LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK (LOCF) FOR UNDERGRADUATE EDUCATION

B.Sc. MICROBIOLOGY

PG DEPARTMENT OF MICROBIOLOGY

EMEA College of Arts and Science, Kondotty

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INTRODUCTION

EMEA College of Arts and Science, Kondotty, is fast emerging as a resourceful destination for higher studies in Malabar, spreading the fragrance of education in the society. The college offers up-to-date, advanced, and job-oriented programmes in the vast expanding horizon of humanities, commerce, and science and technology. The college – affiliated to the University of Calicut, is dedicated to nurturing academic excellence, fostering a culture of research and innovation, and promoting community engagement. Established with a commitment to high-quality education and holistic development, the College aligns its programs with the Learning Outcomes-Based Curriculum Framework (LOCF), ensuring that students acquire not only subject expertise but also skills relevant to real-world applications.

From an LOCF perspective, EMEA College's curriculum prioritizes outcome-based learning, aiming to produce graduates equipped with critical thinking, effective communication, cultural sensitivity, and social responsibility. The College's pedagogical approach integrates both theoretical knowledge and practical experience, creating a learning environment that responds to the dynamic needs of today's society. By mapping program outcomes (POs) and course outcomes (COs) in alignment with UGC's LOCF guidelines, EMEA College ensures that each course contributes to a cohesive learning journey that enhances employability, research capability, and lifelong learning.

In its pursuit of excellence, EMEA College fosters a supportive academic community that encourages students to engage deeply with their disciplines, appreciate diverse perspectives, and contribute meaningfully to their communities. Through this LOCF-aligned curriculum, the College aims to prepare its graduates to meet global challenges while remaining rooted in local values and responsibilities.

VISION AND MISSION OF THE COLLEGE

Vision

EMEA College envisions creating a transformative educational environment that inspires personal growth, social responsibility, and academic excellence. The College aims to become

a beacon of higher learning that empowers students to lead meaningful lives, equipped with the knowledge and skills to contribute positively to society.

Mission

Identifying and developing the talent of the youth and moulding them into useful citizens with due emphasize on right character formation is the avowed mission of EMEA College. The fulfilment of this lofty goal is the basis of educational programes formulated and pursued by the institution. The mission of EMEA College of Arts and Science includes the following core objectives:

1. **Quality Education**: To provide high-quality, inclusive education that fosters intellectual and personal growth, enabling students to reach their fullest potential.
2. **Social Responsibility**: To cultivate a sense of responsibility toward the community, encouraging students to engage in social initiatives and contribute to societal well-being.
3. **Research and Innovation**: To promote a culture of research and innovation, encouraging critical inquiry, creative problem-solving, and continuous learning.
4. **Skill Development**: To equip students with essential life skills and competencies that enhance their employability and adaptability in a dynamic global environment.
5. **Community Empowerment**: To support the development of the local community through outreach and extension activities, addressing social and economic challenges.
6. **Sustainable Practices**: To foster sustainability and inclusivity within the College, embracing practices that promote environmental consciousness and ethical responsibility.

VISION AND MISSION OF THE PG DEPARTMENT OF MICROBIOLOGY

Vision

The mission of the Post graduate department of Microbiology is to educate and train students in the discipline of Microbiology and to enhance the intellectual foundation and preparation of students for life in a complex, dynamic technological world. The specific goal of this

department is to prepare both the graduate and post- graduate students with in-depth knowledge and research skills for professional careers in Microbiology.

Mission

The mission of the PG Department of Microbiology is to provide an outstanding academic and research-driven environment that nurtures scientific curiosity, critical thinking, and a passion for microbiology. We are committed to:

1. **Academic Excellence**: To deliver high-quality education in microbiology through a comprehensive curriculum that blends theoretical knowledge with hands-on laboratory experience, ensuring that students gain a strong foundation in microbiological principles and applications.
2. **Research and Innovation**: To foster a vibrant research culture that encourages students to explore and address critical issues in microbiology, including microbial pathogenesis, antibiotic resistance, environmental microbiology, and biotechnology.
3. **Critical Thinking and Problem Solving**: To cultivate analytical skills and critical thinking in students, empowering them to design experiments, interpret data, and solve complex biological problems.
4. **Career Preparation and Professional Development**: To prepare students for diverse career pathways in academia, healthcare, biotechnology, pharmaceuticals, environmental science, and government. Through career-oriented training, skill development, and industry exposure, we aim to equip graduates with the competencies needed to excel in professional roles and contribute to societal needs.
5. **Pathway to Higher Studies**: To support students aspiring to pursue advanced degrees and research opportunities by equipping them with the academic knowledge, research skills, and confidence required for competitive postgraduate programs globally.
6. **Ethical and Social Responsibility**: To instill a sense of ethical responsibility and social awareness in students, encouraging them to apply their expertise to address global health and environmental challenges. We promote integrity, respect for the environment, and commitment to ethical practices in all scientific endeavors.

Core Values

The PG Department of Microbiology upholds the following core values:

- **Academic Excellence**: Commitment to maintaining high standards of teaching, learning, and scholarly research.
- **Creativity and Innovation**: Encouraging creative thinking and innovative approaches to problem-solving and research.
- **Cultural Sensitivity**: Fostering an appreciation of cultural diversity and respect for different perspectives within science and society.
- **Ethics and Integrity**: Promoting honesty, transparency, and ethical responsibility in all academic and professional practices.
- **Social Responsibility**: Inspiring students to contribute positively to society and address contemporary issues through scientific enlightenment.

INTRODUCTION TO THE LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK (LOCF) FOR THE B.Sc MICROBIOLOGY PROGRAMME

The Learning Outcomes-Based Curriculum Framework (LOCF) for the BSc Microbiology Programme at EMEA College of Arts and Science, Kondotty, is developed in line with the University Grants Commission (UGC) guidelines and reflects the institution's commitment to an outcome-driven educational model. This framework places emphasis on a student-centered approach, where learning outcomes specify the competencies, skills, and values students are expected to acquire upon completing the program.

The LOCF for the BSc Microbiology Programme is designed to provide a thorough grounding in microbial sciences, encompassing diverse aspects of microbiology, including microbial physiology, genetics, immunology, and environmental microbiology. It seeks to foster analytical skills, critical thinking, and a hands-on approach to scientific investigation. By doing so, the framework prepares students to meet the academic and practical demands of today's scientific and professional fields, equipping them with skills that transcend the classroom.

The LOCF employs Programme Outcomes (POs) and Course Outcomes (COs) mapped to each course to guide educational objectives, instructional methods, and evaluation strategies, ensuring a cohesive and relevant curriculum. Through a combination of theoretical knowledge and practical expertise, the LOCF aims to empower students to independently and ethically conduct experiments, analyze data, and apply microbiological knowledge in diverse fields such as healthcare, biotechnology, environmental management, and public health.

This curriculum framework encourages students to engage critically with scientific research, fostering a spirit of inquiry, lifelong learning, and social responsibility. Ultimately, the LOCF aims to develop well-rounded graduates prepared for various professional and academic pathways, enabling them to contribute meaningfully to society and address emerging challenges in microbiology and allied sciences.

GRADUATE ATTRIBUTES FOR THE B.Sc MICROBIOLOGY PROGRAMME

Graduates of the BSc Microbiology Programme at EMEA College of Arts and Science possess a strong foundation in scientific inquiry and critical thinking, enabling them to analyze and interpret complex biological data and draw informed conclusions. They demonstrate proficiency in laboratory techniques, ensuring precision, accuracy, and safety in experimental work, along with the ability to troubleshoot and adapt protocols as needed. With solid research skills, they are adept at evaluating scientific literature, synthesizing information, and conducting independent investigations in various fields of microbiology.

Their education promotes a commitment to ethical principles, emphasizing integrity, accountability, and respect for living organisms and the environment. A strong sense of social responsibility drives them to apply microbiological knowledge to address public health challenges and environmental issues, contributing to societal well-being. Teamwork skills enable them to collaborate effectively in scientific research and projects, valuing diverse perspectives and communicating ideas clearly within team settings.

In today's technology-driven world, these graduates are proficient with digital tools and software for data analysis, research, and presentation, allowing them to adapt quickly to

evolving technological advancements. Self-management skills, including effective time management and goal-setting, equip them to handle complex tasks independently, maintaining a commitment to continuous learning and professional development.

Their global competency allows them to engage with international scientific research and advancements, adapting microbiological practices to diverse contexts. Overall, these attributes prepare graduates to excel in various scientific, healthcare, and environmental fields, enabling them to contribute meaningfully in both local and global settings. Together, these competencies foster adaptability, resilience, and a dedication to lifelong learning and societal impact.

GRADUATE ATTRIBUTES – DEPARTMENT OF MICROBIOLOGY

Graduates from the Department of Microbiology at EMEA College of Arts and Science, Kondotty, possess a distinct set of attributes that prepare them for academic, professional, and societal success. They gain a strong foundation in scientific thinking, allowing them to critically analyze biological data and apply knowledge to real-world challenges. Equipped with advanced laboratory and research skills, they are proficient in scientific investigation, data interpretation, and problem-solving in microbiology and related fields.

The key graduate attributes expected are:

- **Scientific and Analytical Thinking**: Ability to critically analyze and interpret complex biological data, fostering evidence-based insights into microbial sciences.
- **Effective Communication**: Skilled in articulating scientific information accurately and clearly, both orally and in writing, enhancing understanding and collaboration in scientific contexts.
- **Research Proficiency**: Competence in conducting independent research, designing experiments, collecting data, and synthesizing scientific findings for application and further study.
- **Environmental and Public Health Awareness**: Sensitivity to the environmental and health impacts of microbial processes, promoting responsible practices and solutions for societal benefit.

- **Ethical Responsibility**: Strong commitment to ethical practices, integrity, and social responsibility in scientific and professional settings.
- **Creativity and Innovation**: Encouragement of original thought and innovative approaches to solving microbiological challenges, fostering a proactive and inquisitive mindset.
- **Collaborative Skills**: Ability to work effectively within interdisciplinary teams, respecting diverse perspectives and contributing constructively toward shared scientific goals.
- **Digital Literacy**: Proficiency in using digital tools and software for data analysis, research, and presentation, ensuring adaptability to technological advancements in the sciences.
- **Self-Directed Learning**: Development of self-discipline, time management, and continuous learning, instilling values for lifelong professional growth.
- **Global Perspective**: Awareness of global scientific and environmental issues, promoting adaptability and understanding within an interconnected world.
- These attributes equip graduates with the skills and mindset necessary for impactful contributions in fields such as healthcare, environmental science, biotechnology, and research, both locally and globally.

PROGRAMME OUTCOME

PROGRAMME – B.Sc MICROBIOLOGY	
PO1	Acquire knowledge about the fundamental principles and scientific theories related to various scientific phenomena in day-to-day life.
PO2	To develop communication skills and get expertise in scientific writing.
PO3	Acquire the skills in handling scientific instruments, planning and performing in laboratory experiments. Equip them with the skills to think creatively and draw logical inferences from the scientific experiments to draw the objective conclusions or provide new solutions to the problems. To make them Capable of working effectively in diverse teams in both classroom, laboratory and in industry and field-based situations.
PO4	To get an awareness of the impact of science on the environment and society.

MINIMUM CREDIT REQUIREMENTS OF THE DIFFERENT PATHWAYS IN THE THREE-YEAR PROGRAMME IN CUFYUGP

Sl. No.	Academic Pathway	Major	Minor/ Other Disciplines	Foundation Courses AEC: 4 MDC: 3 SEC: 3 VAC: 3	Intern-ship	Total Credits	Example
		Each course has 4 credits		Each course has 3 credits			
1	Single Major	68	24	39	2	133	Major: Microbiology +
	(A)	(17 courses)	(6 courses)	(13 courses)			six courses in different disciplines in different combinations
2	Major (A) with Multiple Disciplines (B, C)	68	12 + 12	39	2	133	Major: Microbiology +
		(17 courses)	(3 + 3 = 6 courses)	(13 courses)			Biochemistry and Biostatistics/Compu ter application
3	Major (A) with Minor (B)	68	24	39	2	133	Major: Microbiology
		(17 courses)	(6 courses)	(13 courses)			Minor: Biochemistry
4	Major (A) with Vocational Minor (B)	68	24	39	2	133	Major: Microbiology
		(17 courses)	(6 courses)	(13 courses)			Minor: Biotechnology
5	Double Major (A, B)	A: 48 (12 courses)	-	12 + 18 + 9	2	133	Microbiology and Biochemistry double major
		B: 44	The 24 credits in the Minor stream are distributed between the two Majors.				

		(11 courses)	2 MDC, 2 SEC, 2 VAC and the Internship should be in Major A. Total credits in Major A should be 48 + 20 = 68 (50% of 133)	
			1 MDC, 1 SEC and 1 VAC should be in Major B. Total credits in Major B should be 44 + 9 = 53 (40% of 133)	
Exit with UG Degree / Proceed to Fourth Year with 133 Credits				

B.Sc. MICROBIOLOGY HONOURS PROGRAMME
COURSE STRUCTURE FOR PATHWAYS 1 – 4

1. Single Major
2. Major with Multiple Disciplines
3. Major with Minor
4. Major with Vocational Minor

Semester	Course Code	Course Title	Total Hours	Hours/ Week	Credits	Marks		
						Internal	External	Total
1	MBY1CJ 101/ MBY1MN100	Introduction to Microbiology	75	5	4	30	70	100
		Minor Course 1	75	5	4	30	70	100
		Minor Course 2	75	5	4	30	70	100
	ENG1FA 101(2)	AEC1– English	60	4	3	25	50	75
		AEC2 – Additional Language	45	3	3	25	50	75
		MDC1 – Other than Major	45	3	3	25	50	75
		Total		**25**	**21**	**165**	**360**	**525**
2	MBY2CJ 101/ MBY2MN100	Basic Techniques in Microbiology	75	5	4	30	70	100
		Minor Course 3	75	5	4	30	70	100
		Minor Course 4	75	5	4	30	70	100
	ENG2FA 103(2)	AEC3– English	60	4	3	25	50	75
		AEC4 – Additional Language	45	3	3	25	50	75
		MDC2 – Other than Major	45	3	3	25	50	75
		Total		**25**	**21**	**165**	**360**	**525**

3	MBY3CJ 201	Microbial Physiology	75	5	4	30	70	100
	MBY3CJ 202/ MBY3MN200	Microbial Metabolism	75	5	4	30	70	100
		Minor Course 5	75	5	4	30	70	100
		Minor Course 6	60/ 75	4	4	30	70	100
		MDC3 – Kerala Knowledge System	45	3	3	25	50	75
	ENG3FV 108(2)	VAC1 – English	45	3	3	25	50	75
		Total		**25**	**22**	**170**	**380**	**550**
4	MBY4CJ 203	Environmental and Sanitation Microbiology	75	5	4	30	70	100
	MBY4CJ 204	Soil and Agricultural Microbiology	75	5	4	30	70	100
	MBY4CJ 205	Molecular Biology	75	5	4	30	70	100
	ENG4FV 109(2)	VAC2 – English	45	3	3	25	50	75
		VAC3 – Additional Language	45	3	3	25	50	75
	ENG4FS 111(2)	SEC1 – English	60	4	3	25	50	75
		Total		**25**	**21**	**165**	**360**	**525**
5	MBY5CJ 301/ MBY8MN305	Systemic Bacteriology	75	5	4	30	70	100
	MBY5CJ 302	Industrial Microbiology	75	5	4	30	70	100
	MBY5CJ 303	Basic Aspects of Immunology	60	4	4	30	70	100
		ElectiveCourse 1 in Major	60	4	4	30	70	100
		ElectiveCourse 2 in Major	60	4	4	30	70	100
		SEC2 Entrepreneurial Microbiology	45	3	3	25	50	75
		Total		**25**	**23**	**175**	**400**	**575**
6	MBY6CJ 304/ MBY8MN304	Food and Dairy Microbiology	75	5	4	30	70	100

	MBY6CJ 305	Microbial Biotechnology	75	5	4	30	70	100
	MBY6CJ 306/ MBY8MN306	Principles of Genetics	60	4	4	30	70	100
		ElectiveCourse 3 in Major	60	4	4	30	70	100
		ElectiveCourse 4 in Major	60	4	4	30	70	100
	MBY6FS 113	SEC3 – Clinical Microbiology	45	3	3	25	50	75
	MBY6CJ 349	Internship in Major (Credit for internship to be awarded only at the end of Semester 6)	60		2	50	-	50
		Total		**25**	**25**	**225**	**400**	**625**
Total Credits for Three Years					**133**			**3325**
7	MBY7CJ 401	Biophysics and Instrumentation	75	5	4	30	70	100
	MBY7CJ 402	Advanced Immunology and Cancer Biology	75	5	4	30	70	100
	MBY7CJ 403	Microbial Biochemistry	75	5	4	30	70	100
	MBY7CJ 404	Mycology and Parasitology	75	5	4	30	70	100
	MBY7CJ 405	Antimicrobials and drug resistance	75	5	4	30	70	100
		Total		**25**	**20**	**150**	**350**	**500**
8	MBY8CJ 406/MBY8MN406	Biostatistics and Bioinformaitcs	75	5	4	30	70	100
	MBY8CJ 407/ MBY8MN407	Software Tools in Research	60	4	4	30	70	100
	MBY8CJ 408/ MBY8MN408	Pharmaceutical Microbiology	60	4	4	30	70	100
	OR (instead of 3 Major courses)							

	MBY8CJ 449	Project (in Honours programme)	360*	13*	12	90	210	300
	MBY8CJ 499	Project (in Honours with Research programme)	360*	13*	12	90	210	300
		Elective Course 5 in Major / Minor Course 7	60	4	4	30	70	100
		Elective Course 6 in Major / Minor Course 8	60	4	4	30	70	100
		Elective Course 7 in Major / Minor Course 9 / Major Course in any Other Discipline	60	4	4	30	70	100
	OR (instead of Elective Course 7 in Major, in the case of Honours with Research Programme)							
	MBY8CJ 489	Research Methodology in Biological Science	60	4	4	30	70	100
		Total		**25**	**24**	**180**	**420**	**600**
Total Credits for Four Years					**177**			**4425**

* The teacher should have 13 hrs/week of engagement (the hours corresponding to the three core courses) in the guidance of the Project(s) in Honours programme and Honours with Research programme, while each student should have 24 hrs/week of engagement in the Project work. Total hours are given based on the student's engagement.

CREDIT DISTRIBUTION FOR PATHWAYS 1 – 4

1. Single Major
2. Major with Multiple Disciplines
3. Major with Minor
4. Major with Vocational Minor

Semester	Major Courses	Minor Courses	General Foundation Courses	Internship/ Project	Total
1	4	4 + 4	3 + 3 + 3	-	21
2	4	4 + 4	3 + 3 + 3	-	21
3	4 + 4	4 + 4	3 + 3	-	22
4	4 + 4 + 4	-	3 + 3 + 3	-	21
5	4 + 4 + 4 + 4 + 4	-	3	-	23
6	4 + 4 + 4 + 4 + 4	-	3	2	25
Total for Three Years	**68**	**24**	**39**	**2**	**133**
7	4 + 4 + 4 + 4 + 4	-	-	-	20
8	4 + 4 + 4	4 + 4 + 4	-	12*	24
*Instead of three Major courses					
Total for Four Years	**88 + 12 = 100**	**36**	**39**	**2**	**177**

DISTRIBUTION OF MAJOR COURSES IN MICROBIOLOGY FOR PATHWAYS 1 – 4

1. Single Major
2. Major with Multiple Disciplines
3. Major with Minor
4. Major with Vocational Minor

Semester	Course Code	Course Title	Total Hours	Hours/ Week	Credits
1	MBY1CJ 101/ MBY1MN100	Introduction to Microbiology	75	5	4
2	MBY2CJ 101/ MBY2MN100	Basic Techniques in Microbiology	75	5	4
3	MBY3CJ 201	Microbial Physiology	75	5	4
	MBY3CJ 202/ MBY3MN200	Microbial Metabolism	75	5	4
4	MBY4CJ 203	Environmental and Sanitation Microbiology	75	5	4
	MBY4CJ 204	Soil and Agricultural Microbiology	75	5	4
	MBY4CJ 205	Molecular Biology	75	5	4
5	MBY5CJ 301/8MN305	Systemic Bacteriology	75	5	4
	MBY5CJ 302	Industrial Microbiology	75	5	4
	MBY5CJ 303	Basic Aspects of Immunology	60	4	4
		Elective Course 1 in Major*	60	4	4
		Elective Course 2 in Major*	60	4	4
6	MBY6CJ 304/ MBY8MN304	Food and Dairy Microbiology	75	5	4
	MBY6CJ 305	Microbial Biotechnology	75	5	4
	MBY6CJ 306/ MBY8MN306	Principles of Genetics	60	4	4
		Elective Course 3 in Major*	60	4	4
		Elective Course 4 in Major*	60	4	4
	MBY6CJ 349	Internship in Major (Credit for internship to be awarded only at the end of Semester 6)	60		2
Total for Three Years					**70**
7	MBY7CJ 401	Biphysics and Instrumentation	75	5	4
	MBY7CJ 402	Advanced Immunology and Cancer Biology	75	5	4

	MBY7CJ 403	Microbial Biochemistry	75	5	4
	MBY7CJ 404	Mycology and Parasitology	75	5	4
	MBY7CJ 405	Antimicrobials and drug resistance	75	5	4
8	MBY8CJ 406/MBY8MN406	Biostatistics and Bioinformaitcs	75	5	4
	MBY8CJ 407/ MBY8MN407	Software Tools in Research	60	4	4
	MBY8CJ 408/ MBY8MN408	Pharmaceutical Microbiology	60	4	4
	OR (instead of Core Courses MBY8CJ 406/MBY8MN406, MBY8CJ 407/ MBY8MN407 and MBY8CJ 408/ MBY8MN408 in Major)				
	MBY8CJ 449	Project (in Honours programme)	360	13	12
	MBY8CJ 499	Project (in Honours with Research programme)	360	13	12
		Elective Course 5 in Major / Minor Course 7**	60	4	4
		Elective Course 6 in Major / Minor Course 8**	60	4	4
		Elective Course 7 in Major / Minor Course 9 / Major Course in any Other Discipline**	60	4	4
	OR (instead of Elective course 7 in Major, in Honours with Research programme)				
	MBY8CJ 489	Research Methodology in Biological Science	60	4	4
		Total for Four Years			**114**

*Choose any two elective courses each form the course basket of seven elective courses in semester 5 and nine elective courses in semester 6, as listed below in the two table of elective courses with specialization and elective courses with no specialization.
** Chose any three elective courses from the course basket of seven elecive courses in semester 8, as listed below in the able of elctive courses with no specialization.

ELECTIVE COURSES IN MICROBIOLOGY WITH SPECIALISATION

Group No.	Sl. No.	Course Code	Title	Semester	Total Hrs	Hrs/ Week	Credits	Marks		
								Internal	External	Total
1		**rDNA Technology**								
	1	MBY5EJ 301(1)	Introduction to rDNA technology	5	60	4	4	30	70	100
	2	MBY5EJ 302(1)	Tools and Techniques in rDNA technology	5	60	4	4	30	70	100
	3	MBY6EJ 301(1)	Applications of rDNA Technology I	6	60	4	4	30	70	100
	4	MBY6EJ 302(1)	Applications of rDNA Technology II	6	60	4	4	30	70	100
2		**Clinical Microbiology**								
	1	MBY5EJ 303(2)	Basic Human Physiology	5	60	4	4	30	70	100
	2	MBY5EJ 304(2)	Techniques in clinical laboratory	5	60	4	4	30	70	100
	3	MBY6EJ 303(2)	Diagnostic Microbiology	6	60	4	4	30	70	100
	4	MBY6EJ 304(2)	Advanced Diagnostic Techniques in Microbiology	6	60	4	4	30	70	100
3	**Food and Water Microbiology**									
	1	MBY5EJ 305(3)	Microbes in food and water	5	60	4	4	30	70	100
	2	MBY5EJ 306(3)	Food quality assurance	5	60	4	4	30	70	100
	3	MBY6EJ 305(3)	Laboratory techniques for Food and water analysis	6	60	4	4	30	70	100
	4	MBY6EJ 306(3)	Food and water borne diseases	6	60	4	4	30	70	100

ELECTIVE COURSES IN MICROBIOLOGY WITH NO SPECIALISATION

Sl. No.	Course Code	Title	Semester	Total Hrs	Hrs/ Week	Credits	Marks		
							Internal	External	Total
1	MBY5EJ 307	Enzymology	5	60	4	4	30	70	100
2	MBY6EJ 307	Microbial Taxonomy	6	60	4	4	30	70	100
3	MBY6EJ 308	Biosafety and Bioethics	6	60	4	4	30	70	100
4	MBY6EJ 309	Virology and emerging microbial diseases	6	60	4	4	30	70	
5	MBY8EJ 401	Cell Biology	8	60	4	4	30	70	100
6	MBY8EJ 402	Cell and Tissue Culture	8	60	4	4	30	70	100
7	MBY8EJ 403	Plant pathology	8	60	4	4	30	70	100
8	MBY8EJ 404	Microbes in extreme environment	8	60	4	4	30	70	100
9	MBY8EJ 405	Virology and emerging microbial diseases	8	60	4	4	30	70	100
10	MBY8EJ 406	Plant derived antimicrobials	8	60	4	4	30	70	100
11	MBY8EJ 407	Developmental biology	8	60	4	4	30	70	100

DISTRIBUTION OF GENERAL FOUNDATION COURSES IN MICROBIOLOGY

Semester	Course Code	Course Title	Total Hours	Hours/ Week	Credits	Marks		
						Internal	External	Total
1	MBY1FM 105	MDC 1 – Microorganisms in Daily life	45	3	3	25	50	75
2	MBY2FM 106	MDC 2 – Applied Microbiology	45	3	3	25	50	75
3	MBY3FV 108	VAC 1 – Microbial Solid Waste Management	45	3	3	25	50	75
4	MBY4FV 110	VAC 2 – Fermented Foods	45	3	3	25	50	75
5	MBY5FS 112	SEC 2 – Entrepreneurial Microbiology	45	3	3	25	50	75
6	MBY6FS 113	SEC 3 – Clinical Microbiology	45	3	3	25	50	75

GROUPING OF MINOR COURSES IN MICROBIOLOGY

(Title of the Minor: MICROBIOLOGY)

The courses given below should not be offered as minor courses to students who have taken microbiology as the major discipline. They should be offered to students from other major disciplines only.

Group No.	Sl. No.	Course Code	Title	Semester	Total Hrs	Hrs/ Week	Credits	Marks		
								Internal	External	Total
I		**GENERAL MICROBIOLOGY**								
	1	MBY1MN 100	Introduction to Microbiology	1	75	5	4	30	70	100
	2	MBY2MN 100	Basic Techniques in Microbiology	2	75	5	4	30	70	100
	3	MBY3MN 200	Microbial metabolism	3	75	5	4	30	70	100
II		**APPLIED MICROBIOLOGY**								
	1	MBY1MN 101	Microbial growth	1	75	5	4	30	70	100
	2	MBY2MN 101	Bacterial infections and Host defense systems	2	75	5	4	30	70	100
	3	MBY3MN 201	Applied Microbiology	3	75	5	4	30	70	100

(i). Students in Single Major pathway can choose course/courses from any of the Minor/ Vocational Minor groups offered by a discipline other than their Major discipline.

(ii). Students in Major with Multiple Disciplines pathway can choose as one of the multiple disciplines, all the three courses from any one of the Minor/ Vocational Minor groups offered by any discipline, including their Major discipline. If they choose one of the Minor/ Vocational Minor groups offered by their Major discipline as the first one of the multiple disciplines, then their choice as the second one of the multiple disciplines should be any one of the Minor/ Vocational Minor groups offered by a discipline other

than the Major discipline. If the students choose any one of the Minor/ Vocational Minor groups in Microbiology as given above, then the title of the group will be the title of that multiple discipline.

