U26

THIRUVALLUVAR UNIVERSITY

SERKKADU, VELLORE–632115

B.Sc. MICROBIOLOGY

SYLLABUS

FROM THE ACADEMIC YEAR

2023 – 2024

Contents

LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK GUIDELINES BASED REGULATIONS FOR UNDER GRADUATE PROGRAMME	
Programme:	**B.Sc. MICROBIOLOGY**
Programme Code:	
Duration:	**3 Years (UG)**
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						✓

2. Highlights of the Revamped Curriculum:

- Student-centric, meeting the demands of industry & society, incorporating industrial components, hands-on training, skill enhancement modules, industrial project, project with viva-voce, exposure to entrepreneurial skills, training for competitive examinations, sustaining the quality of the core components and incorporating application oriented content wherever required.
- The Core subjects include latest developments in the education and scientific front, advanced programming packages allied with the discipline topics, practical training, devising statistical models and algorithms for providing solutions to industry / real life situations. The curriculum also facilitates peer learning with advanced statistical topics in the final semester, catering to the needs of stakeholders with research aptitude.
- The General Studies and Statistics based problem solving skills are included as mandatory components in the 'Training for Competitive Examinations' course at the final semester, a first of its kind.
- The curriculum is designed so as to strengthen the Industry-Academia interface and provide more job opportunities for the students.
- The Statistical Quality Control course is included to expose the students to real life problems and train the students on designing a mathematical model to provide solutions to the industrial problems.
- The Internship during the second year vacation will help the students gain valuable work experience, that connects classroom knowledge to real world experience and to narrow down and focus on the career path.
- Project with viva-voce component in the fifth semester enables the student, application of conceptual knowledge to practical situations. The state of art technologies in conducting a Explain in a scientific and systematic way and arriving at a precise solution is ensured. Such innovative provisions of the industrial training, project and internships will give students an edge over the counterparts in the job market.
- State-of Art techniques from the streams of multi-disciplinary, cross disciplinary and inter disciplinary nature are incorporated as Elective courses, covering conventional topics to the latest DBMS and Computer software for Analytics.

ValueadditionsintheRevampedCurriculum:

Semester	NewlyintroducedComponents	Outcome/ Benefits
I	**FoundationCourse** To ease the transition of learningfrom higher secondary to highereducation,providinganoverviewofthepedagogyoflearningLiteratureandanalysingtheworldthroughtheliterarylens givesrisetoanewperspective.	➢ Instill confidenceamongstudents ➢ Createinterestforthesubject
I,II,III,IV	**SkillEnhancementpapers**(Discipline centric /Generic/Entrepreneurial)	➢ Industry readygraduates ➢ Skilledhumanresource ➢ Studentsareequippedwithessentialskillsto makethememployable
		➢ Trainingonlanguageandcommunicationskillsenablethestudents gain knowledge and exposureinthecompetitiveworld.
		➢ Discipline centric skillwillimprovetheTechnical knowhow ofsolvingreallife problems.
III,IV,V& VI	Electivepapers	➢ Strengthening thedomainknowledge ➢ Introducing thestakeholders to theState-of Arttechniquesfrom the streamsofmulti-disciplinary,crossdisciplinaryandinterdisciplinarynature ➢ Emerging topics inhigher education/industry/communicationnetwork/ healthsectoretc.areintroducedwith hands-on-training.

IV	ElectivePapers	➢ Exposuretoindustrymouldsstudentsintosolutionproviders ➢ GeneratesIndustryreadygraduates ➢ Employmentopportunitiesenhanced
VSemester	Electivepapers	➢ Self-learning isenhanced ➢ Applicationoftheconcepttorealsituationisconceivedresulting intangibleoutcome
VISemester	Electivepapers	➢ Enriches the studybeyondthe course. ➢ Developingaresearchframework and presenting their independent and intellectual idea seffectively.
ExtraCredits: ForAdvancedLearners/Honorsdegree		➢ Tocatertotheneedsofpeerlearners/research aspirants
SkillsacquiredfromtheCourses	Knowledge, Problem Solving, Analytical ability,ProfessionalCompetency,ProfessionalCommunicationandTransferrable Skill	

