
CO4	Compare & contrast antigens and antibodies in electrophoresis	PO5, PO6, PO7, PO8, PO9
CO5	Examine the concept of ELISA.	PO5, PO6, PO7, PO8, PO9

Text Books

1.	Talwar. (2006). Hand Book of Practical and Clinical Immunology, Vol. I, 2nd ed.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.

References Books

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. Current Biology Ltd. London, New York. 3rd Edition.
5	Peter J. Delves, Seamus Martin, Dennis R. Burton, Ivan M. Roitt. (2006). Roitt's Essential Immunology, 11thEdition.,Wiley-Blackwell.
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

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods 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

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	M				S	S	S	S	
CO2				S	M	M	S	S	
CO3					M	S	S	S	M
CO4					M	M	S	S	M
CO5					M	M	S	S	M

SEMESTER – IV ELECTIVE –IV PART - III	23UMICE45 - ELECTIVE – IV: FOOD PROCESSING TECHNOLOGY	CREDIT: 3 HOURS: 3/W

Learning Objectives	
CO1	To provide knowledge on objectives of food preservation.
CO2	To explain the freshness criteria and quality assessment of meat and fish.
CO3	To outline the methods of milk processing and fermented milk products.
CO4	To explain the importance of fat and oil processing.
CO5	To discuss the methods of microbiological examination of foods.

Unit	Details	No.of Hours	Course Objectives
I	Introduction to food preservation –objectives and techniques of food preservation. Preservation: principles of high temperature, low temperature, radiation, chemical preservatives and bio preservatives.	12	CO1
II	Freshness criteria and quality assessment of meat and fish –spoilage and methods of preservation. Production of byproducts after processing waste and their utilization. Role of packaging material, types of packaging material.	12	CO2
III	Composition of milk; assessment of milk, thermal processing of fluid milk-pasteurization (LTH, HTST & UHT techniques). Fermented milk products-cheese, Butter milk, Yogurt, Kumis, Kefir and Acidophilus milk. Hygiene and sanitation requirement in food processing and fermentation industries.	12	CO3
IV	Importance of fats and oils in Food-Extraction of fats and Oils-Rendering, pressing, solvent extraction, pressing of oil- degumming, refining, bleaching, deodorization, fractionation, pyrolysis of fats, toxicity of frying oil.	12	CO4
V	Methods for the microbiological examination of foods. Food borne illness and diseases. Microbial cultures for food fermentation. Indian Factories Act on safety, HACCP, Safety from adulteration of food.	12	CO5
	Total	60	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Assess the fundamental concepts of food preservation.	PO1, PO3, PO5,PO6, PO8
CO2	Investigate the quality assessment of meat and fish.	PO1, PO5, PO6, PO7, PO8
CO3	Design the processing of milk and milk quality assessment.	PO1, PO5, PO6, PO7, PO8
CO4	Explain about the importance of fats and oils.	PO1, PO4, PO6, PO7, PO8
CO5	Plan the food safety and adulteration detection.	PO3, PO4, PO6, PO7, PO8

Text Books	
1.	Avantina Sharma. (2006). Text Book of Food Science and Technology, International Book Distributing Co, Lucknow, UP.

2.	Sivasankar. (2005). Food Processing and Preservation, 3rd Edition., Prentice hall of India Pvt Ltd, NewDelhi.
3	Ramaswamy H & Marcotte M. (2006). Food Processing: Principles & Applications. Taylor & Francis.
4	NIIR Board of Food and Technologist. (2005). Modern Technology of Food Processing and Agrobased industries, National Institute of Industrial Research, Delhi.
5	Adams M.R. and Moss M. O (2007). Food Microbiology. New Age International.
Reference Books	
1	Fellos PJ. (2005). Food Processing Technology: Principle &Practice 2nd Edition. CRC.
2	Peter Zeuthen and Leif Bogh-Sorenson. (2005). Food Preservation Techniques, Woodland Publishing Ltd, Cambridge, England.
3	Gustavo V. Barbosa-Canovas, Maria S. Tapia, M. Pilar Cano. (2004). Novel Food Processing Technologies, CRC.
4	Suman Bhatti, Uma Varma. (1995). Fruit and vegetable processing organizations and institutions, 1st Edition., CBS Publishing, New Delhi.
5	MirdulaMirajkar, Sreelatha Menon. (2002). Food Science and Processing Technology Vol-2,Commercial processing and packaging, Kanishka publishers, New Delhi.
Web Resources	
1	https://sites.google.com/a/uasd.in/ecourse/food-processing-technology
2	https://nptel.ac.in/courses/126105015
3	https://engineeringinterviewquestions.com/biology-notes-on-food-adulteration/
4	food processing | Definition, Purpose, Examples, & Facts | Britannica
5	Food Processing Technology | Food News & Views Updated Daily (foodprocessing-technology.com)

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods 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

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	M		M		S	M		S	
CO2	M				S	M	S	S	
CO3	M				S	M	S	S	
CO4	M			S		S	S	S	
CO5			M	M		M	S	S	

SEMESTER – IV SEC –VI PART - IV	23UMICS46 - SKILL ENHANCEMENT COURSE – VI: VACCINE TECHNOLOGY	CREDIT: 2 HOURS: 2/W

Course Objectives	
CO1	To provide knowledge on the basics of immunization and induction of immunity.
CO2	To learn the types of vaccines, its immunological effects and regulatory guidelines.
CO3	To learn the role of rDNA in vaccine technology.
CO4	To provide the knowledge on conventional to recent technology of vaccine production
CO5	To learn about ethical issues and regulations in vaccine production and clinical trials

Unit	Details	No.of Hours	Course Objectives
I	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,	3hrs	CO1
II	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.	6	CO2
III	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.	5	CO3
IV	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.	5	CO4
V	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.	5	CO5
	Total	24	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Explain the significance of critical antigens, immunogens and adjuvants in developing effective vaccines.	PO1,PO10
CO2	Understand the types of vaccines.	PO5
CO3	Construct vaccine applying rDNA technology.	PO7,PO10
CO4	Formulate the strategies for developing an innovative vaccine technology with different mode of vaccine delivery.	PO9,PO10
CO5	Evaluate the regulatory issues and guidelines for the management of vaccine production.	PO3,PO5
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 JK, Male D, Roitt IM. (2002). Clinical Immunology. 6th Edition, Gower Medical Publishing.	
References 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	

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks

	Total	100 Marks
Methods of Assessment		
Recall (KI)	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	
Analyse (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	

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	M									M	
CO2					S						
CO3							M			M	
CO4									L	M	
CO5			L		M						

SEMESTER – IV SEC –VII PART - IV	23UMICS47 - SKILL ENHANCEMENT COURSE – VII: APICULTURE	CREDIT: 2 HOURS: 2/W

Course Objectives	
CO1	To understand the biology of honey bees.
CO2	To study on honey bee colony establishment.
CO3	To develop knowledge on honey extraction.
CO4	To understand the diseases of honey bees and their control.
CO5	To gain information on financial assistance and funding agencies for bee keeping industry.