(iii). Students in Major with Minor pathway can choose all the courses from any two Minor groups offered by any discipline. If the students choose any two Minor groups in Microbiology as given above, then the title of the Minor will be **Microbiology.**

COURSE STRUCTUREFOR BATCH A1(B2) IN PATHWAY 5: DOUBLE MAJOR

A1: 68 credits in Microbiology (Major A) ***B1: 68 credits in Major B***
A2: 53 credits in Microbiology (Major A) ***B2: 53 credits in Major B***
The combinations available to the students: (A1 & B2), (B1 & A2)
Note: Unless the batch is specified, the course is for all the students of the class

Semester	Course Code	Course Title	Total Hours	Hours/ Week	Credits	Marks		
						Internal	External	Total
1	MBY1CJ 101 / MBY1MN 100	Core Course 1 in Major Microbiology – Introduction to Microbiology	75	5	4	30	70	100
	BBB1CJ 101	Core Course 1 in Major B –	60/ 75	4/ 5	4	30	70	100
	MBY1CJ 102 / MBY2CJ 102 / MBY4CJ 205*	Core Course 2 in Major Microbiology – Molecular Biology (for batch A1 only)	75	5	4	30	70	100
	ENG1FA 101(2)	Ability Enhancement Course 1 – English	60	4	3	25	50	75
		Ability Enhancement Course 2 – Additional Language	45	3	3	25	50	75
	MBY1FM 105	MDC 1 in Microbiology – Microorganisms in Daily life (for batch A1 only)	45	3	3	25	50	75
		Total		**24/ 25**	**21**			**525**
2	MBY2CJ 101 / MBY2MN100	Core Course 3 in Major Microbiology – Basic Techniques in Microbiology	75	5	4	30	70	100
	BBB2CJ 101	Core Course 2 in Major B –	60/ 75	4/ 5	4	30	70	100
	BBB2CJ 102 / BBB1CJ 102	Core Course 3 in Major B – (for batch B2 only)	60/ 75	4/ 5	4	30	70	100
	ENG2FA 103(2)	Ability Enhancement Course 3 – English	60	4	3	25	50	75

		Ability Enhancement Course 4 – Additional Language	45	3	3	25	50	75
	MBY2FM 106 / MBY3FM 106	MDC 2 in Microbiology – Applied Microbiology	45	3	3	25	50	75
		Total		**23/ 25**	**21**			**525**
3	MBY3CJ 201	Core Course 4 in Major Microbiology – Microbial Physiology	75	5	4	30	70	100
	MBY3CJ 202 / MBY3MN 200	Core Course 5 in Major Microbiology – Microbial Metabolism	75	5	4	30	70	100
	BBB3CJ 201	Core Course 4 in Major B	60/ 75	4/ 5	4	30	70	100
	BBB3CJ 202	Core Course 5 in Major B	60/ 75	4/ 5	4	30	70	100
	BBB3FM 106 / BBB2FM 106	MDC 1 in B –	45	3	3	25	50	75
	MBY3FV 108	VAC 1 in Microbiology – Microbial Solid Waste Management (for batch A1 only)	45	3	3	25	50	75
		Total		**23 / 25**	**22**			**550**
4	MBY4CJ 203	Core Course 6 in Major Microbiology – Environmental and Sanitation Microbiology	75	5	4	30	70	100
		Core Course 6 in Major B	60/ 75	4/ 5	4	30	70	100
	MBY4CJ 204	Core Course 7 in Major Microbiology – Soil and Agricultural Microbiology (for batch A1 only)	75	5	4	30	70	100
	MBY4FV 110	VAC 2 in Microbiology – Fermented Foods	45	3	3	25	50	75
	BBB4FV 110	VAC 1in B –	45	3	3	25	50	75
	MBY4FS 112 / MBY5FS 112	SEC 1 in Microbiology – Entrepreneurial Microbiology	45	3	3	25	50	75
		Total		**23/ 24**	**21**			**525**
5	MBY5CJ 303	Core Course 8 in Major Microbiology – Basic Aspects of Immunology	60	4	4	30	70	100
		Core Course 7 in Major B –	60/ 75	4/ 5	4	30	70	100

	MBY5CJ 302	Core Course 9 in Major Microbiology – Industrial Microbiology (for batch A1 only)	75	5	4	30	70	100
		Elective Course 1 in Major Microbiology**	60	4	4	30	70	100
		ElectiveCourse 1 in Major B	60	4	4	30	70	100
	BBB5FS 112 / BBB4FS 112	SEC 1 in B	45	3	3	25	50	75
		Total		**24/ 25**	**23**			**575**
6	MBY5CJ 301*/ MBY8MN 305	Core Course 10 in Major Microbiology Systemic Bacteriology	75	5	4	30	70	100
		Core Course 8 in Major B –	60/ 75	4/ 5	4	30	70	100
	BBB6CJ 305	Core Course 9 in Major B – (for batch B2 only)	60	4	4	30	70	100
		ElectiveCourse 2 in Major Microbiology**	60	4	4	30	70	100
		Elective Course 2 in Major B	60	4	4	30	70	100
	MBY6FS 113	Skill Enhancement Course 2 in Microbiology – Clinical Microbiology (for batch A1 only)	45	3	3	25	50	75
	MBY6CJ 349	Internship in Major Microbiology (Credit for internship to be awarded only at the end of Semester 6)	60		2	50	-	50
		Total		**24/ 25**	**25**			**625**
Total Credits for Three Years					**133**			**3325**

For batch A1(B2), the course structure in semesters 7 and 8 is the same as for pathways 1 – 4, except that the number of the core and elective courses is in continuation of the number of courses in the two categories completed at the end of semester 6.

* The course code of the same course as used for the pathways 1 – 4

**Choose any one elective courses each in Major Microbiology form the course basket of seven elective courses in Microbiology in semester 5 and nine elective courses in Microbiology in semester 6, as listed in the two table of elective courses with specialization

and elective courses with no specialization. Chose any one elective course each in Major B from the course basket of elective courses in Major B in semester 5 and semester 6.
** Chose any three elective courses from the course basket of seven elecive courses in semester 8, as listed below in the able of elctive courses with no specialization.

CREDIT DISTRIBUTION FOR BATCH A1(B2) IN PATHWAY 5: DOUBLE MAJOR

Semester	Major Courses in Microbiology	General Foundation Courses in Microbiology	Internship/ Project in Microbiology	Major Courses in B	General Foundation Courses in B	AEC	Total
1	4 + 4	3	-	4	-	3 + 3	21
2	4	3	-	4 + 4	-	3 + 3	21
3	4 + 4	3	-	4 + 4	3	-	22
4	4 + 4	3 + 3	-	4	3	-	21
5	4 + 4 + 4	-	-	4 + 4	3	-	23
6	4 + 4	3	2	4 + 4 + 4	-	-	25
Total for Three Years	**48**	**18**	**2**	**44**	**9**	**12**	**133**
	68			**53**		**12**	**133**
	Major Courses in Microbiology	Minor Courses					
7	4 + 4 + 4 + 4 + 4	-			-	-	20
8	4 + 4 + 4	4 + 4 + 4	12*		-	-	24
*Instead of three Major courses							
Total for Four Years	**88 + 12 = 100**	**12**					**177**

COURSE STRUCTUREFOR BATCH B1(A2)
IN PATHWAY 5: DOUBLE MAJOR

A1: 68 credits in Microbiology (Major A) ***B1: 68 credits in Major B***

A2: 53 credits in Microbiology (Major A) ***B2: 53 credits in Major B***

The combinations available to the students: (A1 & B2), (B1 & A2)

Note: Unless the batch is specified, the course is for all the students of the class

Semester	Course Code	Course Title	Total Hours	Hours/ Week	Credits	Marks		
						Internal	External	Total
1	MBY1CJ 101 / MBY1MN 100	Core Course 1 in Major Microbiology – Introduction to Microbiology	75	5	4	30	70	100
	BBB1CJ 101	Core Course 1 in Major B –	60/ 75	4/ 5	4	30	70	100
	BBB1CJ 102 / BBB2CJ 102	Core Course 2 in Major B – (for batch B1 only)	60/ 75	4/ 5	4	30	70	100
	ENG1FA 101(2)	Ability Enhancement Course 1 – English	60	4	3	25	50	75
		Ability Enhancement Course 2 – Additional Language	45	3	3	25	50	75
	BBB1FM 105	MDC 1 in B – (for batch B1 only)	45	3	3	25	50	75
		Total		**23 – 25**	**21**			**525**
2	MBY2CJ 101 / MBY2MN100	Core Course 2 in Major Microbiology– Basic Techniques in Microbiology	75	5	4	30	70	100
	BBB2CJ 101	Core Course 3 in Major B –	60/ 75	4/ 5	4	30	70	100
	MBY2CJ 102 / MBY1CJ 102 / MBY4CJ 205*	Core Course 3 in Major Microbiology – Molecular Biology (for batch A2 only)	75	5	4	30	70	100
	ENG2FA 103(2)	Ability Enhancement Course 3 – English	60	4	3	25	50	75
		Ability Enhancement Course 4 – Additional Language	45	3	3	25	50	75

	MBY2FM 105 / MBY3FM 105	MDC 1 in Microbiology – Microorganisms in Daily Life	45	3	3	25	50	75
		Total		**24/ 25**	**21**			**525**
3	MBY3CJ 201	Core Course 4 in Major Microbiology – Microbial Physiology	75	5	4	30	70	100
	MBY3CJ 202 / MBY3MN 200	Core Course 5 in Major Microbiology – Microbial Metabolism	75	5	4	30	70	100
	BBB3CJ 201	Core Course 4 in Major B	60/ 75	4/ 5	4	30	70	100
	BBB3CJ 202	Core Course 5 in Major B	60/ 75	4/ 5	4	30	70	100
	BBB3FM 106 / BBB2FM 106	MDC 2 in B –	45	3	3	25	50	75
	BBB3FV 108	VAC 1 in B – (for batch B1 only)	45	3	3	25	50	75
		Total		**23/ 25**	**22**			**550**
4	MBY4CJ 203	Core Course 6 in Major Microbiology – Environmental and Sanitation Microbiology	75	5	4	30	70	100
		Core Course 6 in Major B	60/ 75	4/ 5	4	30	70	100
		Core Course 7 in Major B – (for batch B1 only)	60/ 75	4/ 5	4	30	70	100
	MBY4FV 110	VAC 1 in Microbiology – Fermented Foods	45	3	3	25	50	75
	BBB4FV 110	VAC 2 in B –	45	3	3	25	50	75
	MBY4FS 112 / MBY5FS 112	SEC 1 in Microbiology – Entrepreneurial Microbiology	45	3	3	25	50	75
		Total		**22/24**	**21**			**525**
5	MBY5CJ 303	Core Course 7 in Major Microbiology – Basic Aspects of Immunology	60	4	4	30	70	100
		Core Course 8 in Major B –	60/ 75	4/ 5	4	30	70	100
		Core Course 9 in Major B – (for batch B1 only)	60	4	4	30	70	100

		Elective Course 1 in Major Microbiology**	60	4	4	30	70	100
		Elective Course 1 in Major B	60	4	4	30	70	100
	BBB5FS 112 / BBB4FS 112	SEC 1 in B	45	3	3	25	50	75
		Total		**23/ 24**	**23**			**575**
6	MBY5CJ 301*/ MBY8MN 305	Core Course 8 in Major Microbiology – Systemic Bacteriology	75	5	4	30	70	100
		Core Course 10 in Major B –	60/ 75	4/ 5	4	30	70	100
	MBY6CJ 306/ MBY8MN306	Core Course 9 in Major Microbiology – Principles of Genetics (for batch A2 only)	60	4	4	30	70	100
		ElectiveCourse 2 in Major Microbiology**	60	4	4	30	70	100
		Elective Course 2 in Major B	60	4	4	30	70	100
	BBB6FS 113	SEC 2 in B – (for batch B1 only)	45	3	3	25	50	75
	BBB6CJ 349	Internship in Major B (Credit for internship to be awarded only at the end of Semester 6)	60		2	50	-	50
		Total		**24/ 25**	**25**			**625**
Total Credits for Three Years					**133**			**3325**

To continue to study Microbiology in semesters 7 and 8, batch B1(A2) needs to earn additional 15 credits in Microbiology to make the total credits of 68. Suppose this condition is achieved, and the student of batch B1(A2) proceeds to the next semesters to study Microbiology. The course structure in semesters 7 and 8 is the same as for pathways 1 – 4, except that the number of the core and elective courses is in continuation of the number of courses in the two categories completed at the end of semester 6, taking into account the number of courses in Microbiology taken online to earn the additional 15 credits.

* The course code of the same course as used for the pathways 1 – 4

**Choose any one elective courses each in Major Microbiology form the course basket of seven elective courses in Microbiology in semester 5 and nine elective courses in

Microbiology in semester 6, as listed in the two table of elective courses with specialization and elective courses with no specialization. Chose any one elective course each in Major B from the course basket of elective courses in Major B in semester 5 and semester 6.

** Chose any three elective courses from the course basket of seven elecive courses in semester 8, as listed below in the able of elctive courses with no specialization.

CREDIT DISTRIBUTION FOR BATCH B1(A2) IN PATHWAY 5: DOUBLE MAJOR

Semester	Major Courses in B	General Foundation Courses in B	Internship/ Project in B	Major Courses in Microbiology	General Foundation Courses in Microbiology	AEC	Total
1	4 + 4	3	-	4	-	3 + 3	21
2	4	-	-	4 + 4	3	3 + 3	21
3	4 + 4	3 + 3	-	4 + 4	-	-	22
4	4 + 4	3	-	4	3 + 3	-	21
5	4 + 4 + 4	3	-	4 + 4	-	-	23
6	4 + 4	3	2	4 + 4 + 4	-	-	25
Total for Three Years	**48**	**18**	**2**	**44**	**9**	**12**	**133**
	68			**53**		**12**	**133**
	Major Courses in B	Minor Courses					
7	4 + 4 + 4 + 4 + 4	-			-	-	20
8	4 + 4 + 4	4 + 4 + 4	12*		-	-	24
*Instead of three Major courses							
Total for Four Years	**88 + 12 = 100**	**12**					**177**

EVALUATION SCHEME

1. The evaluation scheme for each course contains two parts: internal evaluation (about 30%) and external evaluation (about 70%). Each of the Major and Minor courses is of 4-credits. It is evaluated for 100 marks, out of which 30 marks is from internal evaluation and 70 marks, from external evaluation. Each of the General Foundation course is of 3-credits. It is evaluated for 75 marks, out of which 25 marks is from internal evaluation and 50 marks, from external evaluation.
2. The 4-credit courses (Major and Minor courses) are of two types: (i) courses with only theory and (ii) courses with 3-credit theory and 1-credit practical.
    - In 4-credit courses with only theory component, out of the total 5 modules of the syllabus, one open-ended module with 20% content is designed by the faculty member teaching that course, and it is internally evaluated for 10 marks. The internal evaluation of the remaining 4 theory modules is for 20 marks.
    - In 4-credit courses with 3-credit theory and 1-credit practical components, out of the total 5 modules of the syllabus, 4 modules are for theory and the fifth module is for practical. The practical component is internally evaluated for 20 marks. The internal evaluation of the 4 theory modules is for 10 marks.
3. All the 3-credit courses (General Foundational Courses) in Microbiology are with only theory component. Out of the total 5 modules of the syllabus, one open-ended module with 20% content is designed by the faculty member teaching that course, and it is internally evaluated for 5 marks. The internal evaluation of the remaining 4 theory modules is for 20 marks.

Sl. No.	Nature of the Course		Internal Evaluation in Marks (about 30% of the total)		External Exam on 4 modules (Marks)	Total Marks
			Open-ended module / Practical	On the other 4 modules		
1	4-credit course	only theory (5 modules)	10	20	70	100
2	4-credit course	Theory (4 modules) + Practical	20	10	70	100
3	3-credit course	only theory (5 modules)	5	20	50	75

1. MAJOR AND MINOR COURSES

1.1. INTERNAL EVALUATION OF THEORY COMPONENT

Sl. No.	Components of Internal Evaluation of Theory Part of a Major / Minor Course	Internal Marks for the Theory Part of a Major / Minor Course of 4-credits			
		Theory Only		Theory + Practical	
		4 Theory Modules	Open-ended Module	4 Theory Modules	Practical
1	Test paper/ Mid-semester Exam	10	4	5	-
2	Seminar/ Viva/ Quiz	6	4	3	-
3	Assignment	4	2	2	-
Total		20	10	10	20*
		30		30	

* Refer the table in section 1.2 for the evaluation of practical component

1.2. EVALUATION OF PRACTICAL COMPONENT

The evaluation of practical component in Major and Minor courses is completely by internal evaluation.

- Continuous evaluation of practical by the teacher-in-charge shall carry a weightage of 50%.
- The end-semester practical examination and viva-voce, and the evaluation of practical records shall be conducted by the teacher in-charge and an internal examiner appointed by the Department Council.
- The process of continuous evaluation of practical courses shall be completed before 10 days from the commencement of the end-semester examination.
- Those who passed in continuous evaluation alone will be permitted to appear for the end-semester examination and viva-voce.

The scheme of continuous evaluation and the end-semester examination and viva-voce of practical component shall be as given below:

Sl. No.	Evaluation of Practical Component of Credit-1 in a Major / Minor Course	Marks for Practical	Weightage
1	Continuous evaluation of practical/ exercise performed in practical classes by the students	10	50%
2	End-semester examination and viva-voce to be conducted by teacher-in-charge along with an additional examiner arranged internally by the Department Council	7	35%
3	Evaluation of the Practical records submitted for the end semester viva–voce examination by the teacher-in-charge and additional examiner	3	15%
	Total Marks	20	

1.3. EXTERNAL EVALUATION OF THEORY COMPONENT

External evaluation carries 70% marks. Examinations will be conducted at the end of each semester. Individual questions are evaluated in marks and the total marks are converted into grades by the University based on 10-point grading system (refer section 5).

PATTERN OF QUESTION PAPER FOR MAJOR AND MINOR COURSES

Duration	Type	Total No. of Questions	No. of Questions to be Answered	Marks for Each Question	Ceiling of Marks
2 Hours	Short Answer	10	8 – 10	3	24
	Paragraph/ Problem	8	6 – 8	6	36
	Essay	2	1	10	10
				Total Marks	70

2. INTERNSHIP

- All students should undergo Internship of 2-credits during the first six semesters in a firm, industry or organization, or training in labs with faculty and researchers of their own institution or other Higher Educational Institutions (HEIs) or research institutions.
- Internship can be for enhancing the employability of the student or for developing the research aptitude.
- Internship can involve hands-on training on a particular skill/ equipment/ software. It can be a short project on a specific problem or area. Attending seminars or workshops related to an area of learning or skill can be a component of Internship.
- A faculty member/ scientist/ instructor of the respective institution, where the student does the Internship, should be the supervisor of the Internship.

2.1. GUIDELINES FOR INTERNSHIP

1. Internship can be in Microbiology or allied disciplines.
2. There should be minimum 60 hrs. of engagement from the student in the Internship.
3. Summer vacations and other holidays can be used for completing the Internship.
4. In BSc. Microbiology Honours programme, institute/ industry visit or study tour is a requirement for the completion of Internship. Visit to minimum one national research institute, research laboratory and place of scientific importance should be part of the study tour. A brief report of the study tour has to be submitted with photos and analysis.
5. The students should make regular and detailed entries in to a personal log book through the period of Internship. The log book will be a record of the progress of the Internship and the time spent on the work, and it will be useful in writing the final report. It may contain experimental conditions and results, ideas, mathematical expressions, rough work and calculation, computer file names etc. All entries should be dated. The Internship supervisor should periodically examine and countersign the log book.
6. The log book and the typed report must be submitted at the end of the Internship.
7. The institution at which the Internship will be carried out should be prior-approved by the Department Councilof the college where the student has enrolled for the UG Honours programme.

2.2. EVALUATION OF INTERNSHIP

- The evaluation of Internship shall be done internally through continuous assessment mode by a committee internally constituted by the Department Councilof the college where the student has enrolled for the UG Honours programme.
- The credits and marks for the Internship will be awarded only at the end of semester 6.
- The scheme of continuous evaluation and the end-semester viva-voce examination based on the submitted report shall be as given below:

Sl. No.	Components of Evaluation of Internship		Marks for Internship 2 Credits	Weightage
1	Continuous evaluation of internship through interim presentations and reports by the committee internally constituted by the Department Council	Acquisition of skill set	10	40%
2		Interim Presentation and Viva-voce	5	
3		Punctuality and Log Book	5	
4	Report of Institute Visit/ Study Tour		5	10%
5	End-semester viva-voce examination to be conducted by the committee internally constituted by the Department Council	Quality of the work	6	35%
6		Presentation of the work	5	
7		Viva-voce	6	
8	Evaluation of the day-to-day records, the report of internship supervisor, and final report submitted for the end semester viva–voce examination before the committee internally constituted by the Department Council		8	15%
	Total Marks		50	

3. PROJECT

3.1. PROJECT IN HONOURS PROGRAMME

- In Honours programme, the student has the option to do a Project of 12-credits instead of three Core Courses in Major in semester 8.
- The Project can be done in the same institution/ any other higher educational institution (HEI)/ research centre/ training centre.
- The Project in Honours programme can be a short research work or an extended internship or a skill-based training programme.
- A faculty member of the respective institution, where the student does the Project, should be the supervisor of the Project.

3.2. PROJECT IN HONOURS WITH RESEARCH PROGRAMME

- Students who secure 75% marks and above (equivalently, CGPA 7.5 and above) cumulatively in the first six semesters are eligible to get selected to Honours with Research stream in the fourth year.
- A relaxation of 5% in marks (equivalently, a relaxation of 0.5 grade in CGPA) is allowed for those belonging to SC/ST/OBC (non-creamy layer)/ Differently-Abled/ Economically Weaker Section (EWS)/ other categories of candidates asper the decision of the UGC from time to time.
- In Honours with Research programme, the student has to do a mandatory Research Project of 12-creditsinstead of three Core Courses in Major in semester 8.
- The approved research centres of University of Calicut or any other university/ HEI can offer the Honours with Research programme. The departments in the affiliated colleges under University of Calicut, which are not the approved research centres of the University, should get prior approval from the University to offer the Honours with Research programme. Such departments should have minimum two faculty members with Ph.D., and they should also have the necessary infrastructure to offer Honours with Research programme.
- A faculty member of the University/ College with a Ph.D. degree can supervise the research project of the students who have enrolled for Honours with Research. One such faculty member can supervise maximum five students in Honours with Research stream.
- The maximum intake of the department for Honours with Research programme is fixed by the department based on the number of faculty members eligible for project supervision, and other academic, research, and infrastructural facilities available.
- If a greater number of eligible students are opting for the Honours with Research programme than the number of available seats, then the allotment shall be based on the existing rules of reservations and merits.

3.3. GUIDELINES FOR THE PROJECT IN HONOURS PROGRAMME AND HONOURS WITH RESEARCH PROGRAMME

1. Project can be in Microbiology or allied disciplines.
2. Project should be done individually.
3. Project work can be of experimental/ theoretical/ computational in nature.
4. There should be minimum 360 hrs. of engagement from the student in the Project work in Honours programme as well as in Honours with Research programme.
5. There should be minimum 13 hrs./week of engagement (the hours corresponding to the three core courses in Major in semester 8)from the teacher in the guidance of the Project(s) in Honours programme and Honours with Research programme.
6. The various steps in project works are the following:
    - Wide review of a topic.
    - Investigation on a problem in systematic way using appropriate techniques.
    - Systematic recording of the work.
    - Reporting the results with interpretation in a standard documented form.
    - Presenting the results before the examiners.

7. During the Project the students should make regular and detailed entries in to a personal log book through the period of investigation. The log book will be a record of the progress of the Project and the time spent on the work, and it will be useful in writing the final report. It may contain experimental conditions and results, ideas, mathematical expressions, rough work and calculation, computer file names etc. All entries should be dated. The Project supervisor should periodically examine and countersign the log book.
8. The log book and the typed report must be submitted at the end of the Project. A copy of the report should be kept for reference at the department. A soft copy of the report too should be submitted, to be sent to the external examiner in advance.
9. It is desirable, but not mandatory, to publish the results of the Project in a peer reviewed journal.
10. The project report shall have an undertaking from the student and a certificate from the research supervisor for originality of the work, stating that there is no plagiarism, and that the work has not been submitted for the award of any other degree/ diploma in the same institution or any other institution.
11. The project proposal, institution at which the project is being carried out, and the project supervisor should be prior-approved by the Department Council of the college where the student has enrolled for the UG Honours programme.

3.4. EVALUATION OF PROJECT

- The evaluation of Project will be conducted at the end of the eighth semester by both internal and external modes.
- The Project in Honours programme as well as that in Honours with Research programme will be evaluated for 300 marks. Out of this, 90 marks is from internal evaluation and 210 marks, from external evaluation.
- The internal evaluation of the Project work shall be done through continuous assessment mode by a committee internally constituted by the Department Councilof the college where the student has enrolled for the UG Honours programme. 30% of the weightage shall be given through this mode.
- The remaining 70% shall be awarded by the external examiner appointed by the University.
- The scheme of continuous evaluation and the end-semester viva-voce of the Project shall be as given below:

Components of Evaluation of Project	Marks for the Project (Honours/ Honours with Research)	Weightage
Continuous evaluation of project work through interim presentations and reports by the committee internally constituted by the Department Council	90	30%
End-semester viva-voce examination to be conducted by the external examiner appointed by the university	150	50%
Evaluation of the day-to-day records and project report submitted for the end-semester viva–voce examination conducted by the external examiner	60	20%
Total Marks	300	

INTERNAL EVALUATION OF PROJECT

Sl. No	Components of Evaluation of Project	Marks for the Project (Honours/ Honours with Research)
1	Skill in doing project work	30
2	Interim Presentation and Viva-Voce	20
3	Punctuality and Log book	20
4	Scheme/ Organization of Project Report	20
	Total Marks	90

EXTERNAL EVALUATION OF PROJECT

Sl. No	Components of Evaluation of Project	Marks for the Project (Honours/ Honours with Research) 12 credits
1	Content and relevance of the Project, Methodology, Quality of analysis, and Innovations of Research	50
2	Presentation of the Project	50
3	Project Report (typed copy), Log Book and References	60
4	Viva-Voce	50
	Total Marks	210

4. GENERAL FOUNDATION COURSES

- All the General Foundation Courses (3-credits) in Microbiology are with only theory component.

4.1. INTERNAL EVALUATION

Sl. No.	Components of Internal Evaluation of a General Foundation Course in Microbiology	Internal Marks of a General Foundation Course of 3-credits in Microbiology	
		4 Theory Modules	Open-ended Module
1	Test paper/ Mid-semester Exam	10	2
2	Seminar/ Viva/ Quiz	6	2
3	Assignment	4	1
		20	5
	Total	25	

4.2. EXTERNAL EVALUATION

External evaluation carries about 70% marks. Examinations will be conducted at the end of each semester. Individual questions are evaluated in marks and the total marks are converted into grades by the University based on 10-point grading system (refer section 5).

PATTERN OF QUESTION PAPER FOR GENERAL FOUNDATION COURSES

Duration	Type	Total No. of Questions	No. of Questions to be Answered	Marks for Each Question	Ceiling of Marks
1.5 Hours	Short Answer	10	8 – 10	2	16
	Paragraph/ Problem	5	4 – 5	6	24
	Essay	2	1	10	10
				Total Marks	50

5.LETTER GRADES AND GRADE POINTS

- Mark system is followed for evaluating each question.
- For each course in the semester letter grade and grade point are introduced in 10-point indirect grading system as per guidelines given below.
- The Semester Grade Point Average (SGPA) is computed from the grades as a measure of the student's performance in a given semester.
- The Cumulative GPA (CGPA) is based on the grades in all courses taken after joining the programme of study.
- Only the weighted grade point based on marks obtained shall be displayed on the grade card issued to the students.

LETTER GRADES AND GRADE POINTS

Sl. No.	Percentage of Marks (Internal & External Put Together)	Description	Letter Grade	Grade Point	Range of Grade Points	Class
1	95% and above	Outstanding	O	10	9.50 – 10	First Class with Distinction
2	Above 85% and below 95%	Excellent	A+	9	8.50 – 9. 49	
3	75% to below 85%	Very Good	A	8	7.50 – 8.49	
4	65% to below 75%	Good	B+	7	6.50 – 7.49	First Class
5	55% to below 65%	Above Average	B	6	5.50 – 6.49	
6	45% to below 55%	Average	C	5	4.50 – 5.49	Second Class
7	35% to below 45% aggregate (internal and external put together) with a minimum of 30% in external valuation	Pass	P	4	3.50 – 4.49	Third Class
8	Below an aggregate of 35% or below 30% in external evaluation	Fail	F	0	0 – 3.49	Fail
9	Not attending the examination	Absent	Ab	0	0	Fail

- When students take audit courses, they will be given Pass (P) or Fail (F) grade without any credits.

- The successful completion of all the courses and capstone components prescribed for the three-year or four-year programme with 'P' grade shall be the minimum requirement for the award of UG Degree or UG Degree Honours or UG Degree Honours with Research, as the case may be.