Credit Distribution for UG Programmes

Sem I	Credit	H	Sem II	Credit	H	Sem III	Credit	H	Sem IV	Credit	H	Sem V	Credit	H	Sem VI	Credit	H
Part 1. Language – Tamil	3	6	Part..1. Language – Tamil	3	6	Part..1. Language – Tamil	3	6	Part..1. Language – Tamil	3	6	5.1 Core Course – \CC IX	4	5	6.1 Core Course – CC XIII	4	6
Part.2 English	3	6	Part..2 English	3	6	Part..2 English	3	6	Part..2 English	3	6	5.2 Core Course – CC X	4	5	6.2 Core Course – CC XIV	4	6
1.3 Core Course – CC I	5	6	2..3 Core Course – CC III	5	5	3.3 Core Course – CC V	5	5	4.3 Core Course – CC VII Core Industry Module	5	5	5. 3.Core Course CC -XI	4	5	6.3 Core Course – CC XV	4	6
1.4 Core Course – CC II	5	5	2.4 Core Course – CC IV	5	5	3.4 Core Course – CC VI	5	5	4.4 Core Course – CC VIII	5	5	5. 4.Core Course –/ Project with viva-voce CC -XII	4	5	6.4 Elective -VII Generic/ Discipline Specific	3	5
1.5 Elective I Generic/ Discipline Specific	3	5	2.5 Elective II Generic/ Discipline Specific	3	6	3.5 Elective III Generic/ Discipline Specific	3	5	4.5 Elective IV Generic/ Discipline Specific	3	6	5.5 Elective V Generic/ Discipline Specific	3	4	6.5 Elective VIII Generic/ Discipline Specific	3	5
1.6 Skill Enhancement Course SEC-1	2	2	2.6 Skill Enhancement Course SEC-2	2	2	3.6 Skill Enhancement Course SEC-4, (Entrepreneurial Skill)	1	1	4.6 Skill Enhancement Course SEC-6	2	2	5.6 Elective VI Generic/ Discipline Specific	3	4	6.6 Extension Activity	1	-
1.7 Skill Enhancement -(Foundation Course)	2	2	2.7 Skill Enhancement Course –SEC-3	2	2	3.7 Skill Enhancement Course SEC-5	2	2	4.7 Skill Enhancement Course SEC-7	2	2	5.7 Value Education	2	2	6.7 Professional Competency Skill	2	2
						3.8 E.V.S.	2	2				5.8 Summer Internship /Industrial Training	2				
	23	**32**		**23**	**32**		**24**	**32**		**23**	**32**		**26**	**30**		**21**	**30**
Total – 140 Credits																	

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-1	Language – Tamil	3	6
Part-2	English	3	6
Part-3	Core Courses & Elective Courses [in Total]	13	16
Part-4	Skill Enhancement Course SEC-1	2	2
	Foundation Course	2	2
		23	**32**

Semester-II

Part	List of Courses	Credit	No. of Hours
Part-1	Language – Tamil	3	6
Part-2	English	3	6
Part-3	Core Courses & Elective Courses including laboratory [in Total]	13	16
Part-4	Skill Enhancement Course -SEC-2	2	2
	Skill Enhancement Course -SEC-3 (Discipline / Subject Specific)	2	2
		23	**32**

Second Year – Semester-III

Part	List of Courses	Credit	No. of Hours
Part-1	Language - Tamil	3	6
Part-2	English	3	6
Part-3	Core Courses & Elective Courses including laboratory [in Total]	13	15
Part-4	Skill Enhancement Course -SEC-4 (Entrepreneurial Based)	1	1
	Skill Enhancement Course -SEC-5 (Discipline / Subject Specific)	2	2
	E.V.S	2	2
		24	**32**

Semester-IV

Part	List of Courses	Credit	No. of Hours
Part-1	Language - Tamil	3	6
Part-2	English	3	6
Part-3	Core Courses & Elective Courses including laboratory [in Total]	13	16
Part-4	Skill Enhancement Course -SEC-6 (Discipline / Subject Specific)	2	2
	Skill Enhancement Course -SEC-7 (Discipline / Subject Specific)	2	2
		23	**32**

Third Year

Semester-V

Part	List of Courses	Credit	No. of Hours
Part-3	Core Courses including Elective Based	22	26
Part-4	Value Education	2	2
	Internship / Industrial Visit / Field Visit	2	2
		26	**30**

Semester-VI

Part	List of Courses	Credit	No. of Hours
Part-3	Core Courses including Project / Elective Based & LAB	18	28
Part-4	Extension Activity	1	-
	Professional Competency Skill	2	2
		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	1	22
Part V	-	-	-	-	-	2	2
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. IV, V have to be completed during the duration of the programme as per the norms, to be eligible for obtaining the UG degree.**