Unit	Details	No.of Hours	Course Objectives
I	Biology of Bees: Honeybee – Systematic position – Species of Honey bees – Life history of Honey bee – behaviour – swarming – Pheromone.	6	CO1
II	Social life in Bees: Bee colony – Castes – natural colonies and their yield – Types of bee hives – Structure – location, care and management.	6	CO2
III	Bee Rearing:Apiary – Care and Management – Artificial bee hives – types – construction of spaceframes – Selection of sites – Handling – Maintenance – Instruments employed in Apiary – Extraction instruments.	6	CO3
IV	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.	6	CO4
V	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.	6	CO5
	Total	30	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Understand the systematic position and life history of honey bee.	PO1, PO2, PO10
CO2	Reveal the different stages and types of bees and discuss about the care and management of apiculture.	PO1, PO2, PO4, PO5
CO3	Describe the practice of bee rearing process and analyze instruments employed in apiary.	PO2,PO4, PO5, PO10, PO11
CO4	Compare and contrast the composition of honey and bee wax and interpret the yield in National and International markets.	PO4, PO5, PO7, PO8, PO10
CO5	Clarify the proposal for financial assistance and funding agencies and reveal the modern methods employed in artificial bee hives.	PO5, PO8, PO9, PO10,

		PO11
Text Books		
1.	Dewey M. Caron. (2013). Honey Bee Biology and Beekeeping. Revised Edition. Wicwas Press, Kalamazoo. ISBN 10: 1878075292	
2.	R. A. Morse. (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.	
References 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 **a**nd 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://lupine publishers .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)	

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods 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

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S	S								S	
CO2	S	S		S	S						
CO3		S		S	M					S	S
CO4				S	M		S	S		M	
CO5					S			S	S	S	S

V- SEMESTER

SEMESTER: V CORE - IX PART - III	23UMICC51 - CORE – IX : BACTERIOLOGY AND MYCOLOGY		CREDIT: 4 HOURS: 5/W
Course Objectives			
CO1	Understand the role of normal flora and pathogenic microbes of various diseases and clinical microbiological techniques.		
CO2	Basic knowledge about Gram positive pathogenic bacteria and their epidemiology		
CO3	Acquire knowledge about Gram negative pathogenic bacteria and nosocomial infections		
CO4	Comprehensive knowledge about medically important, its classification and its significance		
CO5	Gain knowledge about the general characteristics and mode of action of various antibacterial agents		
Unit	**Details**	**No.of Hours**	**Course Objectives**
I	History, Classification of Medically Important Microbes, Normal microbial flora of the healthy human body – Host-pathogen interactions: Properties of pathogenic microorganisms, Types of infection, Types of Infectious Diseases, Transmission of Infectious Diseases – Pathogenicity and Virulence factors. Collection and transport of clinical specimens for bacterial and fungal infections.	12	CO1
II	Medically important Gram Positive infections - Causative agent, clinical symptoms, pathogenesis, mode of transmission, prevention and treatment of the following bacterial diseases (a) Streptococcal infections (*Streptococcus pyogenes*, *Streptococcus faecalis*), (b) Staphylococcal infections (*Staphylococcus aureus*), (c) Tetanus (*Clostridium tetani*)(d) Diphtheria (*Corynebacteriumdiphtheriae*) (e) Anthrax (*Bacillus anthracis*) (f) Tuberculosis (*Mycobacterium tuberculosis*), (g) Leprosy (*Mycobacterium leprae*).	12	CO2
III	Medically important Gram-Negative infections - Causative agent, clinical symptoms, pathogenesis, mode of transmission, prevention, and treatment of the following bacterial diseases (a) Meningitis (*Streptococcus pneumoniae, Neisseria meningitidis*) (b) typhoid (*Salmonella typhi, Salmonella paratyphi*) (c) cholera (*Vibrio cholerae*) (d) bacillary dysentery (*Shigelladysenteriae*); Sexually Transmitted disease (syphilis– *Treponemapallidum*. Gonorrhoea - *Neisseria gonorrhoeae*); Nosocomial infections – definition, importance, and their control (*Pseudomonas aeruginosa*).	12	CO3
IV	Medically important Fungi - Classification of medically important fungi; Superficial mycoses: PityriasisVersicolor; Tinea Nigra; Piedra. Cutaneous mycoses: *Microsporum* spps., *Trichophyton* spps., and *Epidermophyton floccosum*.	12	CO4

	Subcutaneous mycoses: Chromoblastomycosis; Sporotrichosis; Systemic Mycoses - Blastomycosis; Histoplasmosis; Opportunistic Infections -Candidiasis; Cryptococcosis; Zygomycosis; Mycotoxins: Aflatoxin		
V	Antimicrobial agents -General characteristics and mode of action of Antibacterial agents: Modes of action with an example for each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin.	12	CO5
	Total	60	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Understand the importance of normal flora of human body and acquire knowledge on the process of infectious disease.	PO1, PO3, PO5, PO7, PO10, PO11
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.	PO1, PO3, PO5, PO7, PO10, PO11
CO3	Compile a list of disease-causing bacteria and compare their modes of infection, symptoms, diagnosis and treatment.	PO1, PO3, PO5, PO7, PO10, PO11
CO4	Comprehend human-fungal interaction, which can be applied to obtain in-depth knowledge on fungal diseases and the mechanism behind the disease process.	PO1, PO3, PO5, PO7, PO10, PO11
CO5	Explain the types of mycoses caused in humans and categorize the modes of infection, pathogenesis, and treatment with introduction to mycotoxins.	PO1, PO3, PO4, PO5,PO6, PO7,PO9, PO10

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 Jayaram Panicker C.K. (2020) Text book of Microbiology. Orient Longman, Hyderabad.
5	Jagdish Chander (2018). Textbook of Medical Mycology, 4th edition, Jaypee brothers medical publishers.
References 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. Mac Callum, 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

Methods of Evaluation		
Internal Evaluation	**Continuous Internal Assessment Tests**	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participitation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods of Assessment	
Recall (KI)	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
Analyse (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

Mapping with Programme Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S		S		S		S			M	S
CO2	S		S		S		S			M	S
CO3	S		S		S		S			M	S
CO4	S		S		S		S			M	S
CO5	S		S	M	S	M	S		S	M	

SEMESTER: V CORE - X PART - III	23UMICC52 - CORE – X : VIROLOGY AND PARASITOLOGY	CREDIT: 4 HOURS: 5/W

Course Objectives	
CO1	To gain knowledge on properties and classification of viruses and collection of relevant clinical samples for diagnosing viral infections.
CO2	To understand pathogenic microorganisms of viruses and the mechanisms by which they cause disease in the human body.
CO3	To gain knowledge about re-emerging viral infections and develop diagnostic skills, including the use and interpretation of laboratory test in the diagnosis of infectious diseases.
CO4	Understand the types of parasites causing infections in the intestine.
CO5	To develop skills in the diagnosis of parasitic infections.