5.1. COMPUTATION OF SGPA AND CGPA

- The following method shall be used to compute the Semester Grade Point Average (SGPA):
  The SGPA equals the product of the number of credits (Ci) with the grade points (Gi) scored by a student in each course in a semester, summed over all the courses taken by a student in the semester, and then divided by the total number of credits of all the courses taken by the student in the semester,

  i.e. SGPA (Si) = Σi (Ci x Gi) / Σi (Ci)

  where Ci is the number of credits of the i^{th} course and Gi is the grade point scored by the student in the i^{th}course in the given semester. Credit Point of a course is the value obtained by multiplying the credit (Ci) of the course by the grade point (Gi) of the course.

$$SGPA = \frac{Sum\ of\ the\ credit\ points\ of\ all\ the\ courses\ in\ a\ semester}{Total\ credits\ in\ that\ semester}$$

ILLUSTRATION – COMPUTATION OF SGPA

Semester	**Course**	**Credit**	**Letter Grade**	**Grade point**	**Credit Point** (Credit x Grade)
I	Course 1	3	A	8	3 x 8 = 24
I	Course 2	4	B+	7	4 x 7 = 28
I	Course 3	3	B	6	3 x 6 = 18
I	Course 4	3	O	10	3 x 10 = 30
I	Course 5	3	C	5	3 x 5 = 15
I	Course 6	4	B	6	4 x 6 = 24
	Total	20			139
	SGPA				139/20 = 6.950

- The Cumulative Grade Point Average (CGPA) of the student shall be calculated at the end of a programme. The CGPA of a student determines the overall academic level of the student in a programme and is the criterion for ranking the students.
  CGPA for the three-year programme in CUFYUGP shall be calculated by the following formula.

$$CGPA = \frac{Sum\ of\ the\ credit\ points\ of\ all\ the\ courses\ in\ six\ semesters}{Total\ credits\ in\ six\ semesters\ (133)}$$

  CGPA for the four-year programme in CUFYUGP shall be calculated by the following formula.

$$CGPA = \frac{Sum\ of\ the\ credit\ points\ of\ all\ the\ courses\ in\ eight\ semesters}{Total\ credits\ in\ eight\ semesters\ (177)}$$

- The SGPA and CGPA shall be rounded off to three decimal points and reported in the transcripts.
- Based on the above letter grades, grade points, SGPA and CGPA, the University shall issue the transcript for each semester and a consolidated transcript indicating the performance in all semesters.

MAJOR COURSES

No	Course	Sem	Code	Title
1	Major	I	MBY1CJ 101	Introduction to Microbiology
2	Major	II	MBY2CJ 101	Basic Techniques in Microbiology
3	Major	III	MBY3CJ 201	Microbial Physiology
4	Major	III	MBY3CJ 202	Microbial Metabolism
5	Major	IV	MBY4CJ 203	Environmental and Sanitation Microbiology
6	Major	IV	MBY4CJ 204	Soil and Agricultural Microbiology
7	Major	IV	MBY4CJ 205	Molecular biology
8	Major	V	MBY5CJ 301	Systemic Bacteriology
9	Major	V	MBY5CJ 302	Industrial Microbiology
10	Major	V	MBY5CJ 303	Basic aspects of Immunology
11	Major	VI	MBY6CJ 304	Food and Dairy Microbiology
12	Major	VI	MBY6CJ 305	Microbial Biotechnology
13	Major	VI	MBY6CJ 306	Principles of Genetics
14	Major	VII	MBY7CJ 401	Biophysics and instrumentation
15	Major	VII	MBY7CJ 402	Advanced Immunology and Cancer biology
16	Major	VII	MBY7CJ 403	Microbial Biochemistry
17	Major	VII	MBY7CJ 404	Mycology and Parasitology
18	Major	VII	MBY7CJ 405	Antimicrobials and Drug resistance
19	Major	VIII	MBY8CJ 406	Biostatistics and Bioinformatics
20	Major	VIII	MBY8CJ 407	Software tools in Research
21	Major	VIII	MBY8CJ 408	Pharmaceutical Microbiology
22	Major	VIII	MBY8CJ 489	Research Methodology in biological sciences

MBY1CJ 101/ MBY1MN100. INTRODUCTION TO MICROBIOLOGY

Programme	B. Sc. Microbiology				
Course Code	MBY1CJ 101/ MBY1MN100				
Course Title	Introduction to Microbiology				
Type of Course	Major/Minor				
Semester	I				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Nil				
Course Summary	This introductory course covers the fundamental aspects of microbiology, exploring microbial diversity, structure, function, and its impacts on human and environmental health. It provides students with theoretical knowledge and practical skills fundamental for further studies in microbiology and related fields.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the diversity, morphology, and reproduction of bacteria, fungi, and viruses.	U	C	Internal Exam, Assignment, End Semester Examination
CO2	Explain the historical development and scope of microbiology, including the contributions of key scientists.	U	C	Internal Exam, Assignment, End Semester Examination
CO3	Differentiate the fundamental structures of prokaryotic and eukaryotic cells, and describe the major differences.	An	C	Internal Exam, Assignment, End Semester Examination
CO4	Describe the roles of beneficial and harmful microorganisms in various environments.	U	C	Internal Exam, Assignment, End Semester Examination
CO5	Demonstrate basic microbiological laboratory techniques, including microscopy, staining, and culture methods.	Ap	P	Practical Assessment

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45 +30)	Marks (70)
I	**The Microbial World**		**10**	**15**
	1	Bacterial forms and arrangement of cells.		
	2	Morphology of molds and yeasts		
	3	Sexual and asexual reproduction in fungi.		
	4	Viral morphology and replication processes.		
	5	Structure, lytic cycle, and lysogeny of bacteriophages.		
II	**History of Microbiology**		**10**	**15**
	6	Overview of microbiology's scope and its historical development.		
	7	Debate of Spontaneous generation vs. Biogenesis.		
	8	Contributions of Anton van Leeuwenhoek, Joseph Lister, Paul Ehrlich, and other pioneers.		
	9			
III	**Fundamental Structure of Cell**		**15**	**25**
	10	General structure of prokaryotic and eukaryotic cells and their differences.		
	11	Structures of archaebacteria and eubacteria.		
	12	Detailed analysis of bacterial ultrastructure (e.g., glycocalyx, capsule).		
	13	Composition and structure of gram-positive and gram-negative cell walls.		
	14	Cell membrane structure, function, and composition in bacteria and archaea.		
	15	Cytoplasmic structures (e.g., ribosomes, inclusion bodies).		
	16	Endospore formation and sporulation stages.		
IV	**Beneficial & Harmful Microorganisms**		**10**	**15**
	17	Roles of beneficial soil microbes like PGPR and mycorrhizae.		
	18	Biopesticides and biocontrol agents.		
	19	Beneficial microbes in food industries.		
	20	Application of microbes in pharmaceutical industries.		
	21	Overview of pathogenic bacteria, fungi, protozoa, and viruses.		
	22	Impact of microorganisms on human, animal, and plant health.		
V	**Practical Applications in Microbiology**		**30**	
	1	Introduction to laboratory instruments and safety precautions.		
	2	Common methods of sterilization.		
	3	Microscope maintenance and usage.		

Books and References:

1. Atlas, R. M. (1997). Principles of microbiology (2nd ed). Wm. C. Brown Publishers.
2. Black, J. G., & Black, L. J. (2018). Microbiology: Principles and explorations (10th edition). Wiley.
3. Frobisher, M. (Ed.). (1974). Fundamentals of microbiology (9th ed). W. B. Saunders Co.
4. Gladwin, M., Trattler, B., & Mahan, C. S. (2023). Clinical microbiology made ridiculously simple (Edition 9, in color). MedMaster, Inc.
5. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., Stahl, D. A., & Brock, T. D. (2022). Brock biology of microorganisms (Sixteenth edition, global edition). Pearson.
6. Michael J. Pelczar, Chan, E. C. S., Noel R. Krieg, & Merna Foss Pelczar. (2024). Microbiology (5th edition). Affiliated East-West Press Private Limited.
7. Pommerville, J. (2014). Alcamo's fundamental of microbiology (Tenth edition). Jones and Bartlett India Pvt. Ltd.
8. Salle, A. J. (2007). Fundamental principles of bacteriology (Reprint of the 2. ed., 6. impression 1943). Envins Press.
9. Stanier, R. Y. (2003). General Microbiology. (5th ed). Macmillan.
10. Tortora, G. J., Funke, B. R., & Case, C. L. (2019). Microbiology: An introduction (Thirteenth edition). Pearson.
11. Willey, J. M., Sandman, K., Wood, D. H., & Prescott, L. M. (2023). Prescott's microbiology (Twelfth edition, international student edition). McGraw Hill.

Mapping of COs with PSOs and POs:

	PSO1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		2	3		3		2	3		3	
CO2	3			2		3		3	3		2	
CO3	3		3			2		3		2	3	
CO4	2	3				2	3	3		2		
CO5		3	3	3					3	3		

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (10%)
- Practical Assessment (20%)
- Endsemester Exam (70%)

Mapping of COs to Assessment Rubrics :

Course Outcome (CO)	Internal Exam	Assignment	End Semester Examination	Practical Assessment
CO1	✓	✓	✓	
CO2	✓	✓	✓	
CO3	✓	✓	✓	
CO4	✓		✓	
CO5				✓

MBY2CJ 101/ MBY2MN100. BASIC TECHNIQUES IN MICROBIOLOGY

Programme	**B. Sc. Microbiology**				
Course Code	MBY2CJ 101/ MBY2MN100				
Course Title	Basic Techniques in Microbiology				
Type of Course	**Major/Minor**				
Semester	II				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Nil				
Course Summary	This preliminary course introduces the basic techniques used in microbiology. It enables the students to acquire a sound theoretical and practical knowledge on microscopy techniques, staining methods, media and methods for culturing the microorganisms and culture preservation strategies.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Master the use of various microscopy techniques, including electron, phase contrast, and fluorescence microscopy, to analyze microorganisms.	(U)	(P)	Internal Exam, Assignment, End Semester Examinations
CO2	Execute and differentiate between multiple staining techniques, such as Gram, acid-fast, and capsule staining, to identify and classify microbial structures.	(Ap)	(P)	Internal Exam, Assignment, End Semester Examinations
CO3	Prepare, select, and utilize appropriate culture media for the growth of aerobic and anaerobic microorganisms.	(Ap)	(P)	Internal Exam, End Semester Examinations
CO4	Implement isolation and culture techniques to maintain pure microbial cultures and apply preservation methods for long-term use.	(An)	(P)	Internal Exam, End Semester Examinations
CO5	Demonstrate proficiency in microbiological laboratory techniques through practical application and understanding of	(Ap)	(C)	Practical assessments

	theoretical concepts.			

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45 +30)	Marks (70)
I	**MICROSCOPY**		**10**	**15**
	1	Introduction to microscope-resolving power, numerical aperture, oil immersion objective.		
	2	Types of microscopes -bright field, dark field		
	3	Phase contrast, confocal microscopes		
	4	Fluorescent microscopes		
	5	Electron microscopy - TEM and SEM		
	6	Electron microscopy - sample preparation & fixation, labelling & storage of slides.		
II	**STAINING**		**10**	**15**
	7	Mechanism of staining - Basic dyes, Acidic dyes. Bacterial smear preparation and fixation.		
	8	Simple Staining, Differential staining- Gram staining, Acid fast staining,		
	9	Staining specific structures-Endospore staining, Negative staining, Capsule staining, Flagellar staining,		
	10	Fungal staining		
	11	Preparation of permanent slides		
III	**CULTURE MEDIA**		**15**	**25**
	12	Solid and liquid media, simple and complex, synthetic or defined media.		
	13	Selective, enrichment, enriched media		
	14	differential, indicator media, Transport media		
	15	Anaerobic media- thioglycollate medium, Robertson's media.		
	16	Cultivation of anaerobic bacteria -Production of vacuum, displacement of oxygen with other gases, chemical methods, biological methods and reduction of medium.		
IV	**CULTURE METHODS -**		**10**	**15**
	17	Isolation of microbes- Dilution plating and enrichment technique.		
	18	Pure culture techniques-Streak, spread, pour plate methods		
	19	Stab culture, stroke culture and lawn culture.		
	20	Culture preservation strategies-regular subculture, paraffin		

		method, storage in soil, storage in silica gel		
	21	Storage at refrigerator or cold room storage, storage by freeze drying and drying, preservation under liquid nitrogen		
	22	Microbial culture collections		
V	**Practical Applications in Microbiology**		**30**	
	1	Staining procedures for microorganisms		
	2	Microscopic observation of microorganisms		
	3	Culture media prepartion		
	4	Demonstration/research institute visit - dark field, phase contrast, confocal, fluorescent, Electron microscopes		

Books and References:

1. Atlas, R. M. (1997). Principles of microbiology (2nd ed). Wm. C. Brown Publishers.
2. Black, J. G., & Black, L. J. (2018). Microbiology: Principles and explorations (10th edition). Wiley.
3. Frobisher, M. (Ed.). (1974). Fundamentals of microbiology (9th ed). W. B. Saunders Co.
4. Gladwin, M., Trattler, B., & Mahan, C. S. (2023). Clinical microbiology made ridiculously simple (Edition 9, in color). MedMaster, Inc.
5. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., Stahl, D. A., & Brock, T. D. (2022). Brock biology of microorganisms (Sixteenth edition, global edition). Pearson.
6. Michael J. Pelczar, Chan, E. C. S., Noel R. Krieg, & Merna Foss Pelczar. (2024). Microbiology (5th edition). Affiliated East-West Press Private Limited.
7. Pommerville, J. (2014). Alcamo's fundamental of microbiology (Tenth edition). Jones and Bartlett India Pvt. Ltd.
8. Salle, A. J. (2007). Fundamental principles of bacteriology (Reprint of the 2. ed., 6. impression 1943). Envins Press.
9. Stanier, R. Y. (2003). General Microbiology. (5th ed). Macmillan.
10. Tortora, G. J., Funke, B. R., & Case, C. L. (2019). Microbiology: An introduction (Thirteenth edition). Pearson.
11. Willey, J. M., Sandman, K., Wood, D. H., & Prescott, L. M. (2023). Prescott's microbiology (Twelfth edition, international student edition). McGraw Hill.

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		2	3	3		3		2	3	3	
CO2	3		3	2	3		3		3	2	3	2
CO3	3		3		2		2		3		3	3
CO4	2	3	3		2		2	3	3		2	
CO5	2		2	3	3		3		2	3	3	

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (10%)
- Practical Assessment (20%)
- Endsemester Exam (70%)

Mapping of COs to Assessment Rubrics :

CO	Internal Exam	Assignment	End Semester Examinations	Practical Assessment
CO1	✓	✓	✓	✓
CO2	✓	✓	✓	✓
CO3	✓		✓	✓
CO4	✓		✓	✓
CO5				✓

MBY3CJ 201. MICROBIAL PHYSIOLOGY

Programme	B. Sc. Microbiology				
Course Code	MBY3CJ 201				
Course Title	Microbial Physiology				
Type of Course	Major				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Nil				
Course Summary	This course provides an in-depth understanding of microbial physiology, covering topics such as nutritional diversity, nutrient transport mechanisms, microbial growth kinetics, quantitative measurement of microbes , and reproduction mechanisms in bacteria.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Analyze the nutritional requirements and diversity in microorganisms.	(An)	(C)	Quizzes, Midterm Exam
CO2	Explain nutrient transport mechanisms and their significance in microbial physiology.	(U)	(C)	Assignments, Instructor-created exams
CO3	Evaluate factors affecting microbial growth and growth kinetics in batch and steady state systems	(E)	(P)	End Semester Examinations, Practical assessments
CO4	Assess various quantitative methods for enumeration of bacteria and virus .	(An)	(P)	End Semester Examinations, Practical assessments
CO5	Demonstrate methods for culturing, quantifying, and analyzing microbial growth in practical settings.	(Ap)	(P)	Practical assessments, Lab Reports

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45+30)	Marks (70)
I	**Microbial Nutrition and Nutritional Diversity**		**10**	**15**
	1	Nutritional requirements of bacteria: Major and Minor Elements.		
	2	Nutritional Diversity in Microorganisms.		
	3	Nutritional Types: Autotrophy, Heterotrophy, Chemotrophy, Phototrophy, Lithotrophy, and Organotrophy.		
	4	Acetogens and Methanogens: Methanogenesis and its importance.		
	5	Major Nutritional Groups of Bacteria: Classification and its role.		
II	**Nutrient Transport Mechanisms**		**10**	**15**
	6	Diffusion, Osmosis, Active Transport, Passive Transport, Group Translocation		
	7	Electrogenic and Electroneutral Transport with examples		
	8	Quorum Sensing – Mechanism and Signalling Molecules.		
	9	Ion Channels and pumps in bacteria		
III	**Microbial Growth**		**15**	**20**
	10	Factors affecting Microbial growth – Temperature		
	11	Factors affecting Microbial growth – pH		
	12	Factors affecting Microbial growth – Oxygen, Radiation, Water activity		
	13	Growth curve and its significance		
	14	Growth Kinetics- Batch system, Steady state system		
	15	Synchronous culture		
	16	Diauxic culture		
IV	**Bacterial and Viral Quantitation Methods**		**10**	**20**
	17	Quantitative measurement of bacterial growth by direct methods		
	18	Quantitative measurement of bacterial growth by indirect methods		
	19	Viral quantitative techniques - Plaque assay and Pock assay		
	20	Viral Cultivation methods		
	21	Modes of reproduction in bacteria- fission, budding, fragmentation,		
	22	Mechanism of sporulation.		

V	**Practicals**		**30**	**30**
	23	1. Isolation of bacteria by Pure Culture Techniques . 2. Effects of temperature, pH, and aeration on microbial growth. 3. Bacterial Growth curve 4. Enumeration of bacteria by indirect methods - Spread and Pour plate techniques. 5. Enumeration of bacteria by Direct Methods - Breeds Count, Petroff Hausser Chamber		

Books and References:

1. Moat, A. G., Foster, J. W., & Spector, M. P. (2002). *Microbial Physiology* (4th ed.). Wiley-Liss.
2. Madigan, M. T., Martinko, J. M., Bender, K. S., Buckley, D. H., & Stahl, D. A. (2014). *Brock Biology of Microorganisms* (14th ed.). Pearson.
3. Tortora, G. J., Funke, B. R., & Case, C. L. (2018). *Microbiology: An Introduction* (13th ed.). Pearson.
4. Black, J. G. (2012). *Microbiology: Principles and Explorations* (8th ed.). Wiley.
5. Atlas, R. M. (2010). *Principles of Microbiology*. McGraw-Hill Education.
6. Foster, J. W., & Hall, H. K. (1996). *Microbial responses to environmentally induced stress*. In F. C. Neidhardt, R. Curtiss III, J. L. Ingraham, E. C. C. Lin, K. B. Low, B. Magasanik, W. S. Reznikoff, M. Riley, M. Schaechter, & H. E. Umbarger (Eds.), *Escherichia coli and Salmonella: Cellular and Molecular Biology* (Vol. 2, pp. 1526-1539). ASM Press.

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO 3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		2		3		3		2		3	
CO2	2		3		2		2		3		2	
CO3		3		3				3		3		3
CO4			3	2					3	2		2
CO5				3	3					3	3	

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (10%)
- Practical Assessment (20%)
- Endsemester Exam (70%)

Mapping of COs to Assessment Rubrics :

CO	Internal Exam	Assignment	End Semester Examination	Practical Assessment
CO1	✓	✓	✓	
CO2	✓	✓	✓	
CO3	✓		✓	✓
CO4		✓	✓	✓
CO5				✓

MBY3CJ 202. MICROBIAL METABOLISM

Programme	B. Sc. Microbiology				
Course Code	MBY3CJ 202/MBY3MN 200				
Course Title	Microbial Metabolism				
Type of Course	Major/Minor				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Nil				
Course Summary	This introductory course covers the fundamental aspects of Microbial Metabolism. It involves converting nutrients into energy and essential biomolecules like ATP, crucial for microorganism survival. Key pathways like glycolysis and the Krebs cycle drive energy production. Microbes adapt to diverse environments by utilizing various carbon and nitrogen sources. Understanding microbial metabolism is vital for biotechnology, industry, and environmental solutions.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Explain the nutritional requirements and types of bacteria based on energy, carbon, and electron sources.	U	F	Internal Exam, Assignment, End Semester Exam
CO2	Describe key metabolic pathways, including respiration and fermentation in microbial systems.	U	C	Internal Exam, Assignment, End Semester Exam
CO3	Analyze chemoheterotrophic and chemolithotrophic metabolism, focusing on energy production mechanisms.	An	C	Internal Exam, End Semester Exam
CO4	Evaluate microbial metabolic strategies in environmental adaptation and biotechnological applications.	E	M	Internal Exam, End Semester Exam
CO5	Perform and interpret experiments related to microbial growth curves, biofilm formation, and metabolic pathways.	Ap	P	Practical Assessment
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P)				

Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45+30)	Marks (70)
I	**Nutritional requirements of bacteria**		**10**	**15**
	1	C, electron, energy, and minerals. Nutritional types of bacteria- based on the requirement and their combinations		
	2	Modes of bacterial nutrition.		
	3	Transport of nutrients by bacteria		
	4	Passive, active and group translocation		
	5	Symport, antiport and uniport, electrogenic and electroneutral transport, transport of iron		
II	**Chemoheterotrophic Metabolism - Aerobic Respiration**		**10**	**15**
	6	Concept of aerobic respiration		
	7	Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway. TCA cycle.		
	8	Electron transport chain		
	9	Components of respiratory chain, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation		
III	**Chemoheterotrophic Metabolism- Anaerobic respiration and fermentation**		**15**	**20**
	10	Anaerobic respiration with special reference to dissimilatory nitrate reduction		
	11	Fermentation - Alcohol fermentation		
	12	Pasteur effect;		
	13	Lactate fermentation		
	14	Homofermentative		
	15	Concept of linear and branched fermentation pathways.		
	16	Heterofermentative pathways		
IV	**Chemolithotrophic and Phototrophic Metabolism**		**10**	**20**
	17	Introduction to aerobic and anaerobic chemolithotrophy		
	18	Hydrogen oxidation (definition and reaction) and methanogenesis (definition and reaction).		
	19	Introduction to phototrophic metabolism		
	20	Groups of phototrophic microorganisms		
	21	Anoxygenicvs. oxygenic photosynthesis with reference to photosynthesis in green bacteria		
	22	Purple bacteria and cyanobacteria.		
V	**Practical Applications in Microbiology**		**30**	
	1	Growth curve of bacteria		
	2	Carbohydrate fermentation by different microbes		
	3	Thermal death point, Thermal death time		

Reference :

- Madigan, M. T., &Martinko, J. M. (2014). *Brock Biology of Microorganisms* (14th ed.). PrenticeHall International Inc.
- Moat, A. G., & Foster, J. W. (2002). *Microbial Physiology* (4th ed.). John Wiley & Sons.
- Reddy, S. R., & Reddy, S. M. (2005). *Microbial Physiology*. Scientific Publishers India.
- Gottschalk, G. (1986). *Bacterial Metabolism* (2nd ed.). Springer Verlag.
- Stanier, R. Y., Ingrahm, J. I., Wheelis, M. L., & Painter, P. R. (1987). *General Microbiology* (5th ed.). McMillan Press**.**

Mapping of COs with PSOs and POs:

	PSO1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		2	3		3	2	3		3		
CO2	3		2	3	3	3	3	2	1			
CO3	3	3		2	3	2	3	1			2	
CO4	2	3		3		3	3	2	2			
CO5		3	3	3		1	2	3	3			

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (10%)
- Practical Assessment (20%)
- End semester Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Practical Assessment	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓			✓
CO4	✓			✓
CO5			✓	

MBY4CJ 203. ENVIRONMENTAL AND SANITATION MICROBIOLOGY

Programme	B. Sc. Microbiology				
Course Code	MBY4CJ 203				
Course Title	Environmental and Sanitation Microbiology				
Type of Course	Major				
Semester	IV				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Nil				
Course Summary	This course explores the role of microorganisms in environmental and sanitation contexts, focusing on their impact on air and water quality, waste management, and their use in bioremediation and pollution control.				

Course Outcomes (CO): .

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand microbial dynamics in air and their implications on health.	(U)	(C)	Internal Exam, End Semester Exam
CO2	Evaluate methods of microbial sampling and monitoring in environmental settings.	(E)	(P)	Practical Assessments, Assignments
CO3	Analyze aquatic ecosystems and the role of microbes in water quality management.	(An)	(C)	Assignments, End Semester Exam
CO4	Apply microbial techniques for solid waste management and bioremediation.	(Ap)	(P)	Practical Assessments
CO5	Discuss the impact of microbial processes on pollution control and environmental restoration.	(U)	(C)	Internal Exam, Assignments

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45 +30)	Marks -70
I	**Microbiology of air**		**10**	**15**
	1	Atmospheric layers, organisms in air, distribution and sources		
	2	Disease forecasting in plants		
	3	Indoor and outdoor air		
	4	Droplet nuclei, aerosol, infectious dust		
	5	Microbiological sampling of air - gravity slide, plate exposure, vertical cylinder, Hirst spore trap, Rotorod sampler, Andersen sampler, hand held air sampler, impingers and filtration. Advantages and disadvantages of these techniques		
	6	Brief account of air borne transmission of harmful microbes and air borne infections		
II	**Aquatic Microbiology**		**10**	**15**
	7	Aquatic environment, distribution of microorganisms in aquatic environment - fresh water, estuarine and marine water systems		
	8	Factors influencing growth and distributions		
	9	Water Purification procedures for single dwelling and municipal water supplies		
	10	Concept of indicator organisms, Microbiological examination of water. BOD, COD		
	11	Wastewater treatment steps and methods		
	12	Eutrophication and algal bloom		
	13	Brief account of water borne diseases and transmission		
III	**Solid Waste Management**		**15**	**25**
	14	Sources and types of solid waste		
	15	need for management		
	16	Landfills, composting, vermi- composting, anaerobic digesters, methanogenesis and production of biogas		
	17	Design and management of biogas plants		
IV	**Bioremediation**		**10**	**15**
	18	Novel pollutants, persistence and biomagnification		

	19	Recalcitrant halocarbons- nitroaromatic compounds, PCB, alkyl benzene sulphonates		
	20	Petroleum hydrocarbons - their biodegradation		
	21	Bioremediation of polluted environment - Oil spills, heavy Metals and other xenobiotics.		
	22	Microbial leaching and corrosion of metals		
V	**Open ended**			
	1	Marine Natural products from marine microorganisms- antibiotics, toxins, organic acids, biosurfactants, pigments, biopolymers and enzymes		
	2	Waste management strategies in the local bodies: Discussion, Visit, evaluation, suggestion for improvements		

Books and References:

1. Textbook of Biochemistry by Lehninger
2. Biochemistry by Stryer
3. Molecular Biology of the Gene by Watson, JD, Hopkins NH, Roberts JW, Steitz JA,
4. Weiner AAM, 1987. The Benjamin/Cummings publishing company.
5. Genes V by Lewin B, 1994. Oxford University Press.
6. Molecular Cell Biology by Lodish, H, Baltimore D, Berk A, Zipursky SL, Matsudaira P,
7. Darnell J., 1995. Scientific American Books.
8. Molecular Biology by Freifelder D., 1991 Narosa Publishing Home.
9. Principles of Gene Manipulation, 4th Ed., by R.S.Old and S.B.Primrose. 1989. Blackwell Scientific Publications, London
10. Cell Biology by Karp

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2		1			3	2	1		2	1
CO2	2	3	3	2			2	1	3	2	3	2
CO3	1	2	3		2	1	2	3	2	1	1	3
CO4	3		2	3	1	2	1	2	3	3	2	1
CO5	2	1		2	3		3	2	1	2	3	

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (10%)
- Practical Assessment (20%)
- Endsemester Exam (70%)

Mapping of COs to Assessment Rubrics :

CO	Internal Exam	Assignment	End Semester Examination	Practical Assessment
CO1	✓		✓	
CO2		✓		✓
CO3		✓	✓	
CO4				✓
CO5	✓	✓		

MBY4CJ 204. SOIL AND AGRICULTURAL MICROBIOLOGY

Programme	B. Sc. Microbiology				
Course Code	MBY4CJ 204				
Course Title	Soil and Agricultural Microbiology				
Type of Course	Major				
Semester	IV				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Basic knowledge of microorganisms during previous years of this program				
Course Summary	This course provides a comprehensive overview of soil microbiology, biogeochemical cycles, biological interactions, and the applications of microbes in agriculture, along with insights into microbial plant pathology. Overall, it offers a deep understanding of how microorganisms, soil health, and plant diseases are interconnected, providing practical insights for sustainable agricultural practices.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the general properties of soil and the role of microorganisms in soil health.	(U)	(C)	Internal Exam, Midterm Exam
CO2	Outline the role of microorganisms in biogeochemical cycling and their implications on soil fertility.	(R)	(F)	Assignments, End Semester Exam
CO3	Develop a better knowledge of the interaction of microorganisms with each other and with plants and animals.	(U)	(C)	Instructor-created Exams, Quizzes
CO4	Understand the role of microbes as biofertilizers and biopesticides in agriculture and their advantage over chemical counterparts.	(E)	(P)	Internal Exam, End Semester Exam
CO5	Develop practical skills in the isolation, enumeration, and identification of microbes from soil and plants.	(Ap)	(P)	Practical Assessments, Lab Reports