MethodsofEvaluation		
InternalEvaluation	ContinuousInternalAssessmentTest	25 Marks
	Assignments	
	Seminars	
	AttendanceandClassParticipation	
ExternalEvaluation	EndSemesterExamination	75 Marks
	Total	100 Marks
MethodsofAssessment		
Recall(K1)	Simpledefinitions,MCQ,Recallsteps,Conceptdefinitions	
Understand/Comprehend(K2)	MCQ,True/False,Shortessays,Conceptexplanations,Shortsummaryor overview	
Application (K3)	Suggestidea/conceptwithexamples,Suggestformulae, Solveproblems, Observe,Explain	
Analyze(K4)	Problem-solvingquestions,Finishaprocedureinmanysteps,Differentiate	
	betweenvariousideas,Mapknowledge	
Evaluate(K5)	Longer essay/Evaluationessay,Critiqueorjustifywithprosandcons	
Create(K6)	Checkknowledgeinspecificoroffbeatsituations,Discussion,Debatingor Presentations	

B . Sc. MICROBIOLOGY -2023-24

THIRD SEMESTER

Sl.NO	Course Category	Course	Credit distribution				Overall Credits	Total contact Hours/week	Marks		
			L	T	P	S			CIA	ESE	Total
1	Part –I	Language - Tamil	L				3	6	25	75	100
2	Part –II	English	L				3	6	25	75	100
3	Part –III	CC-5 Molecular Biology and Microbial Genetics	L				5	5	25	75	100
4	Part –III	CC-6 Molecular Biology and Microbial Genetics			P		5	5	25	75	100
5	Part –III	ELECTIVE-3 Clinical Laboratory Technology	L				3	5	25	75	100
6	Part –IV	SEC-4 Organic Farming & Biofertiliser Technology	L				1	2	25	75	100
7	Part –IV	SEC-5 Aquaculture	L				2	2	25	75	100
9	Part –IV	E.V.S	L				2	2	25	75	100
	Total						24	32			

FOURTH SEMESTER

Sl.NO	Course Category	Course	Credit distribution				Overall Credits	Total contact Hours/week	Marks		
			L	T	P	S			CIA	ESE	Total
1	Part –I	Language - Tamil	L				3	6	25	75	100
2	Part –II	English	L				3	6	25	75	100
3	Part –III	CC VII Immunology and Immuno technology	L				5	5	25	75	100
4	Part –III	CC VIII Immunology and Immunotechnology			P		5	5	25	75	100
5	Part –III	ELECTIVE IV Food Processing Technology	L				3	6	25	75	100
6	Part –IV	SEC-6 Vaccine Technology	L				2	2	25	75	100
7	Part –IV	SEC-7 Apiculture	L				2	2	25	75	100
							23	32			

FIFTH SEMESTER

Sl. NO	Course Category	Course	Credit distribution				Overall Credits	Total contact Hours/week	Marks		
			L	T	P	S			CIA	ESE	Total
1	Part -III	CC- IX Bacteriology and mycology	L				4	5	25	75	100
2	Part –III	CC –X Virology and parasitology	L				4	5	25	75	100
3	Part -III	CC- XI Practical V			P		4	5	25	75	100
4	Part -III	Core course/ Project with viva- voce-XII					4	5	25	75	100
5	Part -III	Elective-5 Recombinant DNA Technology	L				3	4	25	75	100
6	Part -III	Elective-6 Biosafety & Bioethics	L				3	4	25	75	100
7	Part -IV	Value Education					2	2	25	75	100
8	Part -IV	Internship/ Industrial visit/ Field visit					2	-	25	75	100
	Total						26	30			

SIXTH SEMESTER

	Course Category	Course	Credit distribution				Overall Credits	Total contact Hours/week	Marks		
			L	T	P	S			CIA	ESE	Total
1	Part -III	CC-XIII Environmental and Agriculture Microbiology	L				4	6	25	75	100
2	Part -III	CC-XIV Food, dairy and Probiotic Microbiology	L				4	6	25	75	100
3	Part -III	CC-XV Practical VI			P		4	6	25	75	100
4	Part -III	Elective-7 Pharmaceutical Microbiology	L				3	5	25	75	100
5	Part -III	Elective-8 Entrepreneurship and Bio-Business	L				3	5	25	75	100
6	Part -IV	Extension activity					1	-	-	-	-
7	Part -IV	Professional competency skill	L				2	2	25	75	100
							21	30			

Credit Distribution for UG MICROBIOLOGY

S.No	Part	Course Details	Credit
1	**III**	Core(15x4)	60
2		Elective Generic/ Discipline Specific Elective(8x3=24)	24
3	I& II	Language & English (Lang - 4x3=12 Eng - 4x3=12)	24
4	IV	NME(2x2)	4
5		EVS(1x2)	2
6		Value Education(1x2)	2
7		Extension Activity(1x1)	1
8		• Ability Enhancement [AECC]- Soft Skill(4x2=8) • Skill Enhancement Course [4 Courses x 2 credits =8 credits] SEC-4 – 1 Credit • Summer internship/ Industrial training (2x1=2 credits) • Foundation course • Professional Competency Skill	8 9 2 2 2
			140

Remarks: English Soft Skill Two Hours Will be handled by English Teachers (4+2 = 6 hours for English).