Unit	Details	No.of Hours	Course Objectives
I	General Properties, replication and Classification of viruses (Baltimore classification), Cultivation of viruses- in animals, embryonated eggs and tissue culture, Virus purification assays - collection and transport of clinical specimens for viral infections.	12	CO1
II	Viral diseases with reference to symptoms, pathogenesis, transmission, prophylaxis and control – Arboviruses (Flavi virus), Picorna viruses (Polio virus and Rhinovirus), Hepatitis viruses (HAV, HBV), Rabies virus, Orthomyoviruses (Influenza virus) and Paramyxoviruses (Mumps and Measles virus), Pox viruses (Variola, Vaccinia), Herpes simplex viruses, Adeno viruses, Rota viruses and HIV viruses.	12	CO2
III	Mechanism of viral Oncogenic viruses (Human Papilloma virus). Emerging and reemerging viral infections (SARS, Swine flu, Ebola, Dengue, Chikungunya- and Corona) – causes, spread and preventive measures. Detection of viruses in clinical specimens – Serological and Molecular diagnosis of virus infections – Antiviral agents, Interferons and Viral Vaccines, Immunization schedules.	12	CO3
IV	General introduction to Medical Parasitology, Classification of medically important parasites. Morphology, life cycle, pathogenesis, clinical features, laboratory diagnosis, prevention and treatment of diseases: *Entameoba histolytica, Giardia lamblia, Leishmania donovani*, Trypanosomiasis, Toxoplasma gondii. Sporozoa- *Plasmodium* spps.	12	CO4
V	Introduction to Helminthes, –*Echinococcus granulosus, Schistosoma haematobium,* Ascaris lumbricoides, *Ancylostoma duodenale, Enterobius vermicularis, Wuchereria bancrofti Taenia infection.* Collection, transport and examination of faeces for ova and cyst by direct wet mount and iodine wet mount, Concentration methods (Floatation and Sedimentation	12	CO5

	techniques), Examination of blood for parasites. Cultivation of parasites.		
	Total	60	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Understand the structure and properties of viruses, cultivation methods and diagnosis of viral diseases.	PO5,PO10
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.	PO5,PO10
CO3	Insights to treatment options of viral diseases.	PO5,PO10
CO4	Knowledge about the importance of protozoans in the intestine.	PO5,PO10
CO5	Knowledge of Nematodes as infectious agent	PO5,PO10

TEXT BOOKS	
1.	S., Rajan(2007). Medical microbiology, MJP publisher.
2.	Jeyaram Paniker, C.K. (2006). Text Book of Parasitology Jay Pee Brothers,New Delhi.
3	AroraD.R. and AroraB. (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, All India Publishers & Distributors.

References Books	
1	Jawetz, E., Melnick, J.L. and Adelberg, E.A. (2000). Review of Medical Microbiology, 19th Edition. Lange Medical Publications, U.S.A.
2	Ananthanarayan, R. and JeyaramPaniker, C.K. (2009). Text Book of Microbiology, 8th Edition. Orient Longman, Chennai .
3	Conrat HF, Kimball PC and Levy JA. (1988). Virology. II edition. Prentice Hall, Englewood Cliff, New Jersey..
4	Topley& Wilsons's (1990). Principles of Bacteriology, Virology and Immunity, 8th Edition, Vol. III Bacterial Diseases, Edward Arnold, London.
5	Finegold, S.M. (2000). Diagnostic Microbiology, 10th Edition. C.V. Mosby Company,St.Louis.

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

Methods of Evaluation		
Internal	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	

Evaluation	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods of Assessment	
Recall (KI)	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
Analyse (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

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1					M					M	
CO2					M					M	
CO3					M					M	
CO4					M					M	
CO5					M					M	

SEMESTER: V CORE - XI PART – III	23UMICP53 - CORE – XI : PRACTICAL V : Covering Core IX & X	CREDIT: 4 HOURS: 5/W

Course Objectives	
CO1	To familiarize students with medical microbiology techniques and technical knowledge on collection and processing of clinical samples.
CO2	To learn the techniques for isolation and identification of bacterial pathogens.
CO3	To gain expertise in various techniques of clinically important viral pathogens and their identification.
CO4	To get acquainted with medically important fungi and their metabolism.
CO5	To categorize parasites and understand their role in infections.

Unit	Details	No.of Hours	Course Objectives
I	1. Collection and Transport of Clinical specimens. 2. Simple, Differential and Special staining of Clinical materials. 3. Culture techniques used to isolate microorganisms.	12	CO1
II	4. Identification of bacterial pathogens by their biochemical reactions. 5. Antimicrobial susceptibility testing by disc-diffusion technique and determination of Minimum Inhibitory Concentration.	12	CO2
III	6. Isolation of Bacteriophages from Sewage and other natural sources. 7. Identification of Viruses in Slides/Smears/Spotters. Demonstration of Negri bodies (Staining). 8. Cultivation of Viruses in Embryonated eggs – Amniotic, Allantoic, Yolk sac routes and Chorio-allantoic membrane.	12	CO3
IV	9. Microscopic identification of medically important Fungi – KOH and Lactophenol cotton Blue staining. 10. Slide culture techniques for fungal Identification 11. Identification of Dermatophytes. 12. Germ tube test, Carbohydrate fermentation and assimilation tests for Yeasts.	12	CO4
V	13. Direct Examination of Faeces – wet mount and Iodine mount – Demonstration of Protozoan cysts and Helminthes eggs. 14. Concentration techniques of stool specimen – Floatation and Sedimentation methods. 15. Examination of blood for malarial parasites – thin and thick smears preparations. 16. Identification of Medically important parasites in slides / specimens as spotters. Visit any industry and submit the report.	12	CO5