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
\# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45 +30)	Marks (70)
I	**Introduction to soil Microbiology**		**10**	**15**
	1	Properties of soil (structure, texture, formation)	1	
	2	Types of soil microorganisms	1	
	3	Role of microorganisms in soil fertility	1	
	4	Factors affecting microbial population in soil- moisture, pH, temperature, organic matter, agronomic practices, etc	2	
	5	Humus formation and its significance	2	
	6	Biogeochemical cycle- Role of microorganisms in Carbon, Phosphorous, Nitrogen, and sulfur cycles.	2	
	7	Soil fertility tests	1	
II	**Biological Interactions**		**10**	**15**
	8	Microbe-Microbe Interactions- Mutualism, Synergism, Commensalism	3	
	9	Microbe-Microbe Interactions- Competition, Amensalism, Parasitism, Predation.	3	
	10	Microbe-Plant Interactions. Roots- Rhizosphere and *Mycorrhizae,* Aerial Plant surfaces	2	
	11	Microbe- Animal Interactions. Role of Microbes in Ruminants, Nematophagus fungi, Luminescent bacteria as Symbiont	2	
III	**Applications of microbes in agriculture : Biofertilizers & Biopesticides**		**15**	**25**
	12	Symbiotic nitrogen fixation - (Rhizobium, Frankia)	2	
	13	Symbiotic nutrient mobilizers - Endomycorrhizae and Ectomycorrizae	2	
	14	Non symbiotic microbes - Azotobacter	1	
	15	Associative Symbiosis - Azospirillum. Cyanobacteria (Nostoc. Gloeocapsa), Azolla-Anabaena System	3	
	16	Bio pesticides- bacterial, fungal and viral biopesticides	3	
	17	Advantages of biofertilizers and biopesticides over their chemical counterparts	2	
	18	Effect of pesticides on soil microflora	2	
IV	**Plant pathology**		**10**	**15**
	19	Plant pathology- symptoms, disease cycle, and control measures	2	
	20	Bacterial diseases - Angular leaf spot of cotton, bacterial leaf blight of rice, crown galls, bacterial cankers of citrus	3	
	21	Fungal disease- Wilt of tomato -*Fusariumoxysporum,*	3	

		Red rot of sugarcane - *Colletotrichumfalcatum,* Early blight of potato -*Alternariasolani,* Wilt of cotton		
	22	Viral diseases- Papaya ringspot, tomato yellow leaf curl, banana bunchy top	2	
V	**Practical Applications in Soil & Agricultural Microbiology**		**30**	
	1	Isolation of Rhizobium and Azotobacter		
	2	Ammonification and nitrification of organic compounds		
	3	Enumeration of bacteria,fungi and actinomycetes from soil		
	4	Isolation of plant pathogenic bacteria		
	5	Isolation of plant pathogenic fungi		

Books and References:

1. Microbial Ecology. John Wiley & Sons, Inc., New York 2.
2. Introduction to Soil Microbiology by Alexander, M.(1977). John Wiley & Sons, Inc.,
3. Agricultural microbiology, 2nd edition. Rangaswami G., Bagyaraj D. J. Prentice hall of India.
4. Ronald M. Atlas., Richard Bartha. Microbial Ecology. Benjamin Cummings. 1998
5. Robert, L Tate (1995). Soil Microbiology. First edition, John Wiley and Sons, Inc. New York edition. Pearson Education.
6. Rangaswami G and Mahadevan A (2002). Disease of Crop Plants in India. Fourth edition,PHI Learning (P) Ltd., New Delhi.
7. Subba Rao NS (2004). Soil Microbiology. Fourth edition, Oxford and IBH Publishing Co.Pvt. Ltd., New Delhi.
8. Mishra RR (2004). Soil Microbiology. First edition, CBS Publishers and distributors, New Delhi.
9. Devlin RM. (1975). *Plant Physiology.* 3rd edition, Willard Grant Press.
10. *Stolp H. (1988).* Microbial Ecology: Organisms Habitats Activities. *Cambridge University* Press, Cambridge, England.
11. Agrios GN. (2006). *Plant Pathology.* 5th edition. Academic press, San Diego
12. Lucas JA. (1998). *Plant Pathology and Plant Pathogens.* 3rd edition. Blackwell Science, Oxford.
13. Mehrotra RS. (1994). *Plant Pathology.* Tata McGraw-Hill Limited.
14. Rangaswami G. (2005). *Diseases of Crop Plants in India.* 4th edition. Prentice Hall of India Pvt. Ltd., New Delhi.
15. Singh RS. (1998). *Plant Diseases Management.* 7th edition. Oxford & IBH, New Delhi.
16. Raina M.Maier. Ian L.Pepper and Charles P.Gerba. (2000)EnvironmentalMicrobiology.Academic press California.UK

Mapping of COs with PSOs and POs:

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3						3				2	
CO2	2						2		3		2	2
CO3	3		3						3		3	3
CO4		3		3				3		3		
CO5			3		3					3	3	

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (10%)
- Practical Assessment (20%)
- Endsemester Exam (70%)

Mapping of COs to Assessment Rubrics :

CO	Internal Exam	Assignment	End Semester Examination	Practical Assessment
CO1	✓		✓	
CO2	✓	✓	✓	
CO3	✓		✓	
CO4	✓		✓	✓
CO5				✓

MBY4CJ205. MOLECULAR BIOLOGY

Programme	B. Sc. Microbiology				
Course Code	MBY4CJ205				
Course Title	Molecular biology				
Type of Course	**Major**				
Semester	IV				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Nil				
Course Summary	This course delves into molecular biology's fundamental principles, focusing on the structure, function, and interactions of biomolecules such as DNA, RNA, proteins, and lipids. Students explore the intricate mechanisms that drive cellular processes and genetic inheritance through lectures, laboratory sessions, and discussions.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the fundamental aspects of nucleic acids and their role as genetic material.	(U)	(C)	Internal Exam, End Semester Examination
CO2	Evaluate the mechanisms of DNA replication, mutation, and repair in prokaryotes and eukaryotes.	(E)	(P)	Assignments, End Semester Examination
CO3	Analyze the processes of transcription and translation, and their regulation in prokaryotes and eukaryotes.	(An)	(P)	Assignments, End Semester Examination
CO4	Apply knowledge of genetic mutations to practical scenarios in molecular biology.	(Ap)	(P)	Internal Exam, Practical Assessments
CO5	Demonstrate practical skills in molecular biology techniques, including DNA, RNA isolation, and gene expression analysis.	(Ap)	(P)	Practical Assessments

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45 +30)	Marks -70
I	**Basic Concept of Genetic Materials**		**10**	**15**
	1	Nucleic acid as the genetic material (Experimental proof)	1	
	2	Structure and functions of Nucleic acids, types and different forms	2	
	3	Organisation of bacterial and eukaryotic chromosomes, Histone and their functions	3	
	4	Denaturations and renaturations, Cot curve	2	
	5	DNA topology - linking number, topoisomerases	2	
II	**Replication of DNA**		**10**	**15**
	6	Semi-conservative model of DNA	2	
	7	Features of prokaryotic DNA replication.	3	
	8	Mechanism of eukaryotic DNA replication.	3	
	9	Models of replication in the circular DNA- D-Loop, rolling circle and theta model.	2	
III	**Mutation**		**10**	**25**
	10	Chromosomal Mutations: Deletion, Duplication, Inversion, Translocation,	2	
	11	Aneuploidy and Polyploidy.	1	
	12	Gene mutations: definition and types	1	
	13	Induced versus Spontaneous mutations	1	
	14	Back versus Suppressor mutations	2	
	15	Molecular basis of Mutations about UV light and chemical mutagens	1	
	16	Detection of mutations-Ames test, Replica plating. Concept of Luria Delbruck experiment	2	
IV	**Gene expression Mechanisms**		**15**	**15**
	17	Transcription- prokaryotic and eukaryotic.	3	
	18	Post-transcriptional modifications	2	
	19	Translation- prokaryotes and eukaryotes	4	
	20	Genetic code.	1	
	21	Post-translational modifications	2	
	22	A brief account of gene regulation in prokaryotes - operon concept - lac and trp operon.	3	
V	**Practical Applications in Microbiology**		**30**	
	1	Preparation of buffers		

	2	Demonstration of mitosis.		
	3	Isolation of genomic DNA from *E. coli*. and agarose gel electrophoresis		
	4	Estimation of DNA.		
	5	Isolation of RNA.		
	6	Estimation of RNA.		

Books and References:

1. Textbook of Biochemistry by Lehninger
2. Biochemistry by Stryer
3. Molecular Biology of the Gene by Watson, JD, Hopkins NH, Roberts JW, Steitz JA,
4. Weiner AAM, 1987. The Benjamin/Cummings publishing company.
5. Genes V by Lewin B, 1994. Oxford University Press.
6. Molecular Cell Biology by Lodish, H, Baltimore D, Berk A, Zipursky SL, Matsudaira P,
7. Darnell J., 1995. Scientific American Books.
8. Molecular Biology by Freifelder D., 1991 Narosa Publishing Home.
9. Principles of Gene Manipulation, 4th Ed., by R.S.Old and S.B.Primrose. 1989. Blackwell Scientific Publications, London
10. Cell Biology by Karp

Mapping of COs with PSOs and POs :

CO	PSO1	PSO2	PSO3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3						3				2	
CO2	2	3					2	2	3		3	2
CO3	3	3	3				3		3		3	3
CO4		3		3				3		3		
CO5			3		3					3	3	

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (10%)
- Practical Assessment (20%)
- Endsemester Exam (70%)

Mapping of COs to Assessment Rubrics :

CO	Internal Exam	Assignment	End Semester Examination	Practical Assessment
CO1	✓		✓	
CO2		✓	✓	✓
CO3		✓	✓	✓
CO4	✓		✓	✓
CO5			✓	✓

MBY5CJ 301. SYSTEMIC BACTERIOLOGY

Programme	B. Sc. Microbiology				
Course Code	MBY5CJ 301				
Course Title	Systemic Bacteriology				
Type of Course	Major				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Nil				
Course Summary	This course delves into the morphology, pathogenesis, laboratory diagnosis, epidemiology, prevention, and control of diseases caused by critical bacterial groups. It covers gram-positive and gram-negative cocci and bacilli, AFB, spirochetes, and obligate intracellular bacteria				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the pathogenic mechanisms and diagnostic methods for gram-positive cocci.	(U)	(C)	Internal Exam, Midterm Exam
CO2	Describe the impact and control strategies of gram-negative bacilli on public health.	(R)	(F)	Assignments, End Semester Exam
CO3	Evaluate the laboratory and clinical diagnosis techniques for AFB and spirochetes.	(E)	(P)	Internal Exam, End Semester Examination
CO4	Apply knowledge of bacterial pathogenesis to develop prevention and control measures.	(Ap)	(P)	Internal Exam, End Semester Examination
CO5	Analyze the epidemiology of diseases caused by obligate intracellular bacteria.	(An)	(C)	Internal Exam, End Semester Examination

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
\# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45 +30)	Marks -70
I	Morphology and Cultural Characteristics, Pathogenesis, Laboratory diagnosis, Epidemiology, Prevention and control of diseases caused by Gram Positive and Gram Negative Cocci		**10**	**15**
	1	*Staphylococcus aureus,*		

	2	*Streptococcus pneumoniae,*		
	3	*Streptococcus pyogenes,*		
	4	*Neisseria gonorrhoeae*		
	5	*Neisseria meningitidis*		
II	Morphology and Cultural Characteristics, Pathogenesis, Laboratory diagnosis, Epidemiology, Prevention and control of diseases caused by Gram positive Bacilli		**10**	**15**
	6	*Bacillus anthracis,*		
	7	*Clostridium botulinum,*		
	8	*Clostridium tetani,*		
	9	*Corynebacterium diphtherieae*		
III	Morphology and Cultural Characteristics, Pathogenesis, Laboratory diagnosis, Epidemiology, Prevention and control of diseases caused by Gram negative bacilli		**12**	**20**
	10	*Escherichia coli, Shigella dysentriae,*		
	11	*Salmonella typhi*		
	12	*Klebsiella pneumoniae, Proteus*		
	13	*Vibrio cholerae,Pseudomonas aeruginosa*		
	14	*Helicobacter pylori,Hemophilus influenzae,*		
	15	*Bordetella pertrussis,*		
	16	*Brucella,Yersinia pestis*		
IV	Morphology and Cultural Characteristics, Pathogenesis, Laboratory diagnosis, Epidemiology, Prevention and control of diseases caused by AFB, Spirochetes and obligate intracellular bacteria		**13**	**20**
	17	*Mycobacterium tuberculosis,*		
	18	*Mycobacterium leprae,*		
	19	Treponema pallidum		
	20	Leptospira interrogans,		
	21	Mycoplasma		
	22	*Rickettsiae and Chlamydiae.*		
V	Practical		**30**	**30**
	1	Isolation and identification of Clinically important bacteria from various samples - Urine, Sputum, blood, pus etc.		
	2	Identification of bacteria via morphological, cultural characteristics, metabolic and biochemical features		
	3	AFB staining		
	4	Differential count of leukocytes		
	5	Blood grouping		
	6	Demonstration of precipitation reactions		

	7	Demonstration of agglutination reactions		

Books and References:

1. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick erg's Medical Microbiology.24th edition. McGraw Hill Publication.
2. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology. 4th edition.
3. Elsevier. Joklik WK, Willett HP and Amos DB (1995). Zinsser Microbiology. 19th edition. Appleton- CenturyCrofts publication.
4. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.
5. Medical Microbiology : David Greenwood, Slack, Peutherer
6. Satish Gupte (2005). The Short Textbook of Medical Microbiology.Eighth edition, Jaypee Brothers, Medical publishers (P) Ltd., New Delhi.
7. Baron EJ, Peterson LR and Finegold SM (1994). Bailey and Scott's diagnostic Microbiology. 9th edition, Mosby publications.
8. Rajan S (2009). Medical Microbiology. First edition, MJP Publishers, Chennai.
9. Rajesh Bhatia and Ratan Lal Ichhpujani (2004). Essentials of Medical Microbiology. Third edition, Jaypee Brothers, Medical Publishers (P) Ltd., New Delhi.
10. Medical Microbiology by Macie and McCartney
11. Ananthanarayan R and Paniker CKJ. (2005). Textbook of Microbiology. 7th edition (edited by Paniker CKJ).

Mapping of COs with PSOs and POs:

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2			1		3	2	1		3	
CO2	2	3				2	2	3	2		2	1
CO3	1	2	3		2		1	2	3	2	3	
CO4		3	2	3				3	2	3		2
CO5	3		1		3		3		2		3	3

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (10%)
- Practical Assessment (20%)
- Endsemester Exam (70%)

Mapping of COs to Assessment Rubrics:

CO	**Internal Exam**	**Assignment**	**End Semester Examination**	**Practical Assessment**
CO1	✓		✓	
CO2	✓	✓	✓	
CO3		✓	✓	✓
CO4	✓		✓	✓
CO5	✓		✓	✓

MBY5CJ 302-INDUSTRIAL MICROBIOLOGY

Programme	B. Sc. Microbiology				
Course Code	MBY5CJ 302				
Course Title	Industrial Microbiology				
Type of Course	Major				
Semester	V				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Nil				
Course Summary	This course covers the application of microbiology in the industrial sector, focusing on the processes of fermentation and the production of valuable products from microbes. The course includes practical sessions to enhance understanding of industrial applications.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the basic principles and processes involved in industrial microbiology.	U	F	Quizzes, Internal Exam
CO2	Describe the design and operation of fermenters and their role in industrial fermentation.	U	C	Assignments, Internal Exam
CO3	Identify and apply methods for the cultivation of industrially important microorganisms.	Ap	P	Practical Assessments
CO4	Analyze methods for the downstream processing and purification of fermentation products.	An	P	Internal Exam, Practical Assessments
CO5	Evaluate the production and practical applications of microbial products in industry.	E	C	Project Evaluation, End Semester Exam

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45+30)	Marks (70)
I	**Fundamentals of Industrial Microbiology**		**10**	**15**
	1	Introduction to Industrial Microbiology - Scope and importance in various industries.		
	2	History and Evolution of Fermentation Technology - Key discoveries and advancements.		
	3	Principles of Fermentation - Overview of fermentation processes.		
	4	Fermenter Design and Operation - Basic design features and operational parameters.		
	5	Types of Fermentation Processes I - Batch fermentation.		
	6	Types of Fermentation Processes II - Continuous and fed-batch fermentation.		
II	**Industrial Microorganisms and Media**		**12**	**20**
	7	Overview of Industrially Important Microorganisms - Characteristics and selection criteria.		
	8	Isolation and Screening of Microorganisms - Techniques for finding industrially valuable strains.		
	9	Improvement of Microbial Strains - Genetic manipulation and adaptive evolution.		
	10	Culture Preservation Techniques - Methods for maintaining industrial microorganisms.		
	11	Development of Fermentation Media - Nutrient requirements and media optimization.		
III	**Downstream Processing**		**13**	**20**
	12	Overview of Downstream Processing - Introduction to product recovery and purification.		
	13	Cell Disruption Methods - Mechanical and non-mechanical disruption techniques.		
	14	Primary Separation Techniques - Filtration and centrifugation.		
	15	Concentration and Purification Techniques I - Precipitation and dialysis.		
	16	Concentration and Purification Techniques II - Chromatographic methods.		
IV	**Products and Applications**		**10**	**15**
	17	Production of Primary Metabolites - Alcohols and organic acids.		
	18	Production of Secondary Metabolites - Antibiotics and vitamins.		
	19	Enzyme Production - Methods and applications in industry.		

	20	Biopolymers and Biofuels - Production techniques and industry uses.		
	21	Food and Beverage Industry Applications - Microbial roles in food production.		
	22	Recent Advances and Future Trends in Industrial Microbiology		
V	**Practical**		**30**	
	1	Cell disruption techniques		
	2	Ammonium Sulfate precipitation		
	3	Dialysis		
	4	Thin Layer Chromatography		
	5	Citric acid production		
	6	Wine production		

Books and References:

1. Prescott, L. M., Harley, J. P., & Klein, D. A. (2002). *Microbiology* (6th ed.). McGraw-Hill Higher Education.
2. Crueger, W., & Crueger, A. (1990). *Biotechnology: A Textbook of Industrial Microbiology*. Sinauer Associates Inc.
3. Demain, A. L., & Adrio, J. L. (2008). *Biotechnology of Microbial Products*. Springer.
4. Waites, M. J., Morgan, N. L., Rockey, J. S., & Higton, G. (2001). *Industrial Microbiology: An Introduction*. Blackwell Science.
5. Stanbury, P. F., Whitaker, A., & Hall, S. J. (2017). *Principles of Fermentation Technology* (3rd ed.). Butterworth-Heinemann.

Mapping of COs with PSOs and POs:

CO	PSO1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	1	1			3	2	1		2	1
CO2	3	2	1	1			2	3	1	2	1	
CO3	2	3	2	1			2	3	2	1	2	1
CO4	1	2	3	2	1		1	2	3	2	1	2
CO5	1	1	2	3	2	1	1	1	2	3	2	1

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (10%)
- Practical Assessment (20%)
- End semester Exam (70%)

Mapping of COs to Assessment Rubrics :

CO	Internal Exam	Assignment	End Semester Examination	Practical Assessment
CO1	✓			
CO2	✓	✓		
CO3				✓
CO4	✓			✓
CO5			✓	✓

MBY5CJ 303. BASIC ASPECTS OF IMMUNOLOGY

Programme	**B. Sc. Microbiology**				
Course Code	MBY5CJ 303				
Course Title	Basic aspects of immunology				
Type of Course	**Major**				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-		60
Pre-requisites					
Course Summary	This course provides an overview on immunity, immune response, different cells involved in immune response etc. It offers a detailed description on antigen and antibody, its types and functions, monoclonal antibody production, complement activation types etc. Students can gain an overall idea on immunity and immunological techniques.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the fundamental principles of the immune system and its components.	U	C	Internal Exam, End Semester Exam
CO2	Analyze the types and functions of antigens and antibodies.	An	C	Assignments, Practical Assessments
CO3	Evaluate the mechanisms of immune response and their clinical applications.	E	E	Assignments, End Semester Exam
CO4	Discuss the role of MHC in immune processes and disease susceptibility.	U	C	Internal Exam, Assignments
CO5	Apply immunological techniques in experimental and diagnostic settings.	Ap	C	Practical Assessments

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (48 +12)	Marks (75)
I	**History and scope of immunology**		**12**	**15**
	1	Contributions of scientists – Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff and Rodney Porter.		
	2	Innate immunity		
	3	Acquired immunity – Active and Passive immunity		
	4	Mechanism of innate immunity – physical, chemical, cellular, molecular etc		
II	**Structure ,Functions and Properties of immune cells**		**12**	**15**
	5	Hematopoiesis and stem cells		
	6	Cells of immune system – lymphocytes, macrophage, leukocytes, mast cells, dendritic cells.		
	7	Primary lymphoid organs – Thymus and Bone marrow		
	8	Secondary lymphoid organs – lymph node, spleen, MALT		
III	**Antigen and Antibody**		**12**	**20**
	9	Antigen and its characteristics		
	10	Types of antigens –hapten, epitope, TD and TI antigens, adjuvants		
	11	Antibodies – basic structure and properties – antigenic determinants, isotype, allotype, idiotype		
	12	Types and functions of antibodies – IgM, IgG,IgD,IgA,IgE		
	13	Monoclonal antibodies and hybridoma technology		
	14	Complement system – components and activation		
	15	Pathways of complement activation – classical, alternative and lectin pathway		
	16	MHC – Structure and Function – MHC 1 and MHC 11 molecules.		
	17	Antigen processing and presentation – cytosolic and Endocytic pathways		
IV	**Immune response**		**12**	**20**
	18	Primary and secondary immune response		
	19	Humoral - plasma cells and memory cells		

	20	Cell mediated immune response- self MHC restriction, T cell activation, co-stimulatory signals, killing mechanism by CTL and NK cells		
	21	Immunological tolerance		
	22	Immunological disorders		
V	**Open ended**		**12**	
	1	How vaccines provide protection ?		
	2	Survey on laboratory test results involving microbial infections.		

Reference books:

1. Abbas, A. K., Lichtman, A. H., & Pillai, S. (2020). *Cellular and Molecular Immunology* (10th ed.). Elsevier.
2. Murphy, K., Weaver, C., & Mowat, A. (2017). *Janeway's Immunobiology* (9th ed.). Garland Science.
3. Owen, J. A., Punt, J., & Stranford, S. A. (2019). *Kuby Immunology* (8th ed.). W.H. Freeman.
4. Parham, P. (2014). *The Immune System* (4th ed.). Garland Science.
5. Sompayrac, L. (2019). *How the Immune System Works* (6th ed.). Wiley-Blackwell.
6. Ritchlin, C., & Firestein, G. (Eds.). (2020). *Immunology, Inflammation and Diseases of the Human Body* (3rd ed.). Elsevier.

Mapping of COs with PSOs and POs:

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		2		1		3	1			2	
CO2	2	3		1			2	2	3	1	3	
CO3		2	3			1		3	2	3	2	1
CO4	1			3	2		1			2	3	2
CO5			3	2	3					3	3	3

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (30%)
- Practical Assessment
- Endsemester Exam (70%)

Mapping of COs to Assessment Rubrics :

CO	Internal Exam	Assignment	End Semester Examination
CO1	✓		✓
CO2		✓	
CO3	✓	✓	✓
CO4	✓	✓	✓
CO1	✓		✓

MBY6CJ 304/ MBY8MN304. FOOD AND DAIRY MICROBIOLOGY

Programme	B. Sc. Microbiology				
Course Code	MBY6CJ 304/ MBY8MN304				
Course Title	Food and Dairy Microbiology				
Type of Course	Major/Minor				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Nil				
Course Summary	This course examines the microbiological aspects of food processing, storage, and safety, including the study of microorganisms that impact food spoilage and preservation. The course explores both detrimental and beneficial aspects of microorganisms in food systems, with an emphasis on dairy products.				

Course Outcomes (CO): .

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the types and sources of microbial contamination in foods.	U	C	Internal Exam, End Semester Exam
CO2	Describe the microbiology of milk and dairy products and their spoilage agents.	U	C	Internal Exam, End Semester Exam
CO3	Analyze the principles of food spoilage and preservation.	An	C	Internal Exam, End Semester Exam
CO4	Evaluate the pathogenesis of foodborne diseases and their control measures.	E	C	Internal Exam, End Semester Exam
CO5	Apply microbiological techniques in the production and safety assessment of food products.	Ap	P	Internal Exam, End Semester Exam

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
\# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45+30)	Marks (70)
I	**Types of microorganisms in Food**		**10**	**15**
	1	Source of contamination		
	2	Factors influencing microbial growth in foods (extrinsic and intrinsic)		

	3	Microbial examination of food- viable colony count		
	4	Examination of fecal Streptococci		
	5	Spoilage microorganisms in various foods		
II	**Dairy Microbiology**		**10**	**15**
	6	Physical and chemical properties of milk		
	7	Milk as a substrate for microorganisms		
	8	Types of microorganisms in Milk: bacteria, fungi, and yeast		
	9	Sources of microbial contamination of milk		
	10	Microbiological analysis of milk		
III	**Food Spoilage and Food preservation**		**15**	**25**
	11	General principles underlying spoilage		
	12	Different kinds of foods, cereals and cereal products - sugar and sugar products - vegetable and fruits - meat and meat products - fish and other sea foods - eggs and poultry		
	13	Dairy and fermentative products (ice cream/milk/bread/wine)		
	14	Food preservation : Principles of food preservation		
	15	Methods of preservation. a. Physical (irradiation, drying, heat processing, pasteurization, chilling and freezing, high pressure and modification of atmosphere)		
	16	Methods of preservation b. Chemical (Sodium benzoate Class I & II)		
IV	**Food Poisoning**		**10**	**15**
	17	Food borne infections		
	18	Bacterial: Staphylococcal, Brucella, Bacillus, Clostridium, Escherichia, Salmonella		
	19	Fungal : Mycotoxins including aflatoxins, ergotism		
	20	Viral: Hepatitis		
	21	Protozoa - Amoebiasis		
	22	Emerging food safety issues		
V	**Practical (Production of Fermented Food products)**		30	
	1	Cheese, bread, yoghurt, idli, Ice cream		
	2	Fermented pickles and fermented vegetables		
	3	SCP, Wine production		
	4	Probiotics and prebiotics		

Books and References:

1. Frazier, W. C., & Westhoff, D. C. (2013). *Food Microbiology* (4th ed.). McGraw-Hill Education.
2. Jay, J. M., Loessner, M. J., & Golden, D. A. (2005). *Modern Food Microbiology* (7th ed.). Springer.

3. Doyle, M. P., & Buchanan, R. L. (2013). *Food Microbiology: Fundamentals and Frontiers* (4th ed.). ASM Press.
4. Robinson, R. K., Batt, C. A., & Patel, P. D. (2015). *Encyclopedia of Food Microbiology* (2nd ed.). Academic Press.

Mapping of COs with PSOs and POs :

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	3					2	3	1		3	
CO 2	3		2		1		3		2		2	
CO 3		2	3			1		3	3	2	2	1
CO 4		3		3				3		3		2
CO 5			3		3							

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (10%)
- Practical Assessment (20%)
- Endsemester Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Practical Exam	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓	✓	✓

MBY6CJ 305. MICROBIAL BIOTECHNOLOGY

Programme	B. Sc. Microbiology				
Course Code	MBY6CJ 305				
Course Title	Microbial Biotechnology				
Type of Course	Major				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	60
Pre-requisites	Nil				
Course Summary	This course outlines the scope of Microbial Biotechnology with respect to different products and processes employing microorganisms. The course discusses different biotechnological approaches using microorganisms in solving existing challenges as well as in novel product development to address the evolving scenario.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the applications of microorganisms in biotechnological processes and product development.	U	C	Internal Exam, Assignments
CO2	Explore the role of microbial biotechnology in environmental remediation and pollution control.	An	C	Internal Exam, Practical Assessments
CO3	Analyze the techniques and methods used in microbial enhancement for biofuel production.	Ap	C	Internal Exam, Practical Assessments
CO4	Evaluate the ethical, safety, and regulatory challenges associated with microbial biotechnology.	E	C	Internal Exam, Assignments
CO5	Apply biotechnological innovations to develop solutions for industry-specific challenges, particularly in energy and environmental sectors.	C	P	Practical Assessments, End Semester Exam

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (55+30)	Marks (70)
I	**Scope of microbial biotechnology**		**12**	**10**
	1	Microbial cells as single cell proteins		
	2	Spirulina-process and safety aspects		
	3	Mushroom production: cultivation of edible and medicinal mushrooms		
	4	Probiotics and prebiotics- importance, production and applications		
	5	Microbial synthesis of exopolysaccharides, biopolymers, bioplastics, pigments, nanoparticles and their applications		
	6	Biomineralization by microorganisms and applications.		
II	**Petroleum microbiology**		**12**	**20**
	7	Microbial enhanced oil recovery		
	8	oil spill degradation by microorganisms-mechanism and microorganisms involved		
	9	Superbug in oil spill removal		
	10	Microbes in alternative energy- Microbial production of fuels- H_2 and ethanol		
	11	Production of biodiesel-oleogenic yeasts and algae.		
	12	Microbial bioelectrochemical systems (BESs).		
III	**Microbial interactions with pollutants**		**12**	**20**
	13	Bioremediation- process and organisms involved, constraints and applications.		
	14	Bioaugmentation; Ex-situ and in-situ processes		
	15	Intrinsic and engineered bioremediation		
	16	Bioremediation of dyes- microorganisms involved		
	17	Bioremediation in paper and pulp industries- microorganisms involved		
	18	Microbe-metal interactions- bioaccumulation, biosorption- mechanisms		
IV	**Microbial biotechnology: applications in novel product development**		**12**	**20**
	19	Genetically Modified Organisms, GMO's		
	20	Biotech products and impact assessment-Bt (cotton, corn, mustard), Golden rice, herbicide resistant plants,		
	21	Insulin and therapeutics production using GMO		
	22	Bioweapons and Bioshields		
V	**Practical**		**30**	
	1	Cultivate and harvest single-cell proteins using yeast or algae.		