SEMESTER III

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
22MBUGCT 3	Molecular Biology and Microbial Genetics	Core Course V -Theory	4	1	-	-	5	5	25	75	100

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, linking number, topoisomerases. DNA organization in prokaryotes, viruses, 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* and *ara* operons as examples. Regulation of	15	CO2

	gene expression by DNA methylation.		
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, curing of plasmids. Types of plasmids – R Plasmids, F plasmids, colicinogenic plasmids, metal resistance plasmids, Ti plasmid, linear plasmids, yeast 2μ plasmid. Bacteriophage-T4, Virulent Phage – Structure and lifecycle. Lambda phage-Structure, Lytic and Lysogenic cycle. Applications of Phages in Microbial Genetics.	15	CO4
V	Gene Transfer Mechanisms- Conjugation and its uses. Transduction - Generalized and Specialized, Transformation - Natural Competence and Transformation. Transposition and Types of Transposition reactions. Mechanism of transposition: Replicative and non- replicative transposition. Transposable elements - Prokaryotic transposable elements – insertion sequences, composite, and non-composite transposons. Uses of transposons.	15	CO5
	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	

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
22MBUGCP3	**Molecular Biology and Microbial Genetics**	**Core Course –VI – Practical III**	**-**	**-**	**Y**	**-**	**5**	**5**	**25**	**75**	**100**

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	Isolation of Genomic and Plasmid DNA from *E. coli* and Analysis by Agarose gel electrophoresis.	15	CO1
II	Estimation of DNA using colorimeter (diphenylamine reagent), UV spectrophotometer (A260 measurement).	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. Estimate RNA.	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	Continuous Internal Assessment Test	25 Marks

Evaluation	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

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
22MBUGDE3	CLINICAL LABORATORY TECHNOLOGY	ELECTIVE GENERIC/DISCIPLINE SPECIFIC ELECTIVE -III	Y	-	-	-	3	4	25	75	100

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,	12	CO2

	transport of specimens and factors affecting the clinical results.		
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.	12	CO3
IV	**Introduction to Haematology**- Laboratory methods used in the investigation of coagulation disorders - coagulation tests , Routine coagulation tests, 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 and demonstrate professionalism by displaying professional conduct, model ethical behavior and operate as a vital member of the medical lab team. Practice safety or infection control procedures in the clinical laboratory, properly use safety equipment and maintain a clean, safe work environment.	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	PO5, PO6, PO11

	by understanding the principles and practices of clinical study design, implementation, and dissemination of results.	
CO3	Identify the basic structure of cells, tissues and organs and describe their contribution to normal function. Interpret light and electron microscopic histological images and identify the tissue source and structures. Relate and recognize the histological appearance of affected tissues to the underlying pathology.	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, 2ndEdition, 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 RanaShinde.(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	

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
22MBUGSEC4	**ORGANIC FARMING & BIOFERTILISER TECHNOLOGY**	**SKILL ENHANCEMENT COURSE – SEC -4 (ENTREPRENEURIAL SKILL)**	**Y**	**-**	**-**	**-**	**1**	**1**	**25**	**75**	**100**

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 featuresof 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.	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	6	CO4

	features offungal biofertilizers- AM mycorrhiza		
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 about 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	

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
22MBUGSEC5	AQUACULTURE	Skill Enhancement Course -5	Y	-	-	-	2	2	25	75	100

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.	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, *Penaeusmonodon* and *LitopenaeusVannamei.* 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. 2nd Edition. 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. 3rd Edition. 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/ 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 IV

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
22MBUGCT4	IMMUNOLOGY AND IMMUNOTECHNOLOGY	CORE COURSE – VII	Y	-	-	-	5	5	25	75	100