	Total	60	
Course Outcomes			
Course Outcomes	On completion of this course, students will;		
CO1	Demonstrate methods to observe and measure microorganisms by standard microbiological techniques		PO4, PO5, PO7.
CO2	Identify pathogenic microorganisms in the laboratory set-up and interpret their sensitivity towards commonly administered antibiotics.		PO4, PO5, PO7, PO8.
CO3	Understand experimental tools used to cultivate and characterize clinically important viruses and bacteriophages		PO4, PO5, PO7, PO8.
CO4	Elucidate clinically important fungi.		PO4, PO5, PO7, PO8.
CO5	Investigate Parasites of medical importance and identify them from clinical specimens.		PO4, PO5, PO7, PO8.
Text Books			
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.		
4	Prince CP (2009). Practical Manual of Medical Microbiology, Ist edition, Jaypee digital publishing.		
5	James H. Jorgensen, Karen C. Carroll, Guido Funke, Michael A. Pfaller, Marie Louise Landry, Sandra S. Richter, David W. Warnock (2015). Manual of Clinical Microbiology, 11th Edition, ASM press		
References 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 EckelMizer (2002). Laboratory Manual and Workbook in Microbiology. 7th Edition. The McGraw Hill Company. ISBN: 0-07-246354-6.		
5	Rowland, S.S., Walsh, S.R., Teel, L.D. and Carnahan, A.M. ((1994). Pathogenic and Clinical Microbiology: A Laboratory Manual. Lippincott Williams & Wilkins. ISBN-10: 0316760498, ISBN-13: 9780316760492.		
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_amuz		

	eshi/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/

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods 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

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1				S	M		S				
CO2				S	S		S	L			
CO3				S	S		S	L			
CO4				S	S		S	L			
CO5				S	S		S	L			

SEMESTER: V CORE - XII PART - III	23UMICD54 PROJECT WITH VIVA-VOCE	CREDIT: 4 HOURS: 5/W

Group projects enable students to get hands-on training in microbiological techniques needed for research. Thus the students can share diverse perspectives resulting in pooling of knowledge and skills. Group work may approach tasks and solve problems in novel, interesting ways, thereby converting established theoretical concepts to practical skills. If structured properly, it will promote team work and collaboration. Group projects also will help students to choose a research design, solve real life problems and benefit the society at large. Thus group project facilitates the students to convert ideas to practice thereby creating a research culture among students.

Guidelines for group project:

A research problem need to be selected based on creative ability and scientific thought.
A brief description of the problem needs to be given.
Hypothesis statement should be framed.
Objectives by which the project work is to be carried out should be clearly stated.
Methodology has to be designed to test the hypothesis.
Results obtained need to be replicable.
Documented report has to be submitted on completion of the project.

(Refer to regulations for additional information)

SEMESTER: V ELECTIVE: V PART - III	23UMICE55 - ELECTIVE – V : RECOMBINANT DNA TECHNOLOGYs	CREDIT: 3 HOURS: 4/W

Course Objectives	
CO1	Understand the principles of rDNA technology.
CO2	Illustrate the molecular tools employed in gene cloning.
CO3	Discuss the importance of various molecular techniques and their importance in Biotechnology.
CO4	Acquire knowledge about the concepts of tissue culture methods and transgenic organisms.
CO5	Examine recent trends in genetic engineering and its application in human welfare.

Unit	Details	No. of Hours	Course Objectives
I	Milestonesinr DNA Technology – Gene Manipulation-Steps involved in Gene Cloning. Isolation of Chromosomal and Plasmid DNA. Restriction endonuclease - Discovery, Types, Mode of action-Application of Ligase, DNA Polymerase, DNA Modifying enzymes and Topoisomerases. Use of Linkers and Adapters.	12	CO1
II	Artificial Gene Transfer methods Calcium Chloride Induction, Electroporation, Microinjection, Biolistic method, Liposome and Viral-mediated delivery. Cloning vectors – Properties and Applications - Plasmid Based Vectors- Natural Vectors-pSC101 and pMB1.Artificial Vectors- pBR322 and pUC. Phage Based Vectors- Lambda phage. Genomic DNA and cDNA library-Construction and Screening.	12	CO2
III	Molecular Tools- PCR- Types. Gel Electrophoresis- AGE and PAGE Blotting Techniques-Southern, Western and Northern. DNA sequencing methods-Sanger's and automated method. Recent Trends in Genetic Engineering- Targeted Genome Editing- CRISPRs. DNA Finger Printing,	12	CO3
IV	Plant Biotechnology – Media, Growth Regulators and Equipment for Plant Tissue Culture-Explant Culture- Micro propagation- Callus and Protoplast Culture-Production of Bio-Active Secondary Metabolites by Plant Tissue Culture –Animal Biotechnology-Principles of Animal Cell Culture, Media and Equipment for Animal Cell Culture – Primary and Secondary Cultures- Cell Lines-Types, Establishment and Maintenance of Cell Lines.	12	CO4
V	Applications of Genetic Engineering - Transgenic Animals – Mice - Human Gene Therapy-Germline and Somatic Cell Therapy-*Ex-vivo* Gene Therapy-SCID (Severe Combined Immuno Deficiency) – *In-vivo* Gene Therapy- CFTR	12	CO5

	(Cystic Fibrosis Transmembrane Regulator) Transgenic Plants–Bt Cotton and Golden Rice.		
	Total	60	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Illustrate the steps involved in introduction and expression of foreign DNA into bacteria, animal and plants cells and their screening.	PO4, PO6, PO7, PO9
CO2	Discuss the various cloning vectors and their applications.	PO4, PO6, PO7, PO9
CO3	Assess the usage and advantages of molecular tools.	PO4, PO6, PO7, PO9
CO4	Explain plant and animal tissue culture protocols and gene transfer mechanism.	PO4, PO6, PO7, PO9
CO5	Elucidate and understand the application of genetic engineering and gene therapy.	PO4, PO6, PO7, PO9

Text Books	
1.	Brown T.A.(2016). Gene Cloning and DNA Analysis. 7thEdition . 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, I Edition,Alpha Science International Ltd