	2	Grow edible or medicinal mushrooms like Agaricus bisporus or Ganoderma lucidum on suitable substrates.		
	3	Ferment dairy or non-dairy substrates with probiotic strains (e.g., Lactobacillus) and test for prebiotic efficacy.		
	4	Produce and isolate exopolysaccharides or bioplastics using bacterial cultures such as Xanthomonas campestris.		
	5	Test the degradation of oil spills using oil-degrading bacteria such as Pseudomonas aeruginosa.		
	6	Extract lipids for biodiesel production.		
	7	Conduct experiments on bioaccumulation and biosorption of heavy metals using microorganisms like Saccharomyces cerevisiae.		
	8	Use microbial cultures to degrade industrial dyes and assess the efficiency of degradation.		

Books and References:

- Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., Stahl, D. A., & Brock, T. D. (2022). *Brock biology of microorganisms* (16th ed.). Pearson.
- Atlas, R. M. (1997). *Principles of microbiology* (2nd ed.). Wm. C. Brown Publishers.
- Black, J. G., & Black, L. J. (2018). *Microbiology: Principles and explorations* (10th ed.). Wiley.
- Salle, A. J. (2007). *Fundamental principles of bacteriology* (Reprint of the 2nd ed., 6th impression 1943). Envins Press.
- Tortora, G. J., Funke, B. R., & Case, C. L. (2019). *Microbiology: An introduction* (13th ed.). Pearson.

Mapping of COs with PSOs and POs :

CO	PSO 1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1				3	1	2		2	
CO2	1	3	2				2	3	2	1	3	
CO3	2	1	3				1	2	3	2	2	1
CO4		2		3	1			3		3	1	2
CO5	1			2	3		1	2	1	2	3	3

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (30%)
- Practical Assessment
- End semester Exam (70%)

Mapping of COs to Assessment Rubrics:

CO	Internal Exam	Assignments	Practical Assessments	End Semester Exam
CO1	✓	✓	✓	
CO2	✓		✓	
CO3	✓		✓	
CO4	✓	✓		
CO5		✓	✓	✓

MBY6CJ306-PRINCIPLES OF GENETICS

Programme	B. Sc. Microbiology				
Course Code	MBY6CJ306/MBY8MN306				
Course Title	Principles of Genetics				
Type of Course	**Major**/Minor				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Nil				
Course Summary	This course explores the historical foundations and basic principles of genetics, from Mendel's laws to the chromosome theory of inheritance. Students delve into mechanisms like sex determination, sex-linked inheritance, and complex patterns such as epistasis and pleiotropy. It covers cellular processes like mitosis and meiosis, and introduces bacterial genetics, emphasizing its role in gene mapping and bacterial evolution.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the historical perspectives on the study of genetics and its evolution.	R	F	Quiz, Internal Exam
CO2	Explain the basic terminology and principles of inheritance, including deviations from Mendelian concepts.	U	C	Class Tests, Internal Exam
CO3	Apply pedigree analysis techniques to trace patterns of inheritance within families and populations.	Ap	P	Case Study Evaluation, Internal Exam
CO4	Investigate the mechanisms of mitosis and meiosis, including their significance and regulation.	E	C	Assignments, Internal Exam
CO5	Analyze the processes of linkage, crossing over, and recombination frequency.	An	C	Problem Solving Tests, Internal Exam
CO6	Discuss bacterial genetics, including mechanisms of conjugation, transformation, and transduction.	An	C	Assignments, Internal Exam

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (48+12)	Marks (70)
I	**Basic concepts in genetics**		**10**	**15**
	1	Historical perspectives and basic terminology on the study of genetics.	1	
	2	Mendalian theories of inheritance: Concept of alleles, crossing, test cross, back cross, mendalian experiments-monohybrid and dihybrid crosses. Unit factor concept, law of dominance/recessiveness, law of segregation, law of independent assortment	7	
	3	Sex determination in genetics	1	
	4	Sex-linked inheritance	1	
II	**Extensions of Mendlalian genetics**		**10**	**15**
	5	Incomplete dominance and codominance in genetics.	1	
	6	Multiple alleles and Lethal alleles: implications	1	
	7	Epistatsis, pleiotropy: role in gene interaction	1	
	8	Environmental effects on phenotypic expression.	1	
	9	Extra chromosomal inheritance:mitochondria/chloroplast	3	
	10	Pedigree analysis: tracing inheritance patterns.	3	
III	**Cell cycle and regulation**		**18**	**25**
	11	Mitosis: process and significance.	2	
	12	Meiosis: stages and significance.	4	
	13	Cell cycle checkpoints and their importance.	3	
	14	Recombination: molecular mechanism and significance in genetic variation	3	
	15	Linkage and crossing over: cytological basis and molecular mechanisms	3	
	16	Recombination frequency as a measure of gene distance and gene order: two factor and three factor crosses	2	
	17	Interference and coincidence	1	
IV	**Bacterial Genetics**		**10**	**15**
	18	Conjugation: mechanism and types	2	
	19	Transformation: mechanism and types	2	
	20	Transduction: mechanism and types	2	
	21	Interrupted mating for gene mapping	2	
	22	Gene mapping using transformation and transduction	2	
V	**Open ended module**		**12**	
		Population Genetics/Case studies/Surveys on Genetic inheritance		

Books and References:

1. Principles of Genetics by Gardner EJ, Simmons MJ, Snustad DP, 1991. John Wiley& Sons.
2. Molecular Biology of the Gene by Watson, JD, Hopkins NH, Roberts JW, Steitz JA, Weiner AAM, 1987. The Benjamin/Cummings publishing company
3. Principles of Genetics by Gardner EJ, Simmons MJ, Snustad DP, 1991. John Wiley& Sons.
4. Molecular Biology of the Gene by Watson, JD, Hopkins NH, Roberts JW, Steitz JA, Weiner AAM, 1987. The Benjamin/Cummings publishing company.
5. Genes V by Lewin B, 1994. Oxford University press.
6. Molecular Cell Biology by Lodish, H, Baltimore D, Berk A, Zipursky SL, Matsudaira P, Darnell J., 1995. Scientific American Books.
7. Biochemistry by Stryer L.,1995. W.H. Freeman and company.
8. Molecular Biology by Freifelder D., 1991 Narosa Publishing Home.
9. Principles of Gene Manipulation, 4th Ed., by R.S. Old and S.B.Primrose. 1989.Blackwell Scientific Publications, London.
10. Alcamo IE. (2001). DNA Technology: The Awesome Skill. 2nd edition. Elsevier Academic Press,
11. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford,
12. Glick BR and Pasternak JJ. (2003). Molecular Biotechnology. 3rd edition. ASM PressWashington D.C.
13. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7thedition. Blackwell Publishing, Oxford, U.K.
14. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.

Mapping of COs with PSOs and POs :

CO	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3						3		1		2	
CO2	2						2		2		3	
CO3	3		3				3		3	3	2	
CO4		3		3				3		3		3
CO5			3						3		3	
CO6	2											

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (30%)
- Practical Assessment
- Endsemester Exam (70%)

Mapping of COs to Assessment Rubrics:

CO	Internal Exam	Assignment	Quiz	End Semester Examination
CO1	✓		✓	✓
CO2	✓			✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5	✓	✓		✓
CO6	✓	✓		✓

MBY7CJ 401. BIOPHYSICS AND INSTRUMENTATION

Programme	B. Sc. Microbiology				
Course Code	MBY7CJ 401				
Course Title	Biophysics and Instrumentation				
Type of Course	**Major**				
Semester	VII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Nil				
Course Summary	This course introduces students to the principles of biophysics and various instrumental techniques used in biological research, including microscopy, spectroscopy, chromatography, and more. It covers the structural aspects of molecules, techniques for analyzing biological materials, and the application of these techniques in real-world scenarios				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the principles and applications of biophysical techniques.	U	C	Internal Exam, End Semester Exam
CO2	Describe the theoretical basis and functionality of key biophysical instruments.	U	C	Assignments, End Semester Exam
CO3	Analyze the role of biophysical methods in studying molecular structure and interactions.	An	C	Assignments, End Semester Exam
CO4	Evaluate the impact of biophysical techniques on advancements in biological research.	E	C	Internal Exam, End Semester Exam
CO5	Understand the concepts of spectroscopy, chromatography, and electrophoresis as used in biophysical studies.	Ap	P	Practical Assessment, End Semester Exam

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45 +30)	Marks (70)
I	**Introduction to Structure of atoms and molecules**		**10**	**15**
	1	Structure of atoms and molecules		
	2	Physico-chemical forces,. Laws of thermodynamics		
	3	DNA-Protein interactions -. Lambda repressor and cro binding to DNA		
	4	Interactions of transcription factors-HLH, bHLH, Leucine Zipper, Cys-His, Zinc fingers. Histone-DNA interaction, RNA protein interactions, DNA-drug Interaction		
	5	Ramachandran plot - alpha, beta, alpha - beta domains		
	6	Structural implications of peptide bond, protein families, Protein-drug interaction.		
II	**Microscopy, Spectrosopy, spectrophotometry, XRD**		**10**	**15**
	7	Principle, Instrument Design, methods and Applications of Microscopy: Light, Scanning and Transmission electron, phase contrast, polarization, confocal and interference microscopy, CCD camera, Introduction to Atomic force microscopy.		
	8	Beer-Lambert's law, Principle, Instrument Design, methods and Applications of UV-Visible spectra		
	9	IR spectra, Raman Spectra, Fluorescence spectra, NMR and ESR spectra.		
	10	Colorimetry, spectrophotometry, Fluorimetry, Flame photometry and Spectroscopy. X Ray diffraction technique-principle and application.		
III	**Chromatography, Centrifugation, Electrophoresis**		**15**	**20**
	11	Principle, Instrument Design, methods and Applications of Chromatography, ion exchange, molecular sieve, affinity chromatography, paper, TLC, GC, HPLC, HPTLC, FPLC, GC-MS, LC-MS.		
	12	Centrifugation - Principle and application of various types of centrifugation.		
	13	Electrophoresis- AGE, PAGE- SDS & Native PAGE, Capillary Electrophoresis, isoelectric focusing, 2D Electrophoresis.		
	14	Peptide mass fingerprinting using MALDI-TOF, MASCOT database.		
	15	Biosensors, etc, attending workshops or trainings on Instrumentation, etc		

IV	**pH meter, Dialysis, Sonication, Lyophilization. Refractometry, Cytometry and Flow cytometry, Radioactive isotopes**		**10**	**20**
	17	pH meter- principle, types and applications.		
	18	Dialysis-principle and applications.		
	19	Principle, methods and Applications of Ultra filtration,		
	20	Sonication, Lyophilization. Refractometry,		
	21	Cytometry and Flow cytometry		
	22	Introduction to Radioactive isotopes, autoradiography, radiation dosimetry- GM counter, Liquid scintillation counting, safety aspects.		
V	**Practicals**		**30**	
	23	Gel filtration chromatography		
	24	Dialysis of proteins		
	25	Paper chromatography		
	26	TLC		
	27	Column separation of plant pigments		
	28	Fractionation of egg protein and its identification		
	29	Polyacrylamide Gel Electrophoresis		
	30	Agarose gel electrophoresis		

Books and References:

1. Keith Wilson and John Walker. Practical Biochemistry- principles and techniques; Cambridge University press, London, UK. 2.
2. David T Plummer, Tata McGraw- Hill publishing company limited; McGrqw office, New Delhi
3. C.R. Kothari, 2 nd Edition,2004. Research methodology- methods and techniques. New Age International (P) limited publishers, New Delhi.
4. Instrumental methods of chemical analysis – P.K. Sharma
5. Biophysical chemistry – Upadhyay.,Upadhyay and Nath 6. A Biologist's guide to principle and techniques of practical biochemistry – Brigan L. Williams.
6. Handbook of Biomedical Instrumentation – R.S. Khandpur, Tata McGraw Hill

Mapping of COs with PSOs and POs:

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		2		1		3		1		2	
CO2	2	3		1			2	2	3	1	3	
CO3		2	3			1		3	2	3	2	1
CO4		3		3				3		3		2
CO5	1		3		2		1		2		3	3

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (10%)
- Practical Assessment (20%)
- Endsemester Exam (70%)

Mapping of COs to Assessment Rubrics:

CO	Internal Exam	Assignment	End Semester Examination	Practical Assessment
CO1	✓		✓	
CO2	✓	✓	✓	
CO3		✓	✓	
CO4	✓		✓	✓
CO5			✓	✓

MBY7CJ 402. ADVANCED IMMUNOLOGY AND CANCER BIOLOGY

Programme	B. Sc. Microbiology				
Course Code	MBY7CJ 402				
Course Title	Advanced Immunology and Cancer Biology				
Type of Course	Major				
Semester	VII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3		2	75
Pre-requisites	Nil				
Course Summary	This course explores advanced topics in immunology and the molecular biology of cancer. It covers immune response mechanisms, the role of immunity in cancer, genetic and molecular bases of cancer, and contemporary strategies for cancer treatment and immunotherapy.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the classification and impact of various immunodeficiency disorders.	U	C	Internal Exam, End Semester Exam, Practical Assessment
CO2	Analyze the pathophysiology and management strategies for major immunodeficiency diseases.	An	C	Assignments, End Semester Exam, Practical Assessment
CO3	Explore the mechanisms and implications of immunodeficiency in HIV infection and its management.	An	C	Assignments, End Semester Exam, Practical Assessment
CO4	Evaluate the concepts and clinical applications of hypersensitivity reactions and transplantation immunology.	An	C	Internal Exam, End Semester Exam, Practical Assessment
CO5	Examine the pathogenesis, diagnosis, and therapeutic strategies in autoimmune disorders and tumor immunology.	E	C	Assignments, End Semester Exam, Practical Assessment

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45+30)	Marks (70)
I	**Immunodeficiency Disorders**		**10**	**15**
	1	Classification of immunodeficiency disorders (Primary, Secondary, Humoral, Cell Mediated etc)	1	
	2	Major immunodeficiency diseases, SCID, Complement deficiencies	3	
	3	Causes and management of immunodeficiency diseases	2	
	4	Animal models of immune deficiencies	2	
	5	Mechanism of immunodeficiency in HIV infection	2	
II	**Hypersensitivity and Transplantation Immunology**		**10**	**15**
	6	Introduction and Classification of Hypersensitivity	2	
	7	Mechanism, Clinical presentation, Diagnosis and Treatment of Type I, II, and III reactions	2	
	8	Delayed Type Hypersensitivity : Tuberculin, Dermatitis, Granulomatous types etc	4	
	9	Transplantation immunology : Classification of grafts and transplantation. Immunology of graft rejections	2	
	10	MHC and Histocompatibility testing, Immunotherapy of transplantation		
III	**Autoimmune Diseases**		**15**	**25**
	11	Introduction - Central tolerance, Peripheral tolerance, Clonal deletion, Clonal anergy	2	
	12	Organ specific and systemic autoimmune disorders- characteristics, clinical features and mechanism of major diseases	2	
	13	Mechanisms of autoimmunity.	3	
	14	Diagnosis of autoimmunity : Antinuclear antibodies and their detection	2	
	15	Management of autoimmune diseases	2	
IV	**Immunology of Malignancy**		**10**	**15**
	16	Tumour and immunity	2	
	17	Characteristics of tumour cells, Tumour antigens and tumor suppressor genes	3	
	18	Mechanism of tumour development	1	
	19	Immunity to tumour and immune surveillance theory	1	
	20	Immunotherapy to tumour	1	
V	**Practical**		**30**	**30**
	1	Blood grouping		
	2	ELISA		
	3	RPR		
	4	WIDAL		

	5	RA test		
	6	Western blotting		
	7	Immuno Electrophoresis		
	8	Immuno diffusion tests		
	9	Latex Agglutination reaction		
	10	Precipitin assay		

Books and References:

1. Kuby Immunology by Judy Owen, Jenni Punt, and Sharon Stranford
2. Janeway's Immunobiology by Kenneth Murphy, Casey Weaver, and Allan Mowat
3. Basic Immunology: Functions and Disorders of the Immune System by Abul K. Abbas, Andrew H. Lichtman, and Shiv Pillai
4. Immunology by David Male
5. Roitt's Essential Immunology by Peter J. Delves, Seamus J. Martin, Dennis R. Burton, and Ivan M. Roitt
6. Principles of Cancer Immunotherapy by Nils Lonberg
7. Cancer Immunotherapy Principles and Practice by Lisa H. Butterfield and Howard L. Kaufman
8. Ananthanarayan and Paniker's Textbook of Microbiology by Ananthanarayan, R., and Paniker, C. K. J.

Mapping of COs with PSOs and POs :

CO	PSO1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1				3	1	2		2	
CO2	2	3	1				2	3	2	1	3	
CO3	1	2	3				1		3	2	2	1
CO4		3	2	1				3	2	3	1	2
CO5	1		2	3			1	2	3	2	3	1

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (10%)
- Practical Assessment (20%)
- End Semester Exam (70%)

Mapping of COs to Assessment Rubrics:

CO	Internal Exam	Assignments	End Semester Exam	Practical Assessment
CO1	✓		✓	✓
CO2		✓	✓	✓
CO3		✓	✓	✓
CO4	✓		✓	✓
CO5		✓	✓	✓

MBY7CJ 403. MICROBIAL BIOCHEMISTRY

Programme	B. Sc. Microbiology				
Course Code	MBY7CJ 403				
Course Title	Microbial Biochemistry				
Type of Course	Major				
Semester	VII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3		2	75
Pre-requisites	Nil				
Course Summary	The Microbial Biochemistry course for undergraduate programs offers a comprehensive exploration of essential biochemical principles with a focus on microbial systems. The course begins with an in-depth examination of biomolecules such as carbohydrates, proteins, lipids, hormones, and vitamins, covering their structures, functions, classifications and metabolism. A detailed study of enzymes involved in microbial metabolism is also envisaged. Laboratory sessions provide hands-on experience to gain practical skills in biochemical analysis and data interpretation, reinforcing theoretical concepts learned in lectures.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the diverse roles and structures of biomolecules in microbes.	U	C	Internal Exam, End Semester Exam
CO2	Analyze metabolic pathways and their regulation in microbial systems.	An	C	Assignments, Practical Assessments
CO3	Evaluate the biochemical mechanisms in microbial growth and disease.	E	P	Assignments, End Semester Exam
CO4	Discuss advanced topics in microbial enzymology and genetic control.	U	C	Internal Exam, Assignments
CO5	Apply biochemical analysis techniques in practical microbial research.	Ap	P	Practical Assessments

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45+30)	Marks (70)
I	**The Diversity of Cells and Biomolecules**		**10**	**15**
	1	Structure and function of carbohydrates: Monosaccharides, Disaccharides, and Polysaccharides		
	2	Heteropolysaccharides, Glycosaminoglycans, and Glycoproteins		
	3	Structure, properties, and functions of amino acids and proteins		
	4	Lipid structure, properties, classification, and functions		
	5	Fatty acid classifications: Saturated, unsaturated, PUFA, short, medium, and long-chain fatty acids		
	6	Phospholipids, Sphingolipids, prostaglandins, prostacyclins, and leukotrienes		
	7	Hormones and vitamins: Structure and functions		
II	**Carbohydrate and Lipid Metabolism**		**15**	**25**
	8	Overview of carbohydrate metabolism: Respiration and fermentation		
	9	Glycolysis: Aerobic and anaerobic types		
	10	Pyruvate dehydrogenase complex; Krebs cycle; Glyoxylate cycle		
	11	Phosphorylation: Substrate level and oxidative phosphorylation		
	12	Electron transport chain and ATP formation		
	13	Gluconeogenesis, Glycogenesis, and Glycogenolysis		
	14	Fatty acid oxidation (alpha, beta, omega)		
	15	Synthesis of unsaturated and long-chain fatty acids		
III	**Amino Acid and Nucleic Acid Metabolism**		**10**	**15**
	16	Amino acid metabolism: Transamination, deamination, transmethylation		
	17	Microbial metabolism of glycine, phenylalanine, and lysine		
	18	Biosynthesis and degradation of purines and pyrimidines		
IV	**Enzymology and Peptidoglycan Biosynthesis**		**10**	**15**
	19	Enzyme–IUB-Nomenclature, classification, active sites, coenzymes, and cofactors		
	20	Factors affecting enzyme activity, kinetics (Michaelis Menton equation)		
	21	Multi-subunit enzymes, isozymes, allosteric enzymes		
	22	Peptidoglycan biosynthesis		
V	**Practicals**		**30**	**30**

	1	Preparation of Buffers		
	2	Protein Estimation using Lowry's Method		
	3	Estimation of Reducing Sugars by DNS Method		
	4	Spectrophotometric Assay of Enzyme Activity		
	5	Estimation of Glucose by ortho toluidine method		
	6	Estimation of fructose by Roe – Pappadopoulos Method		
	7	Qualitative identification of carbohydrates in mixtures containing mono, di and polysaccharides.- starch, dextrin, sucrose, maltose, lactose, glucose, fructose, xylose and galactose.		
	8	Estimation of amino acid, methionine by nitroprusside method.		
	9	Protein estimation by Bradford's method.		
	10	Estimation of citric acid		
	11	Estimation of ascorbic acid in plant matter		
	12	Estimation of DNA and RNA		

Books and References:

1. Berg, J. M., Tymoczko, J. L., Gatto, G. J., & Stryer, L. (2015). *Biochemistry* (8th ed.). W. H. Freeman.
2. Voet, D., Voet, J. G., & Pratt, C. W. (2016). *Fundamentals of Biochemistry: Life at the Molecular Level* (5th ed.). Wiley.
3. Nelson, D. L., & Cox, M. M. (2017). *Lehninger Principles of Biochemistry* (7th ed.). W. H. Freeman.
4. White, D., Drummond, J., & Fuqua, C. (2020). *The Physiology and Biochemistry of Prokaryotes* (5th ed.). Oxford University Press.
5. Garrett, R. H., & Grisham, C. M. (2016). *Biochemistry* (6th ed.). Cengage Learning.

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3				2		3				2	
CO2	2	3					2	2	3	1	3	
CO3		2	3			1		3	2	3	2	1
CO4	1			3	2		1			2	3	2
CO5			3		3					3	3	

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (10%)
- Practical Assessment (20%)
- Endsemester Exam (70%)

Mapping of COs to Assessment Rubrics :

CO	Internal Exam	Assignment	End Semester Examination	Practical Assessment
CO1	✓		✓	
CO2		✓	✓	✓
CO3		✓	✓	
CO4	✓	✓		
CO5				✓

MBY7CJ 404. MYCOLOGY AND PARASITOLOGY

Programme	B. Sc. Microbiology				
Course Code	MBY7CJ 404				
Course Title	Mycology and Parasitology				
Type of Course	Major				
Semester	VII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites					
Course Summary	This course provides an in-depth study of fungi and protozoa, focusing on their general characteristics, classification, and the diseases they cause. It also covers different fungal and protozoan diseases, their treatment, and the drugs used against them.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the basic features and classification of fungi and protozoa.	U	C	Internal Exam, End Semester Exam
CO2	Analyze the pathogenesis and epidemiology of fungal and protozoan diseases.	An	C	Assignments, Midterm Exam
CO3	Evaluate the mechanisms of action of antifungal and antiprotozoal agents.	E	P	Assignments, Practical Assessments
CO4	Discuss the diagnostic techniques for fungal and protozoan infections.	U	P	Internal Exam, Practical Assessments
CO5	Apply laboratory methods for identifying and treating fungal and protozoan diseases.	Ap	P	Practical Assessments

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45+30)	Marks (70)
	FUNGI		7	15
	1	Characteristic features of fungus	2	
1	2	Classification of fungus based on morphology	2	
	3	Classification of fungus based on reproduction	2	
	4	Cultivation of fungus	1	
II	Fungal diseases		12	15
	5	Superficial infections- Piedra and Pityriasis	2	
	6	Cutaneous infections- Dermatophytosis	2	
	7	Subcutaneous infections - Mycetoma	2	
	8	Deep mycoses- Histoplasmosis	2	
	9	Oppurtunistic infections - Candidiasis	2	
	10	Antifungal agents - types	1	
	11	Mode of action of antifungal agents	1	
III	Protozoa		17	25
	12	Characteristics features of protozoa	2	
	13	Classification of protozoa	2	
	14	Entamoeba histolytica - morphology, life cycle, pathogenesis and epidemiology	3	
	15	Giardia lamblia - morphology, life cycle, pathogenesis and epidemiology	2	
	16	Trypanosoma brucei - morphology, life cycle, pathogenesis and epidemiology	2	
	17	Plasmodium - morphoplogy, life cycle, pathogenesis and epidemiology	4	
	18	Antiprotozoal agents - types and mode of action	2	
IV	Helminth infections		9	15
	19	Tapeworm - Taenia solium and Taenia saginata	3	
	20	Hookworm - Ancylostoma duodenale	2	
	21	Roundworm - Ascaris lumbricoides	2	
	22	Filariasis - Wuchereria bancrofti	2	
V	Practical Applications in mycology and parasitology		30	
	1	Laboratory diagnosis of fungal infections		
	2	Laboratory diagnosis of parasitic infections-stool or any other sample may be used		
	3	Antifungal sensitivity tests		

Books and References:

1. Deacon, J. W. (2013). *Fungal Biology* (4th ed.). Wiley-Blackwell.
2. Roberts, L. S., Janovy, J., & Nadler, S. (2013). *Foundations of Parasitology* (9th ed.). McGraw-Hill Education.
3. Cox, F. E. G. (2010). *Modern Parasitology: A Textbook of Parasitology* (2nd ed.). Wiley-Blackwell.
4. White, D., & Fenner, F. (2014). *Medical Mycology: A Practical Approach* (2nd ed.). CRC Press.
5. Murphy, K., Weaver, C. (2016). *Janeway's Immunobiology* (9th ed.). Garland Science.