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.	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, Vaccines – active and passive	12	CO2

	immunization; Classification of vaccines; Types of vaccine - antibacterial, antiviral; Vaccination schedule.		
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 Tumor Immunology - MHC Antigens - structure and function; HLA system - Regulation and response to immune system; Transplantation immunology - tissue transplantation and grafting; Mechanism of graft acceptance and rejection.	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. 5th Edition., Wiley-Blackwell, New York.
2.	Judith A.Owen, Jenni Punt, Sharon A. Stranford, Janis Kuby. (2013). Immunology, 7th Edition., W. H. Freeman and Company, New York.
3.	Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai. (2021). Cellular and Molecular Immunology, 10th Edition.,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, 11th Edition.,Wiley-Blackwell.
3	William R Clark. (1991). The Experimental Foundations of Modern Immunology. 3rd Edition. John Wiley and Sons Inc. New York.
4	Frank C. Hay, Olwyn M. R. Westwood. (2002). Practical Immunology, 4th Edition., 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			

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
22MBUGCP4	**IMMUNOLOGY AND IMMUNOTECHNOLOGY**	CORE COURSE – VIII-PRACTICAL IV	**-**	**-**	**Y**	**-**	**5**	**5**	**25**	**75**	**100**

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.	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.	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	PO4, PO5, PO6, PO7, PO8

	RF, ASO, CRP	
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 edition, CBS.**	
2.	Asim Kumar Roy. (2019). Immunology Theory and Practical**,** Kalyani Publications.	
3.	Richard Coico, Geoffrey Sunshine, Eli Benjamini. (2003). Immunology – A Short Course. 5thEdition., Wiley-Blackwell, New York.	
4.	Judith A.Owen, Jenni Punt, Sharon A. Stranford, Janis Kuby. (2013). Immunology, 7thEdition., W. H. Freeman and Company, New York.	
5.	Pravash Sen. Gupta. (2003). Clinical Immunology. Oxford University Press.	
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

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
22MBUGDE4	FOOD PROCESSING TECHNOLOGY	ELECTIVE GENERIC/ DISCIPLINE SPECIFIC ELECTIVE -IV	Y	-	-	-	3	3	25	75	100

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, WoodlandPublishing 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	

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
22MBUGSEC6	Vaccine Technology	Skill Enhancement Course SEC -6	Y	-	-	-	2	2	25	75	100

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, 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.	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	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain	

(K3)	
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						

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**S**	**Credits**	**Inst. Hours**	**Marks**		
									CIA	**External**	**Total**
22MBUGSEC7	**APICULTURE**	**SKILL ENHANCEMENT COURSE- SEC – 7**	**Y**	**-**	**-**	**-**	**2**	**2**	**25**	**75**	**100**

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://lupinepublishers.com/agriculture-journal/pdf/CIACR.MS.ID.000270.pdf
3	Raising Bumble Bees at Home: A Guide to Getting Started. Retrieved from: https://www.ars.usda.gov/ARSUserFiles/20800500/BumbleBeeRearingGuide.pdf
4	Apiculture – Biology for Everybody (homeomagnet.com)
5	Apiculture: Introduction to Apiculture (iasri.res.in)

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

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
22MBUGCT5	BACTERIOLOGY AND MYCOLOGY	Core Course IX	Y	-	-	-	4	5	25	75	100

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, Koch's, and River's postulates-A brief account on the normal microbial flora of the healthy human body – Host-pathogen interactions: Definitions of infection, invasion, primary and opportunistic pathogens, pathogenicity, virulence, toxigenicity, carriers, endemic, epidemic, pandemic diseases and epidemiology – putative virulence factors of human pathogens –infectious disease	12	CO1

	cycle. Collection and transport of clinical specimens for bacterial and fungal infections.		
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, Streptococcus pneumoniae*), (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 (*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; TineaNigra; Piedra. Cutaneous mycoses: *Microsporum*spps.,*Trichophyton*spps., and *Epidermophytonfloccosum*. Subcutaneous mycoses: Chromoblastomycosis; Sporotrichosis; Systemic Mycoses **-** Blastomycosis; Histoplasmosis*;* Opportunistic Infections **-**Candidiasis; Cryptococcosis; Zygomycosis; Mycotoxins: Aflatoxin	12	CO4
V	Antimicrobial agents -General characteristics and mode of action	12	CO5

	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.		
	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 JayaramPanicker C.K. (2020) Text book of Microbiology. Orient Longman, Hyderabad.
5	JagdishChander (2018). Textbook of Medical Mycology, 4th edition, Jaypeebrothers 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. MacCallum, Rohini J. Manuel (2017). Oxford Textbook of Medical Mycology. Oxford University Press.
Web Resources	
1	http://textbookofbacteriology.net/nd
2	https://microbiologysociety.org/members-outreach-resources/links.html
3	http://mycology.cornell.edu/fteach.html
4	https://www.adelaide.edu.au/mycology/
5	https://www.isham.org/mycology-resources/mycological-links