References Books	
1.	Maloy S. R., Cronan J.E. Jr. and Freifelder, D.(2011). Microbial Genetics. 2nd Edition. Narosa Publishing Home Pvt Ltd.
2.	Glick B. R. and Patten C.L.(2018). Molecular Biotechnology – Principles and Applications of Recombinant DNA. 5th Edition. ASM Press.
3.	Russell P.J. (2010). iGenetics - A Molecular Approach, 3rd Edition. Pearson New International Edition.
4.	Synder L., Peters J. E., Henkin T.M. and Champness W. (2013). Molecular Genetics of Bacteria,4th Edition. ASM Press Washington-D.C. ASM Press.
5.	James D.Watson, Michael Gilman, Jan Witkowski, 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

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods of Assessment	
Recall (KI)	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
Analyse (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

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1				S	L	S	S	M	S		
CO2				S	L	S	S	M	S		
CO3				S	L	S	S	M	S		
CO4				S	L	S	S	M	S		
CO5				S	L	S	S	M	S		

SEMESTER: V ELECTIVE: VI PART - III	23UMICE56 - ELECTIVE – VI : sBIOSAFETY & BIOETHICS		CREDIT: 3 HOURS: 4/W
Course Objectives			
CO1	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		
CO2	Rights in order to assist their application and promotion in the areas of science, biotechnology and medicine.		
CO3	To discuss about various aspects of biosafety regulations, IPR and bioethics concerns arising from the commercialization of biotech products.		
CO4	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.		
CO5	To understand the importance of IPR, Patents and Patent laws.		
Unit	**Details**	**No.of Hours**	**Course Objectives**
I	Basics of Biosafety - Laboratory Hazards and Hazard symbols. Definitions on Biohazard, Biosafety and Biosecurity- Biohazard- LAI, BP. Biohazard Classification. Biological Risk Groups. Need and application of biosafety. Good Laboratory Practices (GLP), Good Manufacturing Practices (GMP).	12	CO1
II	Hazardous materials in Biotechnology - Categories of Waste in the Biotechnology Laboratories, Biohazardous waste and their disposal and treatments- issues in use of GMO's, risk for animal/human/ agriculture and environment owing to GMO. Hazardous materials, Emergency response/ first aids in Laboratories.	12	CO2
III	Biological Safety Containment in Laboratory - Primary and secondary containments - Physical and biological containment. Types of biosafety containments (level I, II, III), PPE, Biosafety guidelines in India - Roles of Institutional Biosafety Committee, RCGM, GEAC.	12	CO3
IV	Introduction and need of Bioethics - its relationship with other branches, Ethical implications of biotechnological products and techniques. Ethical Issues involving human cloning, human genome project, prenatal diagnosis, agriculture and animal rights, Social and ethical implications of biological weapons.	12	CO4
V	IPR, Patents and Patent laws - Intellectual property rights- TRIP- GATT International conventions patents, Methods of application of patents, Legal implications. Biodiversity and farmer rights, Objectives of the patent system, Basic principles and general requirements of patent law, Biotechnological inventions, and patent law. Legal	12	CO5

	development-Patentable subjects and protection in biotechnology. The patenting of living organisms.		
	Total	60	
Course Outcomes			
Course Outcomes	On completion of this course, students will;		
CO1	Understand the control measures of laboratory hazards (chemical, biological and physical) and to practice safety strategies and personal protective equipment		PO1, PO2, PO3, PO7, PO10
CO2	Develop stratagems for the use of genetically modified organisms and Hazardous materials		PO1, PO3, PO4
CO3	Develop skills of critical ethical analysis of contemporary moral problems in medicine and health care.		PO1, PO6
CO4	Analyze and respond to the comments of other students regarding philosophical issues.		PO3, PO4
CO5	Pave the way for the students to catch up Intellectual Property(IP) as a career option a. R&D IP Counsel b. Government Jobs – Patent Examiner c. Private Jobs d. Patent agent and Trademark agent e. Entrepreneur		PO1, PO7, PO10
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.		
References 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	Edited by Sylvia Uzochukwu, Nwadiuto (Diuto) Esiobu, Arinze Stanley Okoli, Emeka Godfrey Nwoba, EzebuiroNwagboChristpeace, Charles OluwaseunAdetunji, 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

Methods of Evaluation

Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods 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

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S	S	S				M			M	
CO2	S		S	S							
CO3	S					S					
CO4			S	S							
CO5	S						M			S	

SEMESTER: V PART – IV	23UMICI58 SUMMER INTERNSHIP	CREDIT: 2 HOURS: -

(Refer to the Regulations)

sVI - SEMESTER

SEMESTER: VI CORE - XIII PART - III	23UMICC61 - CORE – XIII : ENVIRONMENTAL AND AGRICULTURE MICROBIOLOGY		CREDIT: 4 HOURS: 6/W
Course Objectives			
CO1	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.		
CO2	To acquire knowledge about the role of microorganism in water pollution and water quality		
CO3	Gain knowledge about microbes as biofertilizers and the aspects of application.		
CO4	To learn about the process of solid waste management and sewage water treatment.		
CO5	Gain knowledge on various plant diseases and pathogens		
Unit	**Details**	**No. of Hours**	**Course Objectives**
I	Microorganisms and their Habitats: Structure and function of ecosystems/Terrestrial Environment: Soil profile and soil microflora. Role of microorganisms in elemental cycles in nature: Carbon, Nitrogen. Aquatic Environment: Microflora of fresh water (lakes and ponds) and marine habitats (ocean, sea). Atmosphere: Aeromicroflora and dispersal of microbes, Assessment of air quality, Air sanitation. Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels.	12	CO1
II	Water potability: Sources and types of water surface, ground, stored, distilled, mineral and de-mineralized water and their pollution, biological indicators of water Pollution, Eutrophication. Conventional Bacteriological standards of Water Quality, MPN index, coliform test, Membrane filtration. BOD, COD. Advanced molecular methods for water analysis. Water borne diseases. Central Pollution Control Board (CPCB) standards**.**	11	CO2
III	Microbial Interactions: Rhizosphere microflora. Concepts of Nitrogen fixation – Symbiotic and asymbiotic nitrogen fixers. Brief account of microbial interactions: Symbiosis, neutralism, commensalism, competition, Ammensalism, Synergism, parasitism, and predation. General account and Significance of Biofertilizers – Bacterial, cyanobacterial, VAM. Mass production of Rhizobial biofertilizer. Biocontrol agents – Bacterial, viral, fungal.	12	CO3
IV	Waste treatment and bioremediation**:** Solid waste management: Sources and types of solid waste, composting, vermicomposting, production of biogas. Liquid waste management: Primary, secondary, and tertiary sewage treatment. Bioremediation and waste management: Need and	15	CO4

	scope of bioremediation. Degradation of hydrocarbons, oil spills, heavy metals – Chromium, lead, and xenobiotics – PCB.		
V	Plant pathology: Mode of entry of pathogens, Microbial enzymes, toxins, growth regulators and suppressor of plant defense in plant diseases. Plant defense mechanisms. Bacterial diseases – Citrus canker, Blight of paddy. Viral disease – TMV, CMV. Fungal disease- red rots of sugarcane, Tikka disease. Plant disease management.	10	CO5
	Total	60	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Describe about the structure and function of ecosystems and understand the role of microbes in various environments	PO1
CO2	Identify the cause of water pollution, and perform methods to assess the quality of water.	PO4,PO5,PO6, PO7,PO8
CO3	Explain the production of biofertilizers and biopesticides.	PO1, PO7,PO8
CO4	Explain about waste treatment process and microbial decomposition and bio-remediation process.	PO6
CO5	Describe about plant diseases caused by microbes and acquire a clear idea on plant pathogenic interaction	PO1,PO5