Mapping of COs with PSOs and POs:

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2		1			3	2	1		2	
CO2	2	3				1	2	3	2	1	3	
CO3	1		3		2		1		3	2	2	1
CO4		3		3				3		3		2
CO5			3		3					3	3	

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (10%)
- Practical Assessment (20%)
- Endsemester Exam (70%)

Mapping of COs to Assessment Rubrics :

CO	Internal Exam	Assignment	End Semester Examination	Practical Assessment
CO1	✓		✓	
CO2	✓	✓	✓	
CO3	✓	✓		✓
CO4	✓			✓
CO5	✓			✓

MBY7CJ 405. ANTIMICROBIALS AND DRUG RESISTANCE

eProgramme	B. Sc. Microbiology				
Course Code	MBY7CJ 405				
Course Title	Antimicrobials and Drug resistance				
Type of Course	**Major**				
Semester	VII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Nil				
Course Summary	This course provides an in-depth exploration of antimicrobial agents, their mechanisms of action, clinical applications, and the emergence and spread of antimicrobial resistance. Topics include the principles of antimicrobial therapy, mechanisms of drug resistance in bacteria, strategies for combating antimicrobial resistance, and the impact of antimicrobial resistance on public health.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	To classify the different classes of antibacterial agents	(U)	(P)	Internal Exam, Assignment, End Semester Examination
CO2	To understand the mechanisms of action of antimicrobial agents and their clinical applications	(Ap)	(P)	Internal Exam, Assignment, End Semester Examination
CO3	To explore the molecular mechanisms underlying antimicrobial resistance in bacteria	(Ap)	(P)	Internal Exam, End Semester Examination
CO4	To analyze the factors contributing to the emergence and spread of antimicrobial resistance.	(An)	(P)	Internal Exam, End Semester Examination
CO5	To perform the antimicrobial assays	(Ap)	(C)	Practical Assessment
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs (45+30)	Marks (70)
I	**Antibacterial agents**		**10**	**15**
	1	Overview of antibiotics		
	2	Principles of antimicrobial therapy: spectrum of activity, pharmacokinetics, pharmacodynamics		
	3	Different classes of antibiotics- Cell wall inhibitors		
	4	Different classes of antibiotics- Membrane inhibitors		
	5	Different classes of antibiotics- Protein synthesis inhibitors		
	6	Different classes of antibiotics- DNA and RNA synthesis inhibitors		
II	**Antiviral, antifungal and antiparasitic agents**		**10**	**15**
	7	Different classes of antiviral agents		
	8	Different classes of antifungal agents		
	9	Different classes of antiparasitic agents		
III	**Antibiotic resistance**		**15**	**25**
	10	Genetic mechanisms of antimicrobial resistance: mutation, horizontal gene transfer, gene amplification		
	11	Antimicrobial susceptibility testing		
	12	Mechanisms of drug resistance in bacteria-enzymatic degradation of the drugs		
	13	Mechanisms of drug resistance in bacteria-Alteration of the targets		
	14	Mechanisms of antibiotic resistance- changes in membrane permeability		
	15	Mechanisms of antibiotic resistance-efflux pumps and others		
IV	**Factors Contributing to Antimicrobial Resistance and strategies to combat**		**10**	**15**
	16	Antibiotic misuse and overuse in human and veterinary medicine		
	17	Use of antimicrobials in agriculture and animal husbandry		
	18	Nosocomial infections and healthcare-associated antimicrobial resistance		
	19	Globalization, travel, and the spread of antimicrobial-resistant pathogens		
	20	Antimicrobial stewardship programs in healthcare settings		
	21	Development of new antimicrobial agents and alternative therapies		
	22	Education, training, and public awareness campaigns on antimicrobial resistance		

V	**Practical**		**30**	
	1	CLSI guidelines for detection of antibiotic resistance		
	2	Antibioic sensitivity test-Disc diffusion method		
	3	MIC and MBC		

Books and References:

1. Antimicrobial Agents: Chemistry, Mode of Action, Mechanisms of Resistance and Clinical Applications" edited by Rosalind Brice
2. Emerging Antibiotic Resistance: Mechanisms and Strategies" by P. S. Chauhan and R. K. Sharma
3. Antibiotics: Actions, Origins, Resistance" by C. Walsh and A. Wencewicz
4. Antibiotic Policies: Fighting Resistance" by I. M. Gould and J. Van der Meer
5. Antimicrobial Therapy: Challenges and Innovations" by S. K. Jain and R. K. Mishra
6. Antibiotic Resistance Protocols" edited by S. Gillespie and L. B. Woolveridge

Mapping of COs with PSOs and POs:

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1				3	2	1			
CO2	2	1	3				3	2	2	1		
CO3	1	3	2				2	2	3			1
CO4		3	1	2			2	1	2	3		2
CO5			3	2	1			3	2	1		3

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (10%)
- Practical Assessment (20%)
- End semester Exam (70%)

Mapping of COs to Assessment Rubrics :

Course Outcome (CO)	Internal Exam	Assignment	End Semester Examination	Practical Assessment
CO1	✓	✓	✓	
CO2	✓	✓	✓	
CO3	✓		✓	
CO4	✓		✓	
CO5				✓

MBY8CJ 406/MBY8MN 406. BIOSTATISTICS AND BIOINFORMATICS

Programme	B. Sc. Microbiology				
Course Code	MBY8CJ 406/MBY8MN 406				
Course Title	Biostatistics and Bioinformatics				
Type of Course	Major/Minor				
Semester	VIII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	60
Pre-requisites	Nil				
Course Summary	This course provides an in-depth exploration of Biostatistics and Bioinformatics, essential disciplines in modern biological research. The course is designed to equip students with the necessary statistical and computational tools to analyze biological data effectively.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand fundamental biostatistical concepts and apply them to biological data analysis.	U	C	Quizzes, Internal Exam
CO2	Apply regression analysis, ANOVA, and hypothesis testing to solve complex biological questions.	Ap	P	Assignments, Internal Exam
CO3	Utilize bioinformatics tools for sequence analysis and genetic data interpretation.	Ap	P	Practical Assessments, Internal Exam
CO4	Develop proficiency in using biological databases and bioinformatics software for research.	Ap	P	Practical Assessments
CO5	Analyze and construct phylogenetic trees to study molecular evolution.	An	C	End Semester Exam, Practical Assessments
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs (45+30)	Marks (70)
I	**Introduction to Biostatistics and Basic Statistical Methods**		**10**	**10**
	1	Introduction to Biostatistics - Definition and importance in biological research.		
	2	Descriptive Statistics - Frequency distribution, Graphical and diagrammatic representations.		
	3	Measures of Central Tendency - Mean, Median, Mode.		
	4	Measures of Dispersion - Range, Variance, Standard deviation, Coefficient of variation.		
	5	Diversity Index and Data Description - Explanation and calculation methods, including data visualization techniques.		
	6	Statistical Inference - Populations vs. samples, Sampling techniques, Standard error, Confidence intervals.		
II	**Advanced Statistical Methods in Biological Research**		**10**	**20**
	7	Probability Distributions - Binomial distribution, Poisson distribution, Normal distribution and its applications in genetics.		
	8	Regression Analysis **-** Simple linear regression, Multiple regression analysis.		
	9	Correlation and Regression Techniques - Correlation analysis, advanced regression modeling.		
	10	Analysis of Variance (ANOVA) - One-way ANOVA, Two-way ANOVA, principles of experimental design.		
	11	Hypothesis Testing and Goodness of Fit - Null and alternative hypotheses, Type I and Type II errors, Tests of significance: Normal, Chi-square, t-test, F-test, Goodness of fit tests.		
III	**Introduction to Bioinformatics and Biological Databases**		**15**	**20**
	12	Basics of Bioinformatics - Definition, history, and scope of bioinformatics.		
	13	Bioinformatics Web Portals **-** Overview of NCBI, EBI, ExPASy.		
	14	Introduction to Biological Databases - Classification of databases: Primary (GenBank), Secondary (PIR), Tertiary (KEGG) databases.		
	15	Sequence Databases and Data Retrieval - DNA (ENA, DDBJ), Protein (Swissprot, PROSITE), using Entrez, SRS, and DBGet.		
	16	Gene and Protein Sequence Analysis - Practical techniques for analyzing sequences from nucleotide and protein databases.		

IV	**Sequence Analysis and Bioinformatics Tools**		**10**	**20**
	17	Molecular Visualization and Sequence Alignment - Molecular visualization techniques, basics of sequence alignment including match, mismatch, gaps.		
	18	Pairwise and Multiple Sequence Alignment - Scoring alignments, use of scoring matrices like PAM, BLOSUM.		
	19	Sequence Analysis Tools and Applications - Utilizing BLAST, FASTA, GCG Wisconsin/Emboss packages.		
	20	Phylogenetic Analysis and Molecular Evolution - Phylogenetic tree construction methods, evolutionary models and substitution matrices.		
	21	Advanced Bioinformatics Applications - Homology modeling, molecular docking techniques, protein structure prediction using Swiss Model, validation using What Check and Pro Check.		
	22	Molecular Visualization and Sequence Alignment - Molecular visualization techniques, basics of sequence alignment including match, mismatch, gaps.		
V	**Practical**		**30**	
	1	1. Biological Databanks- Sequence Databases, Structure Databases, Specialized Databases 2. Introduction to National Center for Biotechnology Information (NCBI) 3. Data retrieval: Entrez, SRS and DBGet. 4. Analysis of gene sequence from nucleotide database. 5. Analysis of protein sequence from protein database. 6. Introduction to PDB and analysis of PDB file. 7. Molecular visualization 8. Gene structure and function prediction (using GenScan, GeneMark) 9. Sequence similarity searching using BLAST and interpretation of the results. 10. Multiple sequence alignment using Clustal and interpretation of the results. 11. Protein sequence analysis using ExPASy proteomics tools 12. Phylogenetic analysis using web tools 13. Phylogenetic analysis using PHYLIP 14. Sequence analysis using EMBOSS 15. Homology Modeling and Structure Refinement Swiss model 16. Model validation using What Check and Pro Check 17. Statistical software packages (e.g., R, SPSS)		

Books and References:

1. Pagano, M., & Gauvreau, K. (2018). *Principles of Biostatistics* (2nd ed.). Brooks/Cole Cengage Learning.
2. Baldi, P., & Brunak, S. (2021). *Bioinformatics: The Machine Learning Approach* (2nd ed.). MIT Press.
3. Dunn, O. J., & Clark, V. (2018). *Basic Statistics: A Primer for the Biomedical Sciences* (5th ed.). Wiley.
4. Durbin, R., Eddy, S., Krogh, A., & Mitchison, G. (1998). *Biological Sequence Analysis*. Cambridge University Press.
5. Glantz, S. A., & Slinker, B. K. (2021). *Primer of Biostatistics* (8th ed.). McGraw-Hill Education.
6. Pevsner, J. (2015). *Bioinformatics and Functional Genomics* (3rd ed.). Wiley-Blackwell.
7. Baldi, P., & Brunak, S. (2021). *Bioinformatics: The Machine Learning Approach* (2nd ed.). MIT Press.
8. Mount, D. W. (2021). *Bioinformatics: Sequence and Genome Analysis* (3rd ed.). Cold Spring Harbor Laboratory Press.
9. Aluru, S. (Ed.). (2019). *Handbook of Computational Molecular Biology*. Chapman and Hall/CRC.

Mapping of COs with PSOs and POs :

CO	PSO1	PSO2	PSO3	PSO 4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	3			3	2	1		3	1
CO2	3	3	2				3	3	2	1		2
CO3	2	3	3				2	3	3		1	3
CO4	1	2	3	2	3		1	2	3	3	2	
CO5	2	1	2	3			2	1	2	3	3	2

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (30%)
- Practical Assessment
- End semester Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Practical Assessment	End Semester Exam
CO1	✓			✓
CO2	✓	✓	✓	✓
CO3	✓		✓	✓
CO4		✓	✓	✓
CO5			✓	✓

MBY8CJ 407-SOFTWARE TOOLS IN RESEARCH

Programme	B. Sc. Microbiology				
Course Code	MBY8CJ407/MBY8MN407				
Course Title	Software tools in research				
Type of Course	**Major**/Minor				
Semester	VIII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Nil				
Course Summary	This course introduces a variety of software tools that are essential in different stages of the research process, focusing on applications in biological research. Students will become familiar with data management, analysis, and presentation tools, as well as referencing and plagiarism detection software.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand and utilize various academic and referencing tools to support research activities.	U	C	Internal Exam, Assignment
CO2	Apply statistical packages to analyze quantitative and qualitative research data.	Ap	P	Internal Exam, Assignment
CO3	Implement tools for effective writing, formatting, and data representation in research documentation.	Ap	P	Internal Exam, Assignment, Project Evaluation
CO4	Utilize computational applications for analyzing biological data, including sequence and structural analysis.	Ap	P	Internal Exam, Assignment, Project Evaluation
CO5	Evaluate the ethical implications of using software tools in research, particularly in data presentation and publication.	E	C	Assignment, Project Evaluation

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (48+12= 60)	Marks (70)
1	Basic tools for research		**12**	**15**
	1	Literature search academic databases	2	
	2	Referencing tools like Sodhganga/INFLIBNET, ERIC and E-vidwan	2	
	3	Data presentation tools- MS Excel, Origin, Canva, and Adobe Illustrators	2	
	4	Open access publication and software tools to identify predatory publications	2	
	5	Software for the detection of Plagiarism.	2	
2	Reference Management Software		**12**	**15**
	6	Basic features of reference Managing Software	2	
	7	Primary uses in thesis writing and journal article publication	2	
	8	Zotero as reference managing software and its application	2	
	9	Mendeley as reference managing software and its application	2	
	10	Endnote as reference managing software and its application	2	
3	**Statistical packages for data analysis**		**12**	**20**
	11	Difference between quantitative and qualitative packages	1	
	12	R and R studio	4	
	13	SPSS	3	
	14	Graphpad for conducting T-test	1	
	15	Methods of Qualitative data analysis and helpful software tools	1	**20**
4	Tools for effective writing, formatting and data representation		**12**	
	16	Grammer checking tools (Grammarly),	1	
	17	Paraphrasing tools (Quiillbot)	1	
	18	AI tools (Chatgpt)	1	
	19	Data presentation using Microsoft Excel	2	
	20	Data presentation using Origin Software	2	
	21	Data representation using online tools like Canva and Adobe Illustrators	1	
	22	Latex/latex overleaf for data formatting	2	
5	Computational Applications in Biological Research (Open-ended)		**12**	
	1	Introduction to biological databases (e.g., NCBI, UniProt)		
	2	Essential tools for sequence analysis (e.g., BLAST)		
	3	Genome browsers (e.g., UCSC Genome Browser), Protein structure prediction tools (e.g., SWISS-MODEL)		
	4	Structural Biology Tools-Molecular visualisation tools		

		(e.g., PyMOL, Chimera)		
	5	Protein docking and molecular dynamics simulations		

References:

1. Muenchen, Robert A. 2011. *R for SAS and SPSS Users*. 2nd ed. 2011 edition. New York: Springer-Verlag New York Inc.
2. Mount, D.W. 2005. "Bioinformatics: Sequence and Genome Analysis - Mount, D.W.: https://www.abebooks.com/9788123912417/Bioinformatics-Sequence-Genome-Analysis-Mount-8123912412/plp.
3. Bioinformatics for Beginners: Genes, Genomes, Molecular Evolution, Databases and Analytical Tools" by Supratim Choudhuri
4. Online tutorials and documentation for specific tools and databases.

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1				3	1				2
CO2	1	3	2				2	3	1			1
CO3	2	1	3				1	2	3	1		
CO4	2	1	3				1	2	3	1	2	
CO5			1	2	3			1	2	3	2	

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (30%)
- Practical Assessment
- End semester Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
O1	✓	✓		✓
CO2	✓			✓
CO3	✓	✓	✓	✓
CO4		✓	✓	✓
CO5	✓	✓	✓	

MBY8CJ 408. PHARMACEUTICAL MICROBIOLOGY

Programme	B. Sc. Microbiology				
Course Code	MBY8CJ408/MBY8MN408				
Course Title	Pharmaceutical microbiology				
Type of Course	Major/Minor				
Semester	Vlll				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Nil				
Course Summary	This course aims to equip students with the necessary knowledge and skill to address the intricate relationship between Microorganism and human health, infectious diseases and pharmaceutical.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Analyze the principles of chemotherapy including clinical and laboratory diagnostic techniques.	An	C	Internal Exam, End Semester Exam
CO2	Critically evaluate the mechanisms of antibiotic resistance and strategies for developing new therapeutics.	An	C	Assignments, Internal Exam, End Semester Exam
CO3	Investigate microbial contamination processes in pharmaceutical products and detail advanced contamination control strategies.	An	C	Assignments, Internal Exam, End Semester Exam
CO4	Assess the principles and technological applications in the preservation of pharmaceutical products.	E	C	Assignments, Internal Exam, End Semester Exam
CO5	Conduct and interpret antimicrobial assays to evaluate the effectiveness of growth-inhibiting substances.	Ap	C	Assignments, Internal Exam, End Semester Exam
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs (48+12)	Marks (70)
I	**Principles of chemotherapy**		**12**	**10**
	1	Clinical and lab diagnosis		
	2	Sensitivity testing		
	3	Choice of drug and usage		
	4	Route of administration of drugs		
	5	Combined or mixed multi drug therapy		
	6	Control of antibiotic/drug usage.		
II	**Antibiotics resistance and development of new therapeutics**		**12**	**20**
	7	Development and mechanism of antibiotic resistance		
	8	Anti microbial peptides		
	9	Sources, mode of action, application		
	10	Phage therapy: introduction to phage lytic cycle, types of phages involved in phage therapy.		
	11	Plant based therapeutic agents		
III	**Microbial production and spoilage of pharmaceutical products**		**12**	**20**
	12	Microbial contamination and spoilage of pharmaceutical products		
	13	Sterile, injectibles , non injectible, ophthalmic control of pharmaceutical		
	14	pharmaceutical produced by microbial fermentations(streptokinase , streptodornase)		
	15	New vaccine technologies, DNA vaccine, multi sub unit vaccine		
IV	**Preservation of pharama products**		**12**	**20**
	16	principles of preservation		
	17	objectives of preservation		
	18	ideal preservative, rational development of a product preservative system.		
	19	Antimicrobial preservatives and their properties		
	20	preservatives monographs. Preservatives stability and efficiency. method of preservative evaluation and testing.		
	21	antimicrobial activity, factors affecting antimicrobial activity,		
	22	Assay for antibiotics –determination of MIC		
V	**Open Ended**		**12**	
	1	A brief idea on Antimicrobial assay		

Books and References:

1. Hugo, W. B., & Russell, A. D. (2009). Pharmaceutical Microbiology (7th ed.). Wiley-Blackwell.

2. Denyer, S. P., Hodges, N. A., & Gorman, S. P. (Eds.). (2020). *Hugo and Russell's Pharmaceutical Microbiology* (9th ed.). Wiley-Blackwell.
3. Walsh, C., & Wencewicz, T. A. (2016). *Antibiotics: Challenges, Mechanisms, Opportunities*. ASM Press.
4. Roitt, I., Brostoff, J., & Male, D. (2017). *Immunology* (9th ed.). Elsevier Health Sciences.
5. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. (2018). *Brock Biology of Microorganisms* (15th ed.). Pearson.
6. Silver, L. L. (2021). *Challenges of Antibiotic Resistance in the Development of New Therapeutics*. Academic Press.
7. Mims, C., Dockrell, H. M., Goering, R. V., Roitt, I., Wakelin, D., & Zuckerman, M. (2019). *Medical Microbiology* (6th ed.). Elsevier.
8. Bonten, M., & Weinstein, R. A. (Eds.). (2022). *Infection Control in the Pharmaceutical Industry: Preventing Contamination in Production and Non-Clinical Settings*. Springer.

Mapping of COs with PSOs and POs :

CO	PSO1	PSO2	PSO3	PSO 4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		2			1	3		2		3	
CO2	2	3					2	2	3	3		
CO3		2	3		1		1	2	3	2		
CO4	1		3	2				3	2	3		
CO5			3	3				3	3		3	

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (30%)
- Practical Assessment
- End semester Exam (70%)

Mapping of COs to Assessment Rubrics :

CO	Internal Exam	Assignment	Project Evaluation	End Semester Examination
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5	✓	✓		✓

MBY8CJ 489-RESEARCH METHODOLOGY IN BIOLOGICAL SCIENCE

Programme	B. Sc. Microbiology				
Course Code	MBY8CJ489				
Course Title	Research methodology in biological science				
Type of Course	**Major**				
Semester	VIII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Nil				
Course Summary	This course introduces students to the essential principles and techniques involved in conducting scientific research in biological sciences. It covers the process of planning research, conducting a literature review, data collection and analysis, thesis writing, and understanding research ethics.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the fundamental principles of scientific research and methodology in biological sciences.	U	C	Internal Exam, End Semester Exam
CO2	Develop skills in literature review and critical analysis of scientific data.	An	C	Internal Exam, Assignments
CO3	Apply various data collection and analysis methods to enhance research quality.	Ap	P	Assignments, Practical Assessments
CO4	Construct and present scientific research findings effectively.	Ap	C	Internal Exam, Presentations
CO5	Evaluate ethical issues in biological research and implement best practices in research conduct.	E	C	Internal Exam, End Semester Exam

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
\# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45+15=60)	Marks (70)
I	Planning of research		**5**	**15**
	1	Identification of suitable methodology for research	1	
	2	Preparation of work plan	1	
	3	Writing a suitable project proposal	1	
	4	Features of good research design and its uses	1	
	5	Types of research design	1	
II	**Literature search**		**10**	**15**
	6	Print options for literature search-News articles – Newsletters – Magazines – Books - Journals-short communication-thesis	2	
	7	Relevance of digital libraries in literature search	2	
	8	Critical elements in literature search on the internet	2	
	9	Resource databases on the internet in various biological fields	2	
	10	Short communication / Review article search in both print and online media	2	
III	**Data collection, analysis and presentations**		**15**	**25**
	11	Data collection approaches	3	
	12	Work plan for observational and experimental research	2	
	13	Tools for processing of data-basic and advanced methods	3	
	14	Analysis of data by using statistical tools	5	
	15	Pictorial representation of data- Usefu open software	2	
IV	**Components of a thesis**		**15**	**15**
	16	Primary structure and components of the thesis	1	
	17	Software tools for research writings	2	
	18	Thesis draft submission and evaluation	1	
	19	Arrangement of Bibliography and reference managing tools	2	
	20	Publication of thesis for open-access	2	
	21	Research ethics	1	
	22	Plagiarism checking software	1	
V	**Publication/presentation of a research work (open-ended)**		**15**	
	1	Publication of books/book chapters		
	2	Publication of articles in journals- peer-viewed journal selection based on citation indices and impact factor		
	3	Manuscript preparation methods according to journal policies		

	4	Research presentation in Conferences/Seminars		
	5	Research article publications in print and Online media		

Books and References:

1. Anderson, Durston, & Poole. (1970). *Thesis and Assignment Writing*. Wiley Eastern Limited.
2. Booth, W. C., Colomb, G. G., Williams, J. M., Bizup, J., & Fitzgerald, W. T. (2016). *The Craft of Research* (4th ed.). University of Chicago Press.
3. Rajendrakumar, C. (2008). *Research Methodology*. APH Publishing Corporation.
4. Kothari, C. R. (2004). *Research Methodology: Methods and Techniques* (2nd ed.). New Age International Publishers.
5. Gurumani, N. (2006). *Research Methodology for Biological Sciences*. MJP Publishers.
6. Marczyk, G., DeMatteo, D., & Festinger, D. (2005). *Essentials of Research Design and Methodology*. John Wiley & Sons.
7. Katz, M. J. (2009). *From Research to Manuscript: A Guide to Scientific Writing* (2nd ed.). Springer.
8. Alley, M. (1996). *The Craft of Scientific Writing* (3rd ed.). Springer.
9. Cargill, M., & O'Connor, P. (2013). *Writing Scientific Research Articles: Strategy and Steps* (2nd ed.). Wiley-Blackwell.
10. Blake, G., & Bly, R. W. (2000). *The Elements of Technical Writing*. Pearson.
11. Reep, D. C. (2014). *Technical Writing: Principles, Strategies, and Readings* (8th ed.). Longman.

Mapping of COs with PSOs and POs :

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1				3	1	2		2	
CO2	2	3	2				2	3	3		3	
CO3	1	2	3				1	3	2	3	2	1
CO4		3	2	3				3		3		2
CO5			3		3					3	3	3

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (30%)
- Practical Assessment
- End semester Exam (70%)

Mapping of COs to Assessment Rubrics :

CO	Internal Exam	Assignment	Presentations	End Semester Examination
CO1	✓			✓
CO2	✓	✓		
CO3		✓		✓
CO4	✓		✓	
CO5	✓			✓

ELECTIVE COURSES

No	Course	Sem	Code	Title
1	Elective	V	MBY5EJ 301 (1)	Introduction to rDNA technology
2	Elective	V	MBY5EJ 302 (1)	Tools and Techniques in rDNA technology
3	Elective	V	MBY5EJ 303 (2)	Basic Human Physiology
4	Elective	V	MBY5EJ 304 (2)	Techniques in clinical laboratory
5	Elective	V	MBY5EJ 305 (3)	Microbes in Food and Water
6	Elective	V	MBY5EJ 306 (3)	Food quality assurance
7	Elective	V	MBY5EJ 307	Enzymology
8	Elective	VI	MBY6EJ 301 (1)	Applications of rDNA technology-1
9	Elective	VI	MBY6EJ 302 (1)	Applications of rDNA technology-II
10	Elective	VI	MBY6EJ 303 (2)	Diagnostic Microbiology
11	Elective	VI	MBY6EJ 304 (2)	Advanced Diagnostic techniques in microbiology
12	Elective	VI	MBY6EJ 305 (3)	Laboratory techniques for food and water analysis
13	Elective	VI	MBY6EJ 306 (3)	Food and water borne diseases
14	Elective	VI	MBY6EJ 307	Microbial Taxonomy
15	Elective	VI	MBY6EJ 308	Biosafety and Bioethics
16	Elective	VIII	MBY8EJ 401	Cell Biology
17	Elective	VIII	MBY8EJ 402	Cell and Tissue culture
18	Elective	VIII	MBY8EJ 403	Plant Pathology
19	Elective	VIII	MBY8EJ 404	Microbes in extreme environment
20	Elective	VIII	MBY8EJ 405	Virology and Emerging Microbial Diseases
21	Elective	VIII	MBY8EJ 406	Plant derived antimicrobials
22	Elective	VIII	MBY8EJ 407	Developmental biology

MBY5EJ 301(1). INTRODUCTION TO RDNA TECHNOLOGY

Programme	B. Sc. Microbiology				
Course Code	MBY5EJ 301(1)				
Course Title	Introduction to rDNA technology				
Type of Course	Major-Elective				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Nil				
Course Summary	This course offers an introductory exploration of recombinant DNA technology, covering the fundamentals of gene cloning, DNA manipulation, and the various applications of rDNA technology in modern science and medicine.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the basic principles of genetic engineering.	U	C	Internal Exam, End Semester Exam
CO2	Explain the process of purifying DNA from living cells for cloning purposes.	U	C	Assignments, Internal Exam, End Semester Exam
CO3	Detail the steps involved in purifying plasmid DNA as a vector.	U	C	Assignments, Internal Exam, End Semester Exam
CO4	Outline the types of bacteriophages and the method for purifying bacteriophage DNA.	U	C	Assignments, Internal Exam, End Semester Exam
CO5	Provide insights into the isolation and preparation of RNA as a foundation for advanced genetic studies.	U	C	Assignments, Internal Exam, End Semester Exam

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (48+12)	Marks (70)
I	**Introduction to Gene Cloning**		**12**	**10**
	1	History of rDNA technology		
	2	Basic principles of genetic engineering.		
	3	Define Gene cloning		
	4	Define Foreign DNA, Vector, Recombinant DNA molecule		
	5	Introduction to Polymerase Chain Reaction		
	6	Cohen and Boyer Patent		
II	**Isolation of Total cell DNA of bacteria**		**12**	**20**
	7	Define total cell DNA		
	8	Preparation of total cell DNA: Growing and harvesting of a bacterial culture		
	9	Preparation of cell extract		
	10	Purification of DNA from cell extract		
	11	Concentration of DNA samples, Measurement of DNA concentration		
III	**Isolation of Plasmid DNA**		**12**	**20**
	12	Plasmids, Types of plasmids. Plasmids other than bacteria.		
	13	Preparation of plasmid DNA: Separation on the basis of size		
	14	Separation on the basis of conformation		
	15	Plasmid amplification		
	16	Applications of plasmid DNA		
IV	**Isolation of Bacteriophage DNA**		**12**	**20**
	17	Bacteriophages: Lytic and Lysogenic phages		
	18	Lambda phage, M13 Phage		
	19	Growth of cultures to obtain high bacteriophage titre.		
	20	Preparation of non-lysogenic lambda phages		
	21	Collection of phages from an infected culture		
	22	Purification of DNA from lambda phage particles and M13 DNA		
V	**Open Ended**		**12**	
	1	Brief idea on Isolation and Preparation of RNA		

Books and References:

1. Brown, T. A. (2018). *Gene Cloning and DNA Analysis: An Introduction* (8th ed.). Wiley-Blackwell.
2. Primrose, S. B., Twyman, R. M., & Old, R. W. (2016). *Principles of Gene Manipulation and Genomics* (8th ed.). Blackwell Publishing.

3. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2013). *Molecular Biology of the Gene* (7th ed.). Pearson.
4. Griffiths, A. J., Wessler, S. R., Carroll, S. B., & Doebley, J. (2015). *Introduction to Genetic Analysis* (11th ed.). W. H. Freeman.
5. Lewin, B., Cassimeris, L., Lingappa, V. R., & Plopper, G. (2017). *Lewin's GENES XII* (12th ed.). Jones & Bartlett Learning.
6. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). *Molecular Biology of the Cell* (6th ed.). Garland Science.