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	

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
22MBUGCT6	VIROLOGY AND PARASITOLOGY	CORE COURSE X	Y	-	-	-	4	5	25	75	100

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 reemerging 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, HCV, HDV, HEV), Rabies virus, Orthomyoviruses (Influenza virus) and Paramyxoviruses (Mumps and Measles virus), Pox viruses (Variola, Vaccinia), Herpes viruses (Herpes simplex,	12	CO2

	Varicella zoster), Adeno viruses, Rota viruses and HIV viruses. Oncogenic viruses (Human Papilloma virus).		
III	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 caused by the following organisms: *Entameoba histolytica*, flagellates (*Giardia lamblia, Leishmania donovani*), Sporozoa-*Plasmodium*spps.	12	CO4
V	Introduction to Helminthes, Platyhelminthes – *Taenia – Fasciola – Paragonimus – Schistosoma* spps.. Nemat helminthes – Ascaris– *Ankylostoma – Enterobius – Trichuris – Trichinella – Wuchereria – Dracanculus.* Collection, transport and examination of specimen Laboratory techniques in parasitology Examination of faeces for ova and cyst by direct wet mount and iodine wet mount, Concentration methods (Floatation and Sedimentation techniques), Examination of blood for parasites. Cultivation of parasites.	12	CO5
	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.	JeyaramPaniker, C.K. (2006). Text Book of Parasitology Jay Pee Brothers,NewDelhi.	
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, AllIndia 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 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					M	
CO3					M					M	
CO4					M					M	
CO5					M					M	

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
22MBUGCP5	PRACTICAL V	Core course XI	Y	-	-	-	4	5	25	75	100

Course Objectives

CO1	**Learning Objectives** 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. Identification of Viruses in Slides/Smears/Spotters. Demonstration of Negri bodies (Staining).	12	CO3

	7. Cultivation of Viruses in Embryonated eggs – Amniotic, Allantoic, Yolk sac routes and Chorio-allantoic membrane.		
IV	8. Microscopic identification of medically important Fungi – KOH and Lactophenol cotton Blue staining. 9. Slide culture techniques for fungal Identification 10. Identification of Dermatophytes. 11. Germ tube test, Carbohydrate fermentation and assimilation tests for Yeasts.	12	CO4
V	12. Direct Examination of Faeces – wet mount and Iodine mount – Demonstration of Protozoan cysts and Helminthes eggs. 13. Concentration techniques of stool specimen – Floatation and Sedimentation methods. 14. Examination of blood for Malarial parasites – thin and thick smear preparations. 15. Identification of Medically important parasites in slides / specimens as spotters.	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_amuzeshi/Lab_QA_Microbiology_QA.pdf
3	https://www.academia.edu/11977315/Basic_Laboratory_Procedures_in_Clinical_Bacteriology
4	https://cmr.asm.org/content/31/3/e00062-17.full.pdf
5	https://microbiologyinfo.com/techniques-of-virus-cultivation/

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			

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
22MBUGCPR	GROUP PROJECT	Project with Viva-Voce CC-XII	-	-	-	-	4	5	25	75	100

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.

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
22MBUGDE5	RECOMBINANT DNA TECHNOLOGY	ELECTIVE GENERIC/ DISCIPLINE SPECIFIC ELECTIVE- V	Y		-	-	3	4	25	75	100

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	Milestones in Rdna Technology- Gene Manipulation-Steps involved in Gene Cloning. Isolation of Chromosomal and Plasmid DNA. Restriction endonuclease - Discovery, Types, Mode of action-Application of Ligase, DNAPolymerase, DNA Modifying enzymes and Topoisomerases.Use of Linkers and Adapters.	12	CO1
II	ArtificialGeneTransfermethods- CalciumChlorideInduction,Electroporation,Microinjection, Biolistic method, Liposome and Viral-mediated delivery.Cloning vectors –Properties and Applications - Plasmid Based Vectors- Natural Vectors-pSC101 and	12	CO2