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.	K. Vijaya Ramesh.(2004).Environmental Microbiology. 1st Edition. MJP Publishers.
5.	SubbaRao.N.S.(2017). Soil Microbiology.4th Edition. Oxford and IBH Publishing Pvt.Ltd.

References 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.
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 andApplications, 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

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods of Assessment	
Recall (KI)	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
Analyse (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

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S										
CO2				M	S	S	S	S			
CO3	S						S	S			
CO4						S					
CO5	M				M						

SEMESTER: VI CORE - XIV PART - III	23UMICC62 - CORE – XIV: FOOD, DAIRY AND PROBIOTIC MICROBIOLOGY	CREDIT: 4 HOURS: 6/W

Course Objectives	
CO1	To impart current knowledge of basic and applied microbiological aspects of fluid milks and dairy products for improved quality and food safety.
CO2	Gives an insight into various types of food borne diseases and their prevention
CO3	To gain information about microflora of milk
CO4	To study about the production of fermented dairy products
CO5	To impart current knowledge of probiotics, prebiotics and functional dairy foods for the health benefits
CO6	To create a sustainable environmentally and technologically advanced dairy farm

UNIT	Details	No.of Hours	Course Objectives
I	Food as a substrate for micro organisms- Micro organisms important in food microbiology; Molds, yeasts and bacteria - General Characteristics - Classification and importance. Principles of food preservation - Asepsis - Removal of micro organisms, - High temperature - Low temperature - Drying - Food additives. Nanoscience in food preservation; microencapsulation.	12	CO1
II	Contamination and spoilage of food products -Food borne infections (*Bacillus cereus, Salmonellosis, Shigellosis*, *Listeria monocytogenes* and *Campylobacter jejuni*) and intoxications – (*Staphylococcus aureus*, *Clostridium botulinum*, *Clostridium perfringens* and mycotoxins) Food borne disease outbreaks - newly emerging pathogens. Conventional and Novel technology in control of food borne pathogens and preventive measures - Food sanitation - plant sanitation - Employees' health standards. Regulatory Agencies &criteria for food safety.	15	CO2
III	Microflora of raw milk - sources of contamination. Spoilage and preservation of milk and milk products. - antimicrobial systems in raw milk. Importance of biofilms, their role in transmission of pathogens in dairy products and preventive strategies.	15	CO3
IV	Food fermentations: Indian Pickles Bread, vinegar, fermented vegetables (sauerkraut), fermented dairy products (yoghurt, cheese, Acidophilus Milk, Kefir, Koumiss). Oriental fermented foods-Miso –Tempeh **Ontjom. Natto, Idli** Spoilage and defects of fermented dairy products -. Functional fermented foods and nutraceuticals, bioactive proteins and bioactive peptides, genetically modified foods.	15	CO4
V	Probiotic microorganisms, concept, definition safety of probiotic microorganisms, legal status of probiotics Characteristics of Probiotics for selection: stability maintenance of probiotic microorganisms. Role of probiotics in health and disease:	15	CO5

	Mechanism of probiotics. Application of bacteriocins in foods. Biopreservation. Prebiotics: concept, definition, criteria, types and sources of prebiotics, prebiotics and gut microflora - Prebiotics and health benefits: mineral absorption, immune response, cancer prevention, elderly health and infant health, prebiotics in foods.		
	Total	72	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Gain knowledge about food as a substrate for various microbes, Understand about the principles and application of different types of food spoilage and preservation technique,	PO7,PO8,PO10
CO2	Acquire a thorough understanding of food borne diseases, testing methods, and preventive technique	PO5,PO10
CO3	Gain information about spoilage of milk and its products and its antimicrobial properties	PO5,PO7
CO4	Learn about the various fermented product and its various stage spoilage	PO7,PO8,PO10
CO5	Impart current knowledge of probiotics, prebiotics and functional dairy foods for the health benefits	PO5,PO6

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. 1997.
References Books	
1	Jay JM, Loessner MJ and Golden DA.(2005). Modern Food Microbiology. 7th Edition CBS Publishers and Distributors, Delhi, India.
2	Prescott, Harley and Klein Wim.(2008). Microbiology, 7th Edition McGraw Hill Publications.
3	Robinson, R. K.(2002). Dairy Microbiology Handbook - The Microbiology of Milk and Milk Products (Third Edition), A John Wiley & Sons, Inc., New York.
4	Yuankunlee,Sepposalminen. (2008). Handbook of probiotics and prebiotics Second Edition. A John Wiley & Sons publication Inc.
5	DharumauraiDhansekaran, AlwarappanSankaranarayanan. (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/5a1d2e02aca2726120 b28eba/download
2	https://www.fda.gov/food/laboratory-methods-food/bam-foodsamplingpreparation-

	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

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods of Assessment	
Recall (KI)	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
Analyse (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

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1							S	S		M	
CO2					S					M	
CO3					S		M				
CO4							S	S		M	
CO5					M	M					