Mapping of COs with PSOs and POs :

CO	PSO 1	PSO2	PSO3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO 6
CO1	3		2		1		3		1		2	
CO2	2	3					2	2	3		3	
CO3		2	3		1		1	3	2	2	2	1
CO4	1			3	2		1			3	3	2
CO5			3		3					3	3	

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (30%)
- Practical Assessment
- End semester Exam (70%)

Mapping of COs to Assessment Rubrics:

CO	Internal Exam	Assignment	Project Evaluation	End Semester Examination
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5	✓	✓		✓

MBY5EJ 302 (1). TOOLS AND TECHNIQUES IN RDNA TECHNOLOGY

Programme	B. Sc. Microbiology				
Course Code	MBY5EJ 302 (1)				
Course Title	Tools and Techniques in rDNA technology				
Type of Course	Major-Elective				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Nil				
Course Summary	This course attempts to introduce the basic concept of different gene cloning tools like enzymes and different vectors used in genetic engineering and leads to the understanding of procedures that have been developed to exploit the knowledge of the replication and expression of genetic information.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the functions and types of enzymes used in genetic engineering, such as restriction endonucleases and ligases.	U	C	Internal Exam, End Semester Exam
CO2	Explain the different vectors used in gene cloning, including plasmids and artificial chromosomes.	U	C	Internal Exam, End Semester Exam
CO3	Detail methods for introducing recombinant DNA into host cells, such as transformation and electroporation.	U	C	Internal Exam, End Semester Exam
CO4	Interpret techniques used for DNA amplification and sequencing, emphasizing PCR and its variants.	An	C	Internal Exam, End Semester Exam
CO5	Evaluate the applications and ethical considerations of rDNA technology in modern biotechnology.	E	C	Internal Exam, End Semester Exam

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (48+12)	Marks (70)
I	**Enzymes used in genetic engineering.**		**12**	**10**
	1	Restriction endonucleases: Types I,II and III		
	2	DNAPolymerases,RNApolymerases,Terminal deoxynucleotidyl transferase		
	3	Reverse Transcriptase, Ligases		
	4	Taq Polymerase, Topoisomerases		
	5	Methyl transferase,Kinases,Phosphatase,S1 nuclease		
	6	TOPO cloning		
II	**Cloning vectors**		**12**	**20**
	7	Plasmids as cloning vectors. pBR322,pUC λ vectors, M13 vectors,		
	8	λ vectors, M13 vectors,		
	9	Phagemids and Phasmids.		
	10	Artificial Chromosomes YAC,PAC,BAC,HAC.		
	11	Expression vectors, Replacement vectors- Replacement vector, Shuttle vectors, Insertion vectors,Fusion vector, Cosmids.Vectors for yeast and mammalian systems.		
III	**Methods in Gene Cloning**		**12**	**20**
	12	Introduction of recombinant DNA into host cells: Transformation of DNA by Calcium chloride treatment.		
	13	Gene Delivery methods- micro injection, Electroporation, Biolistics (gene gun), *Agrobacterium* mediated gene delivery		
	14	Selection and screening of recombinant clones: alpha complementation and blue white selection, colony and plaque hybridization, insertional inactivation.		
	15	DNA Amplification- PCR		
	16	Types of PCR		
IV	**Techniques in Genetic Engineering**		**12**	**20**
	17	DNA Libraries: Brief account of DNA libraries and its application		
	18	Blotting Techniques : Southern, Western		
	19	DNA sequencing methods.		
	20	DNA Fingerprinting- Brief account of RFLP ,RAPD		
	21	Brief account of Transposons, Transposons tagging and its applications		
	22	Difference between Chromosome walking and chromosome jumping.		
V	**Open Ended**		**12**	
	1	Visit to research institutes		
	2	Discussion on CRISPR technology		

Books and References:

1. Brown, T. A. (2018). *Gene Cloning and DNA Analysis: An Introduction* (7th ed.). Wiley-Blackwell.
2. Primrose, S. B., Twyman, R. M., & Old, R. W. (2013). *Principles of Gene Manipulation and Genomics* (8th ed.). Wiley-Blackwell.
3. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2013). *Molecular Biology of the Gene* (7th ed.). Pearson.
4. Griffiths, A. J. F., Wessler, S. R., Carroll, S. B., & Doebley, J. (2015). *Introduction to Genetic Analysis* (11th ed.). W. H. Freeman and Company.
5. Dale, J. W., & von Schantz, M. (2012). *From Genes to Genomes: Concepts and Applications of DNA Technology* (3rd ed.). Wiley.

Mapping of COs with PSOs and POs :

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		2	1			3	2	1		2	
CO2	2	3					2	3	2	1	3	
CO3	1	2	3				1		3	2	2	1
CO4		3	2	3				3		3		2
CO5			3		3					3	3	

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (30%)
- Practical Assessment
- End semester Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

MBY5EJ 303(2). BASIC HUMAN PHYSIOLOGY

Programme	B. Sc. Microbiology				
Course Code	MBY5EJ 303(2)				
Course Title	Basic Human Physiology				
Type of Course	Major-Elective				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Nil				
Course Summary	This course provides a comprehensive exploration of human physiology, spanning cellular to systemic levels. It examines elementary tissues, various circulatory systems, general mechanisms across major systems, and bio-physical concepts such as filtration and diffusion. Students gain insight into physiological processes crucial for understanding the functioning of the human body.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Demonstrate an understanding of the levels of organization in the human body including cells, tissues, organs, and systems and their interrelationships.	U	C	Internal Exam, End Semester Exam
CO2	Analyze the interplay between erythropoiesis, hemostasis, and coagulation mechanisms to explain how disruptions can lead to various blood disorders.	An	C	Internal Exam, End Semester Exam
CO3	Apply understanding of blood indices to interpret laboratory results of medical conditions associated with blood transfusions and strategies to mitigate them.	Ap	C	Internal Exam, End Semester Exam
CO4	Summarize the general mechanisms involved in various systems of the human body and analyze their interrelationships.	E	C	Internal Exam, End Semester Exam
CO5	Demonstrate a comprehensive understanding of how these systems contribute to overall physiological function and homeostasis.	E	C	Internal Exam, End Semester Exam

CO6	Apply knowledge of bio-physical principles including filtration, osmosis, diffusion, and dialysis to understand physiological processes and their implications in human health and disease.	Ap	P	Internal Exam, End Semester Exam
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs (48+12)	Marks (70)
I	**General Physiology and Circulatory System**		**12**	**15**
	1	Introduction to levels of organization in the human body- cells, tissue organs and different systems	2	
	2	Elementary tissues- epithelial tissue, connective tissue, muscle tissue, nervous tissue,	2	
	3	Circulatory system – blood and Lymph, Erythropoiesis;	2	
	4	Haemostasis, Coagulation of Blood, mechanisms	2	
	5	Blood indices- TC, DC,PCV,MCV,MCHC, Colour index, ESR- Their determination and Significance	2	
	6	Blood groups; Blood Transfusion hazards and Blood Volume;	2	
II	**General Mechanisms involved in various systems of the human body**		**12**	**20**
	7	Chemical composition of the body	2	
	8	Respiratory system	2	
	9	Cardiovascular system	2	
	10	Endocrine system and Exocrine system	2	
	11	Digestive system/excretory system	2	
	12	Reproductive system	2	
III	**General Mechanisms involved in various systems of the human body**		**12**	**20**
	13	Integumentary system	2	
	14	Nervous system	2	
	15	Urinary system/renal system	2	
	16	Reproductive system	2	
	17	Skeletal system	2	
	18	Special senses	2	
IV	**Bio-Physical Science**		**12**	**15**
	19	Filtration, Ultra filtration, Dialysis	3	
	20	Osmosis, Diffusion, Adsorption, Absorption,	3	

	21	Hydrotropy, Colloid, Donnan Equilibrium	3	
	22	Tracer elements, Assimilation, Surface tension.	3	
V	**Open Ended**		**30**	
	1	Explore interdisciplinary connections between human physiology and other fields such as nutrition, exercise science, psychology, or public health. Students can investigate how physiological processes interact with factors like diet, physical activity, mental health, or social determinants of health, and how these interactions impact overall well-being.		
	2	Working/Still model making events		
	3	Seminar/Guest lectures		

Books and References:

1. Microbial Ecology. John Wiley & Sons, Inc., New York 2.
2. Introduction to Soil Microbiology by Alexander, M.(1977). John Wiley & Sons, Inc.,
3. Agricultural microbiology, 2nd edition. Rangaswami G., Bagyaraj D. J. Prentice hall of India.
4. Ronald M. Atlas., Richard Bartha. Microbial Ecology. Benjamin Cummings. 1998
5. Robert, L Tate (1995). Soil Microbiology. First edition, John Wiley and Sons, Inc. New York edition. Pearson Education.
6. Rangaswami G and Mahadevan A (2002). Disease of Crop Plants in India. Fourth edition,PHI Learning (P) Ltd., New Delhi.
7. Subba Rao NS (2004). Soil Microbiology. Fourth edition, Oxford and IBH Publishing Co.Pvt. Ltd., New Delhi.
8. Mishra RR (2004). Soil Microbiology. First edition, CBS Publishers and distributors, New Delhi.
9. Devlin RM. (1975). *Plant Physiology.* 3rd edition, Willard Grant Press.
10. *Stolp H. (1988).* Microbial Ecology: Organisms Habitats Activities. *Cambridge University* Press, Cambridge, England.
11. Agrios GN. (2006). *Plant Pathology.* 5th edition. Academic press, San Diego
12. Lucas JA. (1998). *Plant Pathology and Plant Pathogens.* 3rd edition. Blackwell Science, Oxford.
13. Mehrotra RS. (1994). *Plant Pathology.* Tata McGraw-Hill Limited.
14. Rangaswami G. (2005). *Diseases of Crop Plants in India.* 4th edition. Prentice Hall of India Pvt. Ltd., New Delhi.
15. Singh RS. (1998). *Plant Diseases Management.* 7th edition. Oxford & IBH, New Delhi.
16. Raina M.Maier. Ian L.Pepper and Charles P.Gerba. (2000)EnvironmentalMicrobiology.Academic press California.UK

Mapping of COs with PSOs and POs:

CO	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3						3				2	
CO2	2	3					2	3	2		3	
CO3		2	3					3	3		2	1
CO4	1			3	2		1			3	3	2
CO5			3		3					3	3	3
CO6			3		3					3	3	3

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (30%)
- Practical Assessment
- Endsemester Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓			✓

MBY5EJ 304(2). TECHNIQUES IN CLINICAL LABORATORY

Programme	B. Sc. Microbiology				
Course Code	MBY5EJ 304(2)				
Course Title	Techniques in Clinical Laboratory				
Type of Course	Major-Elective				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Nil				
Course Summary	This course provides a comprehensive understanding of the principles and techniques used in clinical microbiology laboratories for the isolation, identification, and characterization of microorganisms.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Familiarize the basic principles of clinical laboratory techniques	U	C	Internal Exam, End Semester Exam
CO2	Explain various methods used in specimen collection and processing	Ap	F	Assignments, Internal Exam, End Semester Exam
CO3	Detail the steps involved in conventional methods used in clinical laboratory.	U	F	Assignments, Internal Exam, End Semester Exam
CO4	Outline the various advanced and emerging techniques in clinical field	An	C	Assignments, Internal Exam, End Semester Exam
CO5	Provide insights to various molecular level methods	U	C	Assignments, Internal Exam, End Semester Exam
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs (48+12)	Marks (70)
I	**Introduction to Clinical Microbiology**		**12**	**10**
	1	Overview of clinical microbiology		
	2	Scope and importance of clinical laboratory techniques.		
	3	Basic laboratory safety and hygiene		
	4	Introduction to Biosafety levels		

	5	Classification of biosafety levels		
II	**Specimen Collection and Processing**		**12**	**20**
	6	Principles of specimen collection		
	7	Processing of clinical specimens		
	8	Preservation and transportation of specimens		
	9	Blood, Sputum, Urine and fecal sample collection, transport and processing methods.		
	10	Quality assurance in specimen collection		
III	**Conventional Methods**		**12**	**20**
	11	Microscopic and Staining techniques.		
	12	Culture techniques (aerobic, anaerobic, and microaerophilic)		
	13	Biochemical tests for bacterial identification		
	14	Serological and immunological methods Enzyme-linked immunosorbent assay (ELISA), Western blotting, Immunofluorescence assays (IFA)		
	15	Molecular techniques (PCR, DNA sequencing)		
IV	**Advanced and Emerging Methods**		**12**	**20**
	16	Brief Account on Emerging Technologies in Clinical Microbiology - MALDI-TOF mass spectrometry, Nucleic acid amplification techniques (NAATs), Next-generation sequencing (NGS) technologies.		
	17	Advanced Antimicrobial Susceptibility Testing (AST) Methods - Principles and methods of advanced AST Gradient diffusion methods (Etest, M.I.C.Evaluator)		
	18	Automated AST systems (VITEK, MicroScan, Phoenix)		
	19	Point-of-Care Testing (POCT) -Principles and applications of POCT in clinical microbiology		
	20	Emerging Technologies - Digital PCR (dPCR), CRISPR-based diagnostics, Nanopore sequencing		
	21	Quality Control and Assurance in Advanced Clinical Microbiology		
	22	Accreditation and regulatory compliance in advanced clinical laboratories		
V	**Open Ended**		**12**	
	1	Molecular diagnostics for infectious diseases Epidemiological typing techniques Surveillance and outbreak investigation		

Books and References:

1. Murray, P. R., Rosenthal, K. S., & Pfaller, M. A. (Eds.). (2015). Medical Microbiology. Elsevier Health Sciences.
2. Forbes, B. A., Sahm, D. F., & Weissfeld, A. S. (2007). Bailey & Scott's Diagnostic Microbiology (12th ed.). Mosby.
3. Clinical Microbiology Procedures Handbook. (2007). ASM Press.
4. Isenberg, H. D. (Ed.). (2004). Clinical Microbiology Procedures Handbook (2nd ed.). ASM Press.

Mapping of COs with PSOs and POs :

CO	PSO 1	PSO2	PSO3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO 6
CO1	3		2		1		3		1		2	
CO2	2	3					2	2	3		3	
CO3		2	3		1		1	3	2	2	2	1
CO4	1			3	2		1			3	3	2
CO5			3		3					3	3	

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (30%)
- Practical Assessment
- End semester Exam (70%)

Mapping of COs to Assessment Rubrics :

CO	Internal Exam	Assignment	Project Evaluation	End Semester Examination
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5	✓	✓		✓

MBY5EJ 305 (3)-MICROBES IN FOOD AND WATER

Programme	B. Sc. Microbiology				
Course Code	MBY5EJ 305 (3)				
Course Title	Microbes in Food and Water				
Type of Course	Major-Elective				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Nil				
Course Summary	Students will gain a comprehensive understanding of the diversity and roles of microbes in food matrices including their contributions to fermentation processes, food spoilage, and foodborne infections. Additionally, the course will cover the microbial composition of aquatic systems including wastewater treatment and purification of municipal water supplies. Emphasis will be placed on methods for preserving food and ensuring water safety, as well as the prevention and control of waterborne diseases.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the diversity and roles of microbes in food and water ecosystems.	U	C	Assignments, Quizzes, Midterm Exam
CO2	Analyze the factors affecting microbial growth in food and water, and evaluate methods to control food spoilage and foodborne infections.	An	C	Assignments, Quizzes, Midterm Exam
CO3	Discuss the microbial composition of aquatic systems and evaluate methods for wastewater treatment and water purification.	U	C	Assignments, Quizzes, Midterm Exam
CO4	Examine the routes of transmission of food and waterborne pathogens and propose measures for their prevention and control.	E	C	Assignments, Quizzes, Midterm Exam
CO5	Conduct laboratory analysis of fermented and spoiled food samples and water samples from different sources, adhering to quality assurance protocols.	Ap	F	Assignments, Quizzes, Midterm Exam

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (48+12)	Marks (70)
I	**Microbial ecology of food and water**		**12**	**10**
	1	Overview of microbes in food and water ecosystems		
	2	Growth factors of Microbes in food		
	3	Sources of microbes in food		
	4	Fermentation and spoilage		
	5	Microbes in food fermentations- Bacteria and Fungi		
	6	Microbes in food spoilage		
II	**Food spoilage and food infections**		**12**	**20**
	7	Route of transmission of food borne microbes		
	8	Bacterial food spoilage		
	9	Fungal food spoilage		
	10	Microbes in food borne infections- Bacteria, Viruses and protozoa		
	11	Methods for preserving food: refrigeration, freezing, drying, canning, and fermentation		
III	**Microbes in aquatic system**		**12**	**20**
	12	Types of microbes in aquatic ecosystem		
	13	Microbes in waste water		
	14	Biological treatment of waste water		
	15	Purification of municipal water supply		
	16	Small scale water purification		
IV	**Food and water borne diseases**		**12**	**20**
	17	Bacterial water borne diseases		
	18	Viral waterborne diseases		
	19	Protozoal waterborne diseases		
	20	Microbial Water analysis- MPN		
	21	Microbial indicators of water pollution		
	22	Eutrophication and algal blooms		
V	**Open Ended**		**12**	
	1	Laboratory analysis of fermented and spoiled food samples and water samples from different sources.		

Books and References:

1. Doyle, M. P. (2019). *Food microbiology: Fundamentals and frontiers* (5th ed.). ASM Press.
2. Mara, D., & Horan, N. J. (Eds.). (2003). *Water microbiology: Bacterial pathogens and waterborne diseases*. Elsevier.
3. Glibert, P. M., & Church, T. M. (2013). *Aquatic microbial ecology and biogeochemistry: A dual perspective*. Springer.
4. Bhunia, A. K., & Bhola, N. R. C. (2018). *Food microbiology*. McGraw-Hill Education.

5. Rai, R. C. (2016). *Fundamentals of microbiology and immunology*. Kalyani Publishers.
6. Baveja, C. P. (2019). *Textbook of microbiology* (5th ed.). Arya Publications.
7. Yayaver, H. S., Singh, B. K., & Singh, A. P. (2017). *Microbial ecology*. Springer.
8. Agarwal, G. P., & Agarwala, S. K. (2015). *Textbook of environmental microbiology*. Universities Press.
9. Erkmen, O., & Bozoglu, T. F. (Eds.). (2016). *Food microbiology: Principles into practice*. Wiley-Blackwell.
10. Percival, S. L., & Embrey, M. (Eds.). (2004). *Microbiology of waterborne diseases: Microbiological aspects and risks*. Elsevier.

Mapping of COs with PSOs and POs :

CO	PSO1	PSO2	PSO3	PSO 4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1				3	2	1			
CO2	2	1		3			2	3	1			
CO3		3	2	1				2	3	1		
CO4	1		3	2			1		3	2	1	
CO5		1	2	3				1	2	3	1	2

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (30%)
- Practical Assessment
- End semester Exam (70%)

Mapping of COs to Assessment Rubrics :

CO	Internal Exam	Assignment	End Semester Examination
CO1	✓	✓	✓
CO2	✓	✓	✓
CO3	✓	✓	✓
CO4	✓	✓	✓
CO5	✓	✓	✓

MBY5EJ306 (3) FOOD QUALITY ASSURANCE

Programme	B. Sc. Microbiology				
Course Code	MBY5EJ306 (3)				
Course Title	Food Quality Assurance				
Type of Course	Major-Elective				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Nil				
Course Summary	This course provides a comprehensive overview of the principles and practices of food quality assurance. It covers the importance of food safety, different types of food hazards, regulatory standards, quality management systems, and the impact of emerging technologies in food quality assurance.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the fundamentals of food quality assurance and its impact on public health and consumer trust.	U	F	Internal Exam, Assignments, End Semester Exam
CO2	Identify various food hazards and implement effective mitigation strategies.	U	C	Internal Exam, Assignments, End Semester Exam
CO3	Analyze food standards and regulatory requirements to ensure compliance in the food industry.	An	F	Internal Exam, Assignments, End Semester Exam
CO4	Implement and manage quality systems in the food industry to enhance food safety and quality.	Ap	F	Internal Exam, Assignments, End Semester Exam
CO5	Evaluate the role of ISO certifications and integrate quality management principles for business success.	An	C	Internal Exam, Assignments, End Semester Exam

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (48+12)	Marks (70)
I	**Introduction to Food Quality Assurance**:		**12**	**15**
	1	Definition and scope of food quality assurance. Importance of maintaining food quality and safety		
	2	Impact on public health and consumer trust, Historical milestones in food quality assurance, Evolution of food safety standards globally		
	3	Fundamental principles of food quality assurance (prevention, detection, control)		
	4	Objectives of ensuring food safety, quality, and consistency, Relationship between food quality assurance and overall business success		
II	Food Hazardous Materials:		**12**	**15**
	5	Definition of food safety and concept of safe food.		
	6	Types of Food Hazards: Chemical hazards: Naturally occurring chemical hazards (toxins and antinutritional factors) in foods,		
	7	Unintentional Chemicals (Pesticides, Fertilizers, Pollutants), Toxic metals (Lead, Cadmium, Mercury, Aluminium and Arsenic), and Intentional Chemicals (Food preservatives Food additives).		
	8	Biological hazards (pathogens, toxins), Physical hazards (foreign objects, Glass, Wood, Stones, Metal Fragments, Insulation Materials, Plastic and Bones).		
	9	Sources of Food Hazards: Natural sources (microorganisms, toxins), Environmental sources (pollution, cross-contamination)		
	10	Human-induced sources (poor hygiene, improper handling). Mitigation and Control Measures for Food Hazards.		
III	Food Standards and Regulations:		**14**	**25**
	11	Role of Food Standards in Ensuring Safety and Quality		
	12	International Food Standards Organizations (Codex Alimentarius, ISO)		
	13	Indian Food Laws and Regulations: Food Safety and Standards Act, 2006		
	14	Indian Food Laws and Regulations: Food Safety and Standards (Licensing and Registration of Food Businesses) Regulations, 2011		
	15	Roles and Responsibilities of Food Safety and Standards Authority of India (FSSAI)		
	16	Role of Regulatory Authorities: Inspections, Audits, and Enforcement of Food Regulations		

	17	Compliance Requirements for Food Businesses		
IV	Quality Management Systems in Food Industry:		**10**	**15**
	18	Introduction to Quality Management Systems (QMS)		
	19	Principles of Total Quality Management (TQM) in the Food Industry		
	20	Components of QMS: Policies, Procedures, and Documentation Requirements		
	21	Hazard Analysis Critical Control Points (HACCP) Principles and Implementation Steps		
	22	Good Manufacturing Practices (GMP) and Their Importance in Ensuring Food Safety and Quality		
V	**Open ended**		**12**	
		Recent advancements in Food Quality Assurance Technologies, Rapid detection methods for food pathogens and contaminants, Smart packaging technologies for food safety, and shelf-life extension. Case Study of any food safety incidents and recalls.		

Books and References:

1. Principles of Genetics by Gardner EJ, Simmons MJ, Snustad DP, 1991. John Wiley& Sons.
2. Molecular Biology of the Gene by Watson, JD, Hopkins NH, Roberts JW, Steitz JA, Weiner AAM, 1987. The Benjamin/Cummings publishing company
3. Principles of Genetics by Gardner EJ, Simmons MJ, Snustad DP, 1991. John Wiley& Sons.
4. Molecular Biology of the Gene by Watson, JD, Hopkins NH, Roberts JW, Steitz JA, Weiner AAM, 1987. The Benjamin/Cummings publishing company.
5. Genes V by Lewin B, 1994. Oxford University press.
6. Molecular Cell Biology by Lodish, H, Baltimore D, Berk A, Zipursky SL, Matsudaira P, Darnell J., 1995. Scientific American Books.
7. Biochemistry by Stryer L.,1995. W.H. Freeman and company.
8. Molecular Biology by Freifelder D., 1991 Narosa Publishing Home.
9. Principles of Gene Manipulation, 4th Ed., by R.S. Old and S.B.Primrose. 1989.Blackwell Scientific Publications, London.
10. Alcamo IE. (2001). DNA Technology: The Awesome Skill. 2nd edition. Elsevier Academic Press,
11. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford,
12. Glick BR and Pasternak JJ. (2003). Molecular Biotechnology. 3rd edition. ASM PressWashington D.C.
13. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7thedition. Blackwell Publishing, Oxford, U.K.
14. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.

Mapping of COs with PSOs and POs :

CO	PSO1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1				3	2	1		2	
CO2	2	3		1			2	3	2	1	3	
CO3	1		3	2			1		3	2	2	1
CO4		1	2	3				2		3	1	2
CO5				3	2	1		1	2		3	3

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (30%)
- Practical Assessment
- End semester Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

MBY5EJ 307. ENZYMOLOGY

Programme	B. Sc. Microbiology				
Course Code	MBY5EJ 307				
Course Title	Enzymology				
Type of Course	Major-Elective				
Semester	V				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4		-	60
Pre-requisites	Nil				
Course Summary	This Elective course covers Enzymology with introduction to enzymes, enzyme classification, enzyme kinetics, factors influencing enzyme activity, enzyme substrate interactions, regulation of enzyme activity, industrial application of enzymes, and advances in enzyme technology				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand fundamental concepts and classifications of enzymes.	U	C	Internal Exam, End Semester Exam
CO2	Analyse catalytic mechanisms and enzyme kinetics.	An	C	Internal Exam, End Semester Exam
CO3	Apply knowledge of enzymology to industrial processes.	Ap	F	Internal Exam, End Semester Exam
CO4	Evaluate recent advancements in enzyme technology.	E	C	Internal Exam, End Semester Exam
CO5	Demonstrate analytical skills in solving enzymology-related problems.	Ap	F	Internal Exam, End Semester Exam
CO6	Critically discuss the role of enzymes in clinical diagnostics and therapy.	An	F	Internal Exam, End Semester Exam

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (48+12)	Marks (70)
I	Introduction to enzymes and Brief history to enzymology		**10**	**15**
	1	Enzyme–IUB-Nomenclature, Classification, Enzyme kinetics - Michaelis-Menten equation, Lineweaver Burk plot		
	2	Catalytic power and specificity: Optical, geometrical, absolute, group, bond specificities, Active site		
	3	non-protein cofactors and co-enzymes - NAD, NADP+,FAD, FMN, TPP, CoA and pyridoxal phosphate. Roles of cofactors and coenzymes in enzyme action,		
	4	Reversible inhibition - Competitive, non competitive, uncompetitive inhibition - with examples. Irreversible inhibition with examples, Antibiotic inhibitors of enzymes- penicillin, sulfa drugs, methotrexate etc. Inhibitors as tools in biochemical studies,		
	5	Factors affecting enzyme activity		
II	**Enzyme-substrate interactions**		**12**	**15**
	6	Lock and Key hypothesis; Induced fit hypothesis, Mechanism of enzyme catalysis- Acid-base catalysis, Covalent catalysis, Metal ion catalysis, Electrostatic catalysis		
	7	Allosteric / Regulatory enzymes: Allosteric activation and inhibition		
	8	Regulation of enzyme activity - Feed back regulation, Zymogens, covalent modification, Transcriptional regulation, hormone mediated regulation		
	9	Isoenzymes (LDH, Creatine kinase) and Multi-enzyme complex.		
III	**Industrial applications of enzymes**		**13**	**20**
	10	Industrially important microbial enzymes		
	11	Genetically modified enzymes		
	12	Purification of enzymes - fractional precipitation, dialysis, isoelectric precipitation		
	13	Purification of enzymes - chromatography - ion exchange and gel filtration chromatography		
	14	HPLC, PAGE		
	15	Enzymes of clinical importance.		
IV	**Advances in Enzyme technology**		**12**	**20**
	17	Advances in Enzyme technology		
	18	Immobilized enzymes		
	19	Abzymes		
	20	Enzyme engineering		
	21	Diagnostic Enzymology		

	22	Application-based assignments on recent advancements in enzymology.		
V	**Open ended**		**12**	
	1	Assignments/Seminars on the above topics		
	2	Demonstration of immobilized enzyme preparation		
	3	Demonstration of microbial synthesis of enzymes		

Books and References:

1. Nelson, D. L. and Cox, M.M. Lehninger Principles of Biochemistry, 6th Edition,
1. W.H.Freeman and Company, N.Y., USA.
2. Palmer, T. Understanding Enzymes Ellis Horwood Limited, Third Edition. 1991
3. Palmer, T and Bonner, P. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry
4. Publisher: Horwood Publishing Limited.
5. Stryer, L. Biochemistry Pub.W.H.Freeman
6. Voet, D. and. Voet, J. G, Biochemistry, 4th Edition, John Wiley & sons Inc. New York
7. Walsh, G. Protein Biochemistry and Biotechnology, John Wiley and Sons Ltd.2002.
8. West E.S., W.R. Todd, H.S. Mason and J .T. Van Bruggen Text Book of Biochemistry: Oxford & IBH publishing Co-Pvt. Ltd.