	pMB1.Artificial Vectors- pBR322 and pUC.Phage Based Vectors- Lambda phage. Hybrid Vectors,Phagemid, Cosmid, BAC and YAC.Screening of Recombinants.Genomic DNA and cDNAlibrary-ConstructionandScreening.		
III	Molecular Tools- PCR- Types. Gel Electrophoresis- AGE and PAGE BlottingTechniques-Southern, Western & Northern. DNA sequencing methods-Sanger's and Automated method. DNA Finger Printing,	12	CO3
IV	Plant Biotechnology – Media, Growth Regulators and Equipment for Plant Tissue Culture-Explant Culture-Micropropagation- Callus and Protoplast Culture-Production of Bio-Active Secondary Metabolites by Plant Tissue Culture -Agrobacterium and Crown Gall Tumors, Ti Plasmid and Ri Plasmid- Animal Biotechnology-Principles of Animal Cell Culture, Media and Equipment for Animal Cell Culture – Primary and Secondary Cultures- Cell Lines-Types, Establishment and Maintenance of Cell Lines.	12	CO4
V	Applications of Genetic Engineering - Transgenic Animals – Mice and Sheep-RecombinantCytokines and their use in the Treatment of Animal infections- - Human Gene Therapy-Germline and Somatic Cell Therapy-*Ex-vivo* Gene Therapy- SCID (SevereCombinedImmunoDeficiency) – *In-vivo* Gene Therapy- CFTR (Cystic Fibrosis Transmembrane Regulator) –Vectors in Gene Therapy-Viral and Non-Viral Vectors.Transgenic Plants– Bt Cotton, Bt Corn, Round Ready soybean, Flavr Savr Tomato and Golden Rice.	12	CO5
	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. 7th Edition . John Wiley and Jones, Ltd.	
2.	Dale J. W., Schantz M.V. and Plant N. (2012). From Gene to Genomes – Concepts and Applications of DNA Technology. 3rd Edition. John Wileys and Sons Ltd.	
3.	Keya Chaudhuri (2013). Recombinant DNA technology. The Energy and Resources Institute	
4.	Siddra Ijaz, Imran UlHaq (2019). Recombinant DNA Technology. Cambridge Scholars Publishing.	
5.	Monika Jain (2012). Recombinant DNA Techniques: A Textbook, I Edition,Alpha Science International Ltd	
References Books		
1.	Maloy S. R., Cronan J.E. Jr. and FreifelderD.(2011). Microbial Genetics. 2nd Edition. Narosa Publishing Home Pvt Ltd.	
2.	Glick B. R. and Patten C.L.(2018). Molecular Biotechnology – Principles and Applications of Recombinant DNA. 5th Edition. ASM Press.	
3.	Russell P.J. (2010). iGenetics - A Molecular Approach, 3rd Edition. Pearson New International Edition.	
4.	Synder L., Peters J. E., Henkin T.M. and Champness W. (2013). Molecular Genetics of Bacteria,4th Edition. ASM Press Washington-D.C. ASM Press.	
5.	James D.Watson, Michael Gilman, Jan Witkowski, Mark Zoller (1992). Recombinant DNA. Scientific American Books	
Web Resources		
1	https://www.britannica.com/recombinant-DNA-technology	
2	https://www.byjus.com/recombinant-dna-technology	
3	https://www..rpi.edu	
4	https://www..ncbi.nlm.nih.gov	
5	https://www.le.ac.uk/recombinant-dna-and-genetic-techniques	

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		

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
22MBUGDE6	BIOSAFETY &BIOETHICS	CORE ELECTIVE VI	Y	-	-	-	3	4	25	75	100

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	12	CO2

	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.		
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. The patenting of living organisms.	12	CO5
	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 propertyHandbook. 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	

VI - SEMESTER

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
22MBUGCT7	**ENVIRONMENTAL AND AGRICULTURE MICROBIOLOGY**	CORE COURSE –XIII	**Y**	**-**	**-**	**-**	**4**	**6**	**25**	**75**	**100**

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, Microbial succession in decomposition of soil organic matter. Role of microorganisms in elemental cycles in nature: Carbon, Nitrogen. Aquatic Environment: Microflora of fresh water and marine habitats, factors influencing microbial growth in the aquatic environments. Atmosphere: Aeromicroflora and dispersal of microbes, Assessment of air quality, Enumeration of microorganism in air, Air sanitation.	12	CO1

	Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels. Predisposing factors for Environmental diseases – infectious (water and air borne) and pollution related, spread and control of these diseases. Environmental Protection Agency (EPA) - role in environmental protection.		
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. 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. Biocontrol agents – Bacterial, viral, fungal.	12	CO3
IV	Waste treatment and bioremediation**:** Solid waste management: Sources and types of solid waste, composting, vermin composting, production of biogas. Liquid waste management: Primary, secondary, and tertiary sewage treatment. Bioremediation and waste management: Need and scope of bioremediation.	15	CO4
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 rot of sugarcane, Tikka disease. Plant disease management.	10	CO5
	Total	60	
Course Outcomes			
Course	On completion of this course, students will;		

Outcomes		
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 productionof biofertilizers and biopesticides.	PO1, PO7,PO8
CO4	Explainabout 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. BrightSun Publications.
2.	Pradipta. K.M. (2008). Textbook of Environmental Microbiology.I.K.Publishing. House.
3.	Ramanathan, and Muthukaruppan SM. (2005). Environmental Microbiology.OmSakthiPathipagam, 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
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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						