SEMESTER: VI CORE - XV PART - III	23UMICP63 - CORE – XV: PRACTICAL VI: Covering Core XIII & XIV		CREDIT: 4 HOURS: 6/W
Course Objectives			
CO1	Toassess the water quality and potability.		
CO2	To acquire knowledge on enumeration of bacteria from milk and milk quality analysis		
CO3	To investigate various extracellular enzyme producers in soil and to gain knowledge on preparation of biofertilizers		
CO4	Improve knowledge on plant pathogens		
CO5	To acquire knowledge on preparation of probiotics and prebiotics		
Unit	**Details**	**No.of Hours**	**Course Objectives**
I	1. Physical, chemical, and microbiological assessment of water and potability test forwater. ✓ Physical a – Color, pH, ✓ Chemical - alkalinity, acidity, DO, BOD, COD ✓ Microbiological – MPN index (Presumptive, Completed and Confirmatory test) 2. Study of air microflora by settle plate method.	12	CO1
II	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.	12	CO2
III	7. Isolation of extracellular enzyme producers –Amylase, protease, lipase 8. Microbiological assay of antibiotics by cup plate method and other methods 9. Isolation of *Rhizobium*/ *Azotobacter*/ phosphate solubilizing organisms 10. Preparation of biofertilizers – Demonstration	12	CO3
IV	11. Study of plant pathogens- Tikka Disease, Red rot of sugarcane, Citrus canker, Blight of paddy. 12. Study of fungi - *Mucor,Curvularia, Alternaria, Rhizopus, Aspergillus*	10	CO4
V	13. Isolation of constituent flora of fermented milk. 14. Growth of probiotic LAB in broth, milk and whey. 15. Preparation of probiotic fermented milks like dahi, yoghurt, lassi and whey drink. 16. Effect of prebiotics on the growth of LAB in milk and broth. 17. Survivability of probiotic organisms in fermented milks. 18. Antimicrobial potential of the functional dairy products. 19. Visit any food, dairy, Agricultural and Pharmaceutical industry and submit the report.	14	CO5
	Total	60	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Assess the microbial quality of water and relate the experimental results to the prescribed standards by the statutory bodies	PO1, PO4,PO5,PO6, PO7, PO8
CO2	Evaluate the quality of milk and enumerate bacteria in milk by standard plate count method	PO5,PO6, PO7, PO8
CO3	Identify extracellular enzyme producing and nitrogen fixing microorganism form soil and to prepare a biofertilizer.	PO1,PO8
CO4	Identifyvarious plant pathogenic bacteria	PO1
CO5	Synthesize probiotic fermented milks using microorganisms	PO1,PO7,PO8
Text Books		
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	
5.	Aneja, KR.(2010). Experiments in Microbiology, Plant pathology and Biotechnology. New Age International (P) Limited.	
References 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	
Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks

	Total	100 Marks
Methods of Assessment		
Recall (KI)	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	
Analyse (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	

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S			M	S	S	S	S
CO2					M	M	M	M
CO3	M							S
CO4	M							
CO5	M						S	S

SEMESTER: VI ELECTIVE: VII PART - III	23UMICE64 - ELECTIVE – VII : PHARMACEUTICAL MICROBIOLOGY		CREDIT: 3 HOURS: 5/W
Course Objectives			
CO1	To provide the knowledge on basics of chemotherapy		
CO2	To learn the assays and testing methods of antibiotics.		
CO3	To gain information about spoilage of pharmaceutical products		
CO4	To provide the knowledge on drug discovery and clinical trials		
CO5	To learn about regulations in pharmaceutical industry		
Unit	**Details**	**No.of Hours**	**Course Objectives**
I	Introduction to Pharmaceutical microbiology: Ecology of microorganisms in pharmaceutical industry: Atmosphere, water, skin and respiratory flora of workers, raw materials, packaging, building and equipments and their control measures; Design and layout of sterile manufacturing.	12	CO1
II	Microbial contamination and spoilage of pharmaceutical products: Microbial aspects of pharmaceutical products; Sterilization of pharmaceutical products: Heat, gaseous, radiation and filtration; Contamination and Spoilage of Pharmaceutical products: sterile injectable and non-injectable, ophthalmologic preparation, implants.	10	CO2
III	Production of antibiotics: Production of antibacterial – Tetracycline; antifungal- Amphotericin; antiparasitic agents - Metronidazole; Additional application of microorganisms in pharmaceutical sciences: Enzymes- L-asperginase and clinical dextrin; Immobilization procedures for pharmaceutical applications (liposomes).	12	CO3
IV	Production of immunological products and their quality control: Vaccines - DNA vaccines, synthetic peptide vaccines, multivalent vaccines; Vaccine clinical trials; Immunodiagnostics - immuno sera and immunoglobulin. Quality control in Pharmaceutical: In – Process and Final Product Control; Sterility tests.	16	CO4
V	Quality Assurance and Validation: Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry; Regulatory aspects of quality control; Quality assurance and quality management in pharmaceuticals – BIS (IS), ISI, ISO, WHO and US certification.	10	CO5
	Total	60	
Course Outcomes			
Course Outcomes	On completion of this course, students will;		

CO1	Learn the basics of chemotherapy and action of antibiotics	PO1,PO10
CO2	Carry out the microbiological assay of antibiotics	PO7
CO3	Analyse Microbiological standardization of Pharmaceuticals, sterility testing of pharmaceutical products Apply sterilization in pharmaceutical industry	PO5,PO8,PO10
CO4	Evaluate the process and develop new strategies for rational drug design	PO9,PO10
CO5	Learn the Regulatory guidelines in pharmaceuticals product.	PO3,PO5
Text Books		
1.	Chand Pasha Kedernath. (2021). Text book of Pharmaceutical Microbiology. Ramnath Publisher.	
2.	Hugo WB and Russell AD. (2004).Pharmaceutical Microbiology VII edition. Blackwell Scientific Publication, Oxford.	
3	Franklin,DJ. and Snow, GA. (2013). Biochemistry of antimicrobial action.Chapman& Hall.	
4	Kuntal Das (2019). Pharmaceutical Microbiology, second edition, NiraliPrakashan.	
5	PriyatamaPowar, Shital Nimbargi, VaijayantiSapre (2020). Pharmaceutical Microbiology, I edition, Technical publications.	
References Books		
1	Handa, S.S. and Kapoor, V.K. (2022) .Pharamcognosy. 4thEdition.VallabhPrakashanPublishers,New Delhi.	
2	Kokate, C.K., Durohit, A.P. and Gokhale, S.R.,(2002). Pharmacognosy. 12thedition NiraliPrakasham Publishers, Pune.	
3	S. P. Vyas & V. K. Dixit.(2003). Pharmaceutical Biotechnology. CBS Publishers & Distributors, New Delhi.	
4	Wallis, T.E. (2005). Text book of Pharmacognosy. 5th edition. CBS publishers and distributors, New Delhi.	
5	Garrod, L.P., Lambert, HP. And C'Grady, F. (1973). Antibiotics and Chemotherapy. (eds). Churchill Livingstone.	
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	

Methods of Evaluation

Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods of Assessment

Recall (KI)	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
Analyse (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

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	M									M	
CO2							M				
CO3					S			M		M	
CO4									L	M	
CO5			L		M						

SEMESTER: VI ELECTIVE: VIII PART - III	23UMICE65 - ELECTIVE – VIII : ENTREPRENEURSHIP AND BIO-BUSINESS		CREDIT: 3 HOURS: 5/W
Course Objectives			
CO1	Understanding basic concepts in the area of entrepreneurship, the role and importance of entrepreneurship for economic development		
CO2	Developing personal creativity and entrepreneurial initiative, adopting the key steps in the elaboration of business idea.		
CO3	Understanding the stages of the entrepreneurial process and the resources needed for the successful development of entrepreneurial ventures.		
CO4	Explain the central components of successful business strategies in biotechnology, and create a business plan.		
CO5	Understand the various funding resources and develop as Entrepreneur		
Unit	**Details**	**No.of Hours**	**Course Objectives**
I	Bio Entrepreneurship: Introduction to bio-business, SWOT analysis of bio-business. Ownership, Development of Entrepreneurship; Stages in entrepreneurial process; Government schemes and funding. Small scale industries: Definition; Characteristics; Need and rationale.	12	CO1
II	Entrepreneurship Opportunity in Agricultural Biotechnology: Business opportunity, Essential requirement, marketing, strategies, schemes, challenges and scope-with case study on Plant cell and tissue culture technique, polyhouse culture. Herbal bulk drug production, Nutraceuticals, value added herbal products. Bioethanol production using Agricultural waste, Algal source. Integration of system biology for agricultural applications. Biosensor development in Agriculture management.	12	CO2
III	Entrepreneurship Opportunity in Industrial Biotechnology**:** Business opportunity, Essential requirement, marketing strategies, schemes, challenges, and scope- Pollution monitoring and Bioremediation for Industrial pollutants. Integrated compost production- microbe enriched compost. Bio pesticide/ insecticide production. Biofertilizer. Single cell protein.	12	CO3
IV	Therapeutic and Fermented products: Stem cell production, stem cell bank, production of monoclonal/polyclonal antibodies, secondary metabolite production – antibiotics, probiotic and prebiotics.	12	CO4
V	Project Management, Technology Management and Startup Schemes: Building Biotech business challenges in Indian context-biotech partners (BIRAC, DBT, Incubation centers. etc.,), operational biotech parks in India. Indian Company act for	12	CO5

	Bio business-schemes and subsidies. Project proposal preparation, Successful start-ups-case study.		
	Total	60	
Course Outcomes			
Course Outcomes	On completion of this course, students will;		
CO1	Describe and apply several entrepreneurial ideas and business theories in practical framework.	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11, PO12, PO13, PO14	
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.	PO2, PO5, PO7, PO8, PO10, PO12, PO14	
CO3	Express the mass production of microbial inoculants used as Biofertilizers and Bioinsecticides in response with field application and crop response.	PO4, PO6, PO9, PO11	
CO4	Analyze the application and commercial production of Monoclonal antibodies, Cytokines. TPH and teaching kits.	PO5, PO6, PO9, PO11	
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.	PO2,PO7, PO8	
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 Scholorly 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.		
References Books			
1	Crueger, W, and Crueger. A.(2000). Biotechnology: A Text Book of Industrialmicrobiology, 2nd Edition, Sinauer Associates: Sunderland.Mass.		
2	Paul S Teng. (2008). Bioscience Entrepreneurship in AsiaWorld Scientific Publishing Company.		
3	Charles E. Bamford, Garry D. Bruton (2015). ENTREPRENEURSHIP: The Art, Science, and Process for Success, 2nd Edition, McGraw Hill publisher.		
4	Yali Friedman (2014). Building Biotechnology: Biotechnology Business,		

	Regulations, Patents, Law, Policy and Science 4th Edition, Logos press publication.
5	Stephanie A. Wisner (2022). Building Backwards to Biotech: The Power of Entrepreneurship to Drive Cutting-Edge Science to Market, International Kindle paperwhite.
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

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods 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
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Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S	S	S	S	S	S	S	S	S	S	S
CO2		S			M		S	S		M	
CO3											
CO4				S		S			S		S
CO5		S					S	S			

SEMESTER: VI PART - IV	23UMICF66 - PROFESSIONAL COMPETENCY SKILL- MICROBIAL QUALITY CONTROL AND TESTING		CREDIT: 2 HOURS: 2/W
Course Objectives			
CO1	To understand the use of various advanced techniques for application in the field of quality control and quality assurance.		
CO2	To cultivate skills involved execution of microbiological techniques and to develop the good laboratory practices.		
CO3	To ensure the food safety regulations and its standards.		
CO4	To acquire knowledge on laboratory testing, Control & safety process.		
CO5	To analyze microbial standards to establish the quality of food products.		
Unit	**Details**	**No. of Hours**	**Course Objectives**
I	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.	12	CO1
II	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.	12	CO2
III	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, McConkey Agar, Saboraud Agar.	12	CO3
IV	Determining Microbes in Pharmaceutical Samples**:** Sterility testing for pharmaceutical products, Bioburden, pyrogen test, inprocess and final process control, safety and sterility test.	12	CO4
V	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	12	CO5

	methods of microbiological quality of milk at milk collection centers.		
	Total	60	
Course Outcomes			
Course Outcomes	On completion of this course, students will;		
CO1	Understand the theoretical assessment of microbial quality methods and its good laboratory practices.		PO1, PO5, PO6, PO9, PO10
CO2	Describe the microbiological aspects of quality control of food and pharmaceutical products.		PO1, PO4, PO5, PO6
CO3	Explain the identification of pathogenic microorganisms and good laboratory practices.		PO1, PO3, PO5, PO6, PO9
CO4	Acquire the knowledge of different sterility test for the pharmaceutical products.		PO1, PO4, PO5, PO6
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.		PO1,PO3, PO4, PO5, PO6, PO9, PO10
Text Books			
1	W.B.Hugo&A.D.Russell. (1998). Pharmaceutical Microbiology.6thEdition. Blackwell scientific Publications.		
2	Kulkarni A. K. Bewoor V. A. ()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 V K Joshi (2011).Quality Control For Value Addition In Food Processing, New India Publishing Agency.		
References 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)SVikas 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	
Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks
Methods 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	

Mapping with Programme Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S				S	S			S	S	
CO2	S			M	M	M					
CO3	S		M		S	S			M		
CO4	S			S	M	M					
CO5	S		S	M	S	S			S	S	

□□□□□□

SEMESTER: VI PART – V	23UMICX67 EXTENSION ACTIVITY	CREDIT: 1 HOURS: -

(Refer to the Regulations)