Mapping of COs with PSOs and POs:

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		2		1		3		1		2	
CO2	2	3					2	3	2		3	
CO3		2	3		1		1	3	3	2	2	1
CO4		3		3				3		3		2
CO5			3		3					3	3	
CO6	2			3						3	3	3

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (30%)
- End semester Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓			✓
CO 4		✓		✓
CO 5	✓	✓		✓
CO 6	✓			✓

MBY6EJ 301(1). APPLICATIONS OF rDNA TECHNOLOGY 1

Programme	B. Sc. Microbiology				
Course Code	MBY6EJ 301(1)				
Course Title	**Applications of rDNA technology 1**				
Type of Course	**Major**-Elective				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Nil				
Course Summary	This course delves into the practical applications of recombinant DNA technology in various fields including biotechnology, medicine, agriculture, and environmental sciences. The focus is on the methodologies of gene cloning, production of recombinant proteins, and the ethical, safety, and regulatory aspects of biotechnology.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Design and execute gene cloning strategies for protein production.	Ap	F	Assignments, End Semester Exam
CO2	Develop recombinant proteins using eukaryotic systems and analyze their applications.	Ap	C	Assignments, End Semester Exam
CO3	Implement gene cloning techniques in agriculture for crop improvement.	Ap	C	Assignments, End Semester Exam
CO4	Address safety, ethical, and regulatory issues associated with GMOs.	An	C	Assignments, End Semester Exam
CO5	Evaluate the impact of genetic engineering on ecosystems and food security.	E	C	Assignments, End Semester Exam

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
\# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs 48-12	Marks (70)
I	Gene cloning and DNA analysis in Biotechnology		**12**	**20**
	1	Production of protein from cloned genes in bacteria		
	2	Importance of promoter in gene expression		
	3	Examples of important promoter used for expression vector		
	4	Cassettes and gene fusion		
	5	Problems encountered with cloning in bacteria		
	6	Problems of heterologous gene expression		
II	Production of recombinant proteins in eukaryotic cells		**12**	**20**
	8	Production of recombinant proteins in eukaryotic cells - filamentous fungi		
		Production of recombinant proteins in eukaryotic cells -yeast		
	9	Using animal cells for recombinant protein production (mammalian and insect)		
	10	Pharming recombinant protein from animals		
	11	Pharming recombinant protein from plants		
	12	Ethical concerns raised by pharming		
III	Gene cloning and DNA analysis in Agriculture		**12**	**20**
	13	Gene manipulations in insecticide development		
	14	Manipulations to develop herbicides in plants		
	15	Gene subtraction studies - antisense RNA in plant ripening		
	16	Use of antisense RNA in polygalacturonase gene		
	17	Use of antisense RNA in inactivating ethylene synthesis		
IV	Problems related to genetically modified plants		**12**	**10**
	18	Safety concerns with selectable markers		
	19	The terminator technology		
	20	The possibility of harmful effects on the environment		
	21	Public perception and legal issues related to GMOs		
	22	Future directions in genetically modified crops		
V	**Open ended**		**12**	
	1			

Books and References:

1. Brown, T. A. (2018). *Gene Cloning and DNA Analysis: An Introduction* (7th ed.). Wiley-Blackwell.
2. Primrose, S. B., Twyman, R. M., & Old, R. W. (2013). *Principles of Gene Manipulation and Genomics* (8th ed.). Wiley-Blackwell.
3. Dale, J. W., & von Schantz, M. (2015). *From Genes to Genomes: Concepts and Applications of DNA Technology* (3rd ed.). Wiley.
4. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2013). *Molecular Biology of the Gene* (7th ed.). Pearson.
5. Russell, P. J. (2014). *iGenetics: A Molecular Approach* (3rd ed.). Benjamin Cummings.
6. Miesfeld, R., & McEvoy, M. (2017). *Biochemistry and Molecular Biology: How Life Works* (1st ed.). W. H. Freeman.

Mapping of COs with PSOs and POs:

CO	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1				3	1	2		2	
CO2	2	3		1			2	3	2	1	3	
CO3	1		3	2		1	1		3	2	2	1
CO4		2		3	1			3		3	1	2
CO5			2		3	1			3		3	3

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (30%)
- Practical Assessment
- End semester Exam (70%)

Mapping of COs to Assessment Rubrics :

CO	Internal Exam	Assignments	End Semester Exam
CO1	✓	✓	✓
CO2	✓	✓	✓
CO3	✓	✓	✓
CO4	✓	✓	✓
CO5	✓	✓	✓

MBY6EJ 302(1). APPLICATIONS OF rDNA TECHNOLOGY II

Programme	B. Sc. Microbiology				
Course Code	MBY6EJ 302(1)				
Course Title	Applications of rDNA technology II				
Type of Course	Major-Elective				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Nil				
Course Summary	This course further explores the practical applications of recombinant DNA technology in fields such as medicine, forensic science, and archaeology, emphasizing the production of recombinant pharmaceuticals, gene therapy, forensic DNA analysis, and ethical considerations.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Demonstrate comprehensive knowledge of the applications of genetic engineering in producing recombinant pharmaceuticals.	C	C	Assignments, End Semester Exams
CO2	Understand the development and application of diagnostic tools and recombinant vaccines in medical biotechnology.	U	C	Assignments, Lab Reports
CO3	Analyze the ethical, social, and scientific implications of gene therapy in medicine.	An	C	Midterm Exams, Assignments
CO4	Apply DNA analysis techniques to forensic challenges, enhancing skills in genetic profiling and kinship analysis.	Ap	F	Instructor-Created Exams, Quizzes
CO5	Evaluate the integration of rDNA technology in archaeological studies to trace historical human migrations and ancient diseases.	E	C	Case Studies, Internal Exam

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (48-12)	Marks (70)
I	Applications of genetic engineering in Research		**12**	**15**
	1	To study the RNA transcript of a gene		
	2	Studying the regulation of gene expression		
	3	Identifying the control sequences by deletion analysis		
	4	Reporter genes		
	5	Identifying and studying the translation product of a cloned gene		
	6	Use of HRT and HART		
	7	Analysis of protein by invitro mutagenesis		
II	Studying genomes		**12**	**20**
	8	Genome annotation in a genome sequence		
	9	Determining the function of unknown gene		
	10	Studying the transcriptome		
	11	Studying the proteome		
	12	Studying the protein protein interactions		
III	Applications of genetic engineering in medicine		**12**	**20**
	13	Production of recombinant pharmaceuticals- insulin,		
	14	Synthesis of growth hormone		
	15	Diagnosis and Gene therapy for human disease		
	16	Recombinant Vaccine		
	17	Ethical issues raised by gene therapy		
IV	Gene cloning and DNA analysis in forensic science		**12**	**15**
	18	DNA analysis in identification of crime suspects		
	19	Studying kinship by DNA profiling		
	20	Sex determination by DNA analysis		
	21	Use of DNA profiling to trace missing children		
	22	Study of prehistoric human migrations		
V	**Open ended**		**12**	
	1			

Books and References:

1. Brown, T. A. (2018). *Gene Cloning and DNA Analysis: An Introduction* (7th ed.). Wiley-Blackwell.
2. Primrose, S. B., Twyman, R. M., & Old, R. W. (2013). *Principles of Gene Manipulation and Genomics* (8th ed.). Wiley-Blackwell.
3. Dale, J. W., & von Schantz, M. (2015). *From Genes to Genomes: Concepts and Applications of DNA Technology* (3rd ed.). Wiley.
4. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2013). *Molecular Biology of the Gene* (7th ed.). Pearson.
5. Russell, P. J. (2014). *iGenetics: A Molecular Approach* (3rd ed.). Benjamin Cummings.
6. Miesfeld, R., & McEvoy, M. (2017). *Biochemistry and Molecular Biology: How Life Works* (1st ed.). W. H. Freeman.

Mapping of COs with PSOs and POs:

CO	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1		2		3	1	2		2	
CO2	2	3		1	3		2	3	2	1	3	
CO3	1	2	3			1	1	3	3	2	2	1
CO4		3		3				3		3		2
CO5	2		3		3			1	2	3	3	3

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (30%)
- Practical Assessment
- End semester Exam (70%)

Mapping of COs to Assessment Rubrics:

CO	Internal Exam	Assignments	End Semester Examinations
CO1	✓	✓	✓
CO2	✓	✓	
CO3	✓	✓	
CO4	✓		✓
CO5	✓		

MBY6EJ 303 (2). DIAGNOSTIC MICROBIOLOGY

Programme	B. Sc. Microbiology				
Course Code	MBY6EJ303 (2)				
Course Title	Diagnostic Microbiology				
Type of Course	Major-Elective				
Semester	VI				
Academic Level	300-399				
Course Details	Credit 4	Lecture per week 4	Tutorial per week -	Practical per week -	Total Hours 60
Pre-requisites	Nil				
Course Summary	This course provides a comprehensive overview of diagnostic microbiology, covering fundamental principles, advanced techniques, and practical applications in healthcare settings. Students will learn about the importance of diagnostic microbiology in disease diagnosis and public health, laboratory design and biosafety considerations, automated blood culture systems, rapid antigen tests, advanced antibody detection methods, and phenotypic testing of microbial antimicrobial susceptibility. Emphasis is placed on understanding laboratory techniques, interpreting results, troubleshooting common issues, and applying diagnostic microbiology principles in clinical practice.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Explain the significance of diagnostic microbiology in healthcare and public health, emphasizing its role in disease diagnosis and management.	U	C	Quizzes, Midterm Exam
CO2	Identify the design and structure of diagnostic microbiology laboratories, applying principles of biosafety and biosecurity to ensure safe laboratory practices.	U	C	Quizzes, Assignments
CO3	Describe the operation and interpretation of automated blood culture systems and rapid antigen tests for microbial detection, highlighting their importance in diagnosing infectious diseases.	U	C	Assignments, Final Exam

CO4	Understand advanced antibody detection methods such as ELISA and immunoblotting, interpreting results accurately to aid in disease diagnosis.	U	P	Midterm Exam, Final Exam
CO5	Conduct phenotypic testing of bacterial antimicrobial susceptibility and interpret findings contributing to effective treatment strategies and antimicrobial stewardship efforts.	Ap	P	Assignments, Final Exam

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (48+12)	Marks (70)
I	**Introduction to Diagnostic Microbiology**		**10**	**15**
	1	Overview of diagnostic microbiology and its significance in healthcare		
	2	Role and importance of diagnostic microbiology laboratories		
	3	Principles of biosafety and biosecurity in diagnostic microbiology		
	4	Laboratory design considerations for diagnostic microbiology facilities		
	5	Equipment and instrumentation used in diagnostic microbiology laboratories		
II	**Automated Blood Culture**		**10**	**15**
	6	Principles of blood culture and its importance in diagnosing bloodstream infections		
	7	Overview of automated blood culture systems		
	8	Operation and maintenance of automated blood culture instruments		
	9	Interpretation of blood culture results and identification of microbial pathogens		
	10	Troubleshooting common issues in automated blood culture systems		

III	**Rapid Antigen Test**		**18**	**25**
	11	Introduction to rapid antigen tests for microbial detection		
	12	Principles of antigen-antibody interactions in rapid antigen tests		
	13	Techniques for performing rapid antigen tests		
	14	Interpretation of rapid antigen test results		
	15	Applications of rapid antigen tests in diagnostic microbiology		
	16	Limitations of rapid antigen tests in diagnostic microbiology		
IV	**Advanced Antibody Detection and Phenotypic Testing**		**10**	**15**
	17	Principles and applications of advanced antibody detection methods		
	18	Techniques for performing enzyme-linked immunosorbent assay (ELISA)		
	19	Immunoblotting techniques		
	20	Phenotypic testing of bacterial antimicrobial susceptibility		
	21	Introduction to biochemical profile-based microbial identification systems		
	22	Interpretation of phenotypic testing results and their clinical significance		
V	**Open ended**		**12**	
		Discuss the advantages and disadvantages of different diagnostic techniques		

Books and References:

1. Tille, P. (Ed.). (2017). *Bailey & Scott's diagnostic microbiology* (14th ed.). Elsevier.
2. Mahon, C. R., & Manuselis, G. (2014). *Textbook of diagnostic microbiology* (5th ed.). Saunders.
3. Kiser, K., Payne, W. C., & Taff, T. (2011). *Clinical laboratory microbiology: A practical approach* (1st ed.). Pearson.
4. Sastry, A. S., & Bhat, S. (2018). *Essentials of medical microbiology* (2nd ed.). Jaypee Brothers Medical Publishers.
5. Ananthanarayan, R., & Paniker, C. K. J. (2017). *A textbook of microbiology* (10th ed.). Universities Press.
6. Gladwin, M., & Trattler, B. (2013). *Clinical microbiology made ridiculously simple* (6th ed.). MedMaster Inc.
7. Chakraborty, R., & Mandal, S. C. (2015). *A concise textbook of microbiology* (1st ed.). CBS Publishers & Distributors.
8. Dubey, R. C. (2014). *Practical microbiology* (4th ed.). S. Chand Publishing.
9. Wright, W. F., & LeClair, A. C. (2020). *Essentials of clinical infectious diseases* (1st ed.). Springer.
10. Parish, C. R. (2015). *Diagnostic microbiology: Test yourself* (1st ed.). Wiley.

Mapping of COs with PSOs and POs :

CO	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1				3	2	1			
CO2	2	1		3			2	3	1			
CO3		3	2	1				2	3	1		
CO4	1		3	2			1		3	2	1	
CO5		1	2	3				1	2	3	1	2

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (30%)
- Practical Assessment
- End semester Exam (70%)

Mapping of COs to Assessment Rubrics:

CO	Internal Exam	Assignment	End Semester Examination
CO1	✓		✓
CO2	✓	✓	
CO3		✓	✓
CO4	✓		✓
CO5		✓	✓

MBY6EJ 304(2)-ADVANCED DIAGNOSTIC TECHNIQUES IN MICROBIOLOGY

Programme	B. Sc. Microbiology				
Course Code	MBY6EJ304(2)				
Course Title	Advanced Diagnostic Techniques in Microbiology				
Type of Course	Major-Elective				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Nil				
Course Summary	This course provides an in-depth exploration of advanced molecular techniques used in diagnostic microbiology. Topics include probe-based microbial detection, nucleic acid amplification, molecular diagnostics, and automation in microbiology. Students will gain hands-on experience with techniques such as real-time PCR, PFGE, ELISA, and microarray-based molecular identification. Emphasis is placed on understanding the principles, applications, and interpretation of these techniques in diagnosing infectious diseases and controlling antimicrobial therapy.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the principles and applications of probe-based microbial detection techniques in diagnostic microbiology.	U	C	Assignments, Quizzes, Midterm Exam
CO2	Explain the fundamentals of nucleic acid amplification techniques, including PCR and real-time PCR, and their applications in microbial diagnostics.	U	C	Assignments, Quizzes, Midterm Exam
CO3	Analyze and interpret data from advanced molecular techniques such as PFGE, ELISA, and microarray-based molecular identification.	An	C	Assignments, Quizzes, Midterm Exam
CO4	Evaluate the role of molecular diagnostics in detecting drug resistance and characterizing microbial pathogens.	E	C	Assignments, Quizzes, Midterm Exam
CO5	Integrate advanced diagnostic techniques into clinical practice and public health interventions to improve patient care and disease management.	Ap	F	Assignments, Quizzes, Midterm Exam

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (48 +12)	Marks (70)
I	**Probe-Based Microbial Detection and Nucleic Acid Amplification**		**10**	**15**
	1	Principles of probe-based microbial detection	1	
	2	Applications of probe-based microbial detection	7	
	3	Overview of invitro nucleic acid amplification techniques	1	
	4	Polymerase chain reaction (PCR) fundamentals		
	5	Real-time PCR principles and applications		
	6	Introduction to Pulsed-Field Gel Electrophoresis (PFGE)		
	7	Principles and applications of bDNA signal amplification technique		
II	**Molecular Techniques in Diagnostic Microbiology**		**10**	**15**
	8	Introduction to agarose gel electrophoresis	1	
	9	Applications of agarose gel electrophoresis in diagnostic microbiology	1	
	10	Techniques and interpretation of Southern blot hybridization	1	
	11	Principles and applications of enzyme-linked immunoassay (ELISA)	1	
	12	Microarray-based molecular identification techniques		
	13	Interpretation of microarray-based molecular identification results		
III	**Advanced Molecular Diagnostics**		**18**	**25**
	14	Diagnostic microbiology using real-time PCR based on FRET technology	2	
	15	Advances in the diagnosis of Mycobacterium tuberculosis	4	
	16	Principles and applications of drug resistance detection in Mycobacterium tuberculosis	3	
	17	Molecular strain typing using repetitive sequence-based PCR (rep-PCR)	3	
	18	Automation in microbiology: principles and applications	3	
	19	Laboratory control of antimicrobial therapy: techniques and considerations		
IV	**Application and Integration**		**10**	**15**
	20	Case studies in probe-based microbial detection and nucleic acid amplification	2	
	21	Practical applications of molecular techniques in diagnostic microbiology	2	
	22	Integration of advanced molecular diagnostics into clinical practice and public health interventions	2	

V	**Open ended**		**12**	
		Emerging Infectious Diseases: Exploration of recent outbreaks and their impact on global health.		
		Innovations in Healthcare Technology: Advancements in medical devices, telemedicine, and digital health solutions.		

Books and References:

1. Dicker, R., et al. (2006). *Principles of Epidemiology in Public Health Practice* (3rd ed.). CDC.
2. Tille, P. (Ed.). (2017). *Bailey & Scott's Diagnostic Microbiology* (14th ed.). Elsevier.
3. Mahon, C. R., & Manuselis, G. (2014). *Textbook of Diagnostic Microbiology* (5th ed.). Saunders.
4. Kiser, K., Payne, W. C., & Taff, T. (2011). *Clinical Laboratory Microbiology: A Practical Approach* (1st ed.). Pearson.
5. Sastry, A. S., & Bhat, S. (2018). *Essentials of Medical Microbiology* (2nd ed.). Jaypee Brothers Medical Publishers.
6. Ananthanarayan, R., & Paniker, C. K. J. (2017). *A Textbook of Microbiology* (10th ed.). Universities Press.
7. Gladwin, M., & Trattler, B. (2013). *Clinical Microbiology Made Ridiculously Simple* (6th ed.). MedMaster Inc.
8. Chakraborty, R., & Mandal, S. C. (2015). *A Concise Textbook of Microbiology* (1st ed.). CBS Publishers & Distributors.
9. Dubey, R. C. (2014). *Practical Microbiology* (4th ed.). S. Chand Publishing.
10. Wright, W. F., & LeClair, A. C. (2020). *Essentials of Clinical Infectious Diseases* (1st ed.). Springer.
11. Parish, C. R. (2015). *Diagnostic Microbiology: Test Yourself* (1st ed.). Wiley.
12. Somerville, M., & Kumaran, K. (2012). *Public Health and Epidemiology at a Glance*. Wiley-Blackwell.

Mapping of COs with PSOs and POs :

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1				3	2	1			
CO2	2	1		3			2	3	1			
CO3		3	2	1				2	3	1		
CO4	1		3	2			1		3	2	1	
CO5		1	2	3				1	2	3	1	2

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (30%)
- Practical Assessment
- End semester Exam (70%)

Mapping of COs to Assessment Rubrics:

CO	Internal Exam	Assignment	End Semester Examination
CO1	✓	✓	✓
CO2	✓	✓	✓
CO3	✓	✓	✓
CO4	✓	✓	✓
CO5	✓	✓	✓

MBY6EJ 305 (3). LABORATORY TECHNIQUES FOR FOOD AND WATER ANALYSIS

Programme	B. Sc. Microbiology				
Course Code	MBY6EJ 305 (3)				
Course Title	Laboratory techniques for food and water analysis				
Type of Course	Major-Elective				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Nil				
Course Summary	This course provides a detailed study of laboratory techniques used for the analysis of food and water. It covers good laboratory practices, equipment handling, sterilization methods, staining techniques, microscopy, culture media preparation, food and water sampling, and analysis. Advanced analytical techniques such as mass spectrometry, UV-visible spectrometry, chromatography, and PCR are also discussed. The course emphasizes quality assurance and safety protocols in laboratory practice.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the principles of good laboratory practices, equipment handling, and sterilization methods.	U	C	Assignments, Quizzes, Midterm Exam
CO2	Explain the techniques for staining, microscopy, and culture media preparation used in food and water analysis.	U	C	Assignments, Quizzes, Midterm Exam
CO3	Analyze methods for sampling, chemical, physical, and microbiological analysis of food and water.	An	C	Assignments, Quizzes, Midterm Exam
CO4	Understand and apply advanced analytical techniques such as mass spectrometry, UV-visible spectrometry, chromatography, and PCR in food and water analysis.	Ap	F	Assignments, Quizzes, Midterm Exam
CO5	Implement quality assurance and quality control measures in laboratory procedures, ensuring reliability and validity of results.	Ap	M	Assignments, Quizzes, Midterm Exam

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (48+12)	Marks (70)
I	**Introduction to laboratory practices**		**12**	**10**
	1	Good laboratory practices		
	2	Basic laboratory equipments		
	3	Sterilization methods		
	4	Staining methods		
	5	Microscopy and types		
	6	Culture media and types		
II	**Food and water analysis**		**12**	**20**
	7	Food sampling qnd preparation of samples		
	8	Basic Principles of Classical Methods of food analysis		
	9	Chemical methods of analysis		
	10	Physical methods of analysis		
	11	Microbiological methods of analysis		
III	**Basic Laboratory protocols**		**12**	**20**
	12	Direct microscopic examination of food		
	13	Detection of pathogens from food and water		
	14	Enumeration of microbes by Aerobic plate count		
	15	Methods of detection of pathogens and toxins		
	16	Detection of coliforms and indicator organisms		
	17	Evaluation of microbial quality of water by MPN technique and membrane filtration technique		
IV	**Advanced Analytical techniques**		**12**	**20**
	18	Instrumentation and Princple of Mass spectrometry		
	19	UV-Visible and Fluorescence Spectrometry		
	20	Liquid and Gas Chromatography		
	21	Nuclear Magnetic Resonance spectroscopy		
	22	Polymerase chain reaction		
V	**Open Ended**		**12**	
	1	Visit food and water testing laboratories		
	2	Familiarise with standard procedures used in food and water testing laboratories		
	3	Policies on food security and food safety		

Books and References:

1. Nielsen, S. S. (Ed.). (2017). *Food analysis* (5th ed.). Springer.
2. Nielsen, S. S. (2010). *Principles of food analysis: For filth adulteration, pesticides, and marine toxins*. Springer.
3. Murthy, P. S. (2015). *Analytical techniques in food safety: A laboratory manual*. John Wiley & Sons.

4. Rao, V. R. S., & Narayanan, S. S. (2018). *Food analysis*. CBS Publishers & Distributors.
5. Nielsen, S. S., & Almeida, L. M. S. F. (2018). *Handbook of food analysis*. CRC Press.
6. Krishnamoorthy, G. (2016). *Food safety analysis: Biosensor based approaches*. Springer.
7. Salvi, D. N. (2014). *Practical food microbiology and technology*. Springer.
8. Qader, N., & Rajan, R. (2017). *Microbiological examination methods of food and water: A laboratory manual*. CRC Press.
9. Young, A. H. (2015). *Analytical chemistry in a GMP environment: A practical guide.* John Wiley & Sons.
10. Ananthanarayan, R., & Paniker, C. K. J. (2017). *Practical microbiology and analytical techniques*. Universities Press.

Mapping of COs with PSOs and POs:

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1				3	2	1			
CO2	2	1		3			2	3	1			
CO3		3	2	1				2	3	1		
CO4	1		3	2			1		3	2	1	
CO5		1	2	3				1	2	3	1	2

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (30%)
- Practical Assessment
- End semester Exam (70%)

Mapping of COs to Assessment Rubrics:

CO	Internal Exam	Assignment	End Semester Examination
CO1	✓	✓	✓
CO2	✓	✓	✓
CO3	✓	✓	✓
CO4	✓	✓	✓
CO5	✓	✓	✓

MBY6EJ306 (3)-FOOD AND WATER BORNE DISEASES

Programme	B. Sc. Microbiology				
Course Code	MBY6EJ306 (3)				
Course Title	Food and water borne diseases				
Type of Course	Major-Elective				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Nil				
Course Summary	This course provides an overview of the microbial pathogens and toxins associated with food and water borne diseases, their epidemiology, transmission routes, clinical manifestations, diagnosis, treatment, and prevention strategies. Emphasis will be placed on understanding the microbiological, epidemiological, and public health aspects of food and water borne diseases.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the etiology, epidemiology, and transmission routes of common food and water borne pathogens.	R	F	Quizzes, Assignments
CO2	Recognize the clinical manifestations, diagnostic methods, and treatment options for food and water borne diseases.	U	C	Midterm Examination
CO3	Evaluate the role of food safety measures, water sanitation practices, and public health interventions in preventing food and water borne illnesses.	E	F	Quizzes, Assignment, Case Study Analyses
CO4	Analyze case studies and outbreaks of food and water borne diseases to identify contributing factors and recommend control measures.	An	F	Assignment, Quizzes, Midterm Examinations
CO5	Develop effective communication skills for disseminating information on food and water safety practices to the public.	Ap	M	Assignment, Quizzes, Midterm Examinations

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (48+12)	Marks (70)
I	**Introduction to Food and Water Borne Diseases**		**12**	**10**
	1	Definition, scope, and significance of food and water borne diseases		
	2	Historical perspectives and major outbreaks of food and water borne illnesses		
	3	Epidemiology of food and water borne diseases: global burden and trends		
	4	Routes of transmission: foodborne, waterborne, and fecal-oral transmission		
	5	Factors influencing the incidence and spread of food and water borne diseases		
	6	Surveillance systems and outbreak investigations of food and water borne illnesses		
II	**Microbial Pathogens in Food and Water**		**12**	**20**
	7	Bacterial pathogens: Salmonella, Escherichia coli,		
	8	Bacterial pathogens: Campylobacter, Listeria, Vibrio, etc.		
	9	Viral pathogens: Norovirus, Hepatitis A virus, Rotavirus, etc.		
	10	Parasitic pathogens: Giardia, Cryptosporidium, Entamoeba, etc.		
	11	Toxigenic pathogens: Clostridium botulinum, Staphylococcus aureus, Bacillus cereus, etc.		
III	**Clinical Manifestations and Diagnosis**		**12**	**20**
	12	Gastrointestinal symptoms: diarrhea, vomiting, abdominal pain, etc		
	13	Extraintestinal manifestations: hepatitis, meningitis, septicemia, etc.		
	14	Laboratory methods for detecting food and water borne pathogens: culture, serological,		
	15	Laboratory methods for detecting food and water borne pathogens: molecular methods		
IV	**Treatment, Prevention and Control Strategies**		**12**	**20**
	16	Antimicrobial therapy for bacterial infections		
	17	Supportive care and fluid replacement therapy		
	18	Prevention of complications and sequelae associated with food and water borne diseases		
	19	Food safety practices: Hazard Analysis Critical Control Points (HACCP), Good Hygiene Practices (GHP), etc.		
	20	Water sanitation measures: chlorination, filtration, boiling, etc.		
	21	Public health interventions: health education, surveillance, regulation, etc.		

	22	Challenges and opportunities in food safety and water sanitation		
V	**Open Ended**		**12**	
	1	Emerging pathogens and trends in food and water borne diseases		

Books and References:

1. Griffin, P. M., Tauxe, R. V., Kock, M. E., & Osterholm, R. M. (2021). *Food and waterborne diseases in the United States: A public health handbook*. Centers for Disease Control and Prevention.
2. Heymann, D. L. (Ed.). (2015). *Control of communicable diseases manual* (20th ed.). American Public Health Association.
3. Dolan, C. T., & Law, B. A. (2019). *Foodborne diseases*. Academic Press.
4. Riemann, H., & Bryan, M. (2018). *Foodborne infections and intoxications* (4th ed.). Academic Press.
5. Singh, R. K., & Mishra, A. (2022). *Emerging food and waterborne diseases in India*. Springer.
6. Tiwari, R., & Sharma, A. (2020). *Food and water safety: Strategies for developing countries*. Springer.
7. Narrod, P., & Ollinger, C. (Eds.). (2023). *Foodborne illness: Latest trends, prevention strategies, and control measures*. Wiley.

Mapping of COs with PSOs and POs :

CO	PSO1	PSO 2	PSO 3	PSO 4	PSO5	PSO6	PO 1	PO 2	PO 3	PO 4	PO 5	PO6
CO1	3	2	1				3	2	1			
CO2	2	3	1				2	3	1	2		
CO3	1	2	3				1	2	3	1	2	
CO4		1	2	3				1	2	3	1	2
CO5			1	2	3				1	2	3	3

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (30%)
- Practical Assessment
- End semester Exam (70%)

Mapping of COs to Assessment Rubrics :

CO	Internal Exam	Assignment	End Semester Examination
CO1	✓	✓	✓

CO2	✓		✓
CO3	✓	✓	
CO4	✓	✓	
CO5	✓	✓	

MBY6EJ 307.MICROBIAL TAXONOMY

Programme	B. Sc. Microbiology				
Course Code	MBY6EJ 307				
Course Title	Microbial Taxonomy				
Type of Course	Major- Elective				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	0	60
Pre-requisites	Nil				
Course Summary	This course provides a detailed exploration of microbial taxonomy, covering the classification, nomenclature, and identification of various microbial species. It emphasizes understanding the historical development, current methods, and applications of microbial classification systems.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the historical and conceptual development of microbial taxonomy.	U	C	Internal Exam, End Semester Exam
CO2	Describe the criteria and techniques used for classifying microorganisms, including phenotypic and genotypic methods.	U	C	Internal Exam, End Semester Exam
CO3	Analyze the roles and implications of microbial taxonomy in scientific research and its applications in health and environment.	An	C	Internal Exam, End Semester Exam
CO4	Evaluate modern approaches in microbial taxonomy, including molecular methods and metagenomics.	E	C	Internal Exam, End Semester Exam
CO5	Critically assess the challenges and emerging trends in microbial taxonomy.	E	C	Internal Exam, End Semester Exam

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45+30)	Marks (70)
I	**Introduction to Microbial Taxonomy**		**12**	**10**
	1	Microbial diversity		
	2	Hierarchical organization and position of microbes in the living world.		
	3	Haeckel's three kingdom classification		
	4	Whittaker's