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
22MBUGCT8	**FOOD, DAIRY AND PROBIOTIC MICROBIOLOGY**	**CORE COURSE - XIV**	**Y**	**-**	**-**	**-**	**4**	**6**	**25**	**75**	**100**

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 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	15	CO2

	sanitation - Employees' health standards. Regulatory Agencies &criteria for food safety.		
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, AcidophilusMilk,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: 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.	15	CO5
	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 1st edition. 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_Predictin

	g_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	Longer essay/ Evaluation essay, Critique or justify with pros and cons

(K5)	
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					

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
22MBUGCP6	**PRACTICAL VI**	**CORE COURSE – XV-PRACTICAL VI**	**Y**	**-**	**-**	**-**	**4**	**6**	**25**	**75**	**100**

Course Objectives	
CO1	Toassess the water quality and potability.
CO**22MU**2	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. o Microbiological – MPN index (Presumptive, Completed and Confirmatorytest) 2. Study of air microflora by settle plate method.	12	CO1
II	3. Isolation and identification of bacteria and fungi from fruits and vegetables	12	CO2

	4. Direct microscopic count of milk. 5. Methylene blue reductase test and Resazurin test 6. Microbiological examination of milk by SPC.		
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, 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.	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

ELECTIVE GENERIC /DISCIPLINE SPECIFIC ELECTIVE- VIII- PHARMACEUTICAL MICROBIOLOGY

Subject Code	**Subject Name**	**Category**	**L**	**T**	**P**	**S**	**Credits**	**Inst. Hours**	**Marks**		
									CIA	**External**	**Total**
22MBUGDE7	**PHARMACEUTICAL MICROBIOLOGY**	ELECTIVE GENERIC /DISCIPL	**Y**	**-**	**-**	**-**	**3**	**5**	**25**	**75**	**100**

		INE SPECIFIC ELECTIVE- VII-									

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: Sterilization of pharmaceutical products: Heat, gaseous, radiation and filtration; sterile injectable and non-injectable, ophthalmologic preparation, implants.	10	CO2
III	Production of antibiotics: Production of antibacterial – Penicillin, Tetracycline; antifungal – Griseofulvin, Amphotericin; antiparasitic agents – Artemesin, Metronidazole; Semi-synthetic antibiotics and anticancerous agents; Additional application of microorganisms in	12	CO3

	pharmaceutical sciences: Enzymes- Streptokinase, Streptodornase, L-asperginase and clinical dextrin; Immobilization procedures for pharmaceutical applications (liposomes); Biosensors in pharmaceuticals.		
IV	Production of immunological products and their quality control: Vaccines - DNA vaccines, synthetic peptide vaccines, multivalent vaccines; Vaccine clinical trials; 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 productsApplysterilization 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. 4th Edition.VallabhPrakashanPublishers,New Delhi.
2	Kokate, C.K., Durohit, A.P. and Gokhale, S.R.,(2002). Pharmacognosy. 12th edition 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	
	Continuous Internal Assessment Test Assignments — 25 Marks

Internal Evaluation	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						

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
22MBUGDE8	**ENTREPRENEURSHIP AND BIO-BUSINESS**	ELECTIVE GENERIC /DISCIPLINE SPECIFIC ELECTIVE - VIII	**Y**	**-**	**-**	**-**	**3**	5	**25**	**75**	**100**

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	12	CO2

	source. Integration of system biology for agricultural applications. Biosensor development in Agriculture management.		
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 Bio business-schemes and subsidies. Project proposal preparation, Successful start-ups-case study.	12	CO5
	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	
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	S	S	S	S	S	S
CO2		S			M		S	S		M	
CO3											
CO4				S		S			S		S
CO5		S					S	S			

PROFESSIONAL COMPETENCY SKILL- MICROBIAL QUALITY CONTROL

Subject Code	Subject Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
22MBUGPCS	**MICROBIAL QUALITY CONTROL AND TESTING**	**PROFESSIONAL COMPETENCY SKILL**	**Y**	**-**	**-**	**-**	**2**	**2**	**25**	**75**	**100**

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	12	CO2

	(LAF), Autoclave, Incubator, pH meter, Colony counter, Hot air oven, Centrifuges, colorimeter/ spectrophotometer, ELISA and storage devices. Methodology of Disinfection, Autoclaving & Incineration.		
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 methods of microbiological quality of milk at milk collection centers.	12	CO5
	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	
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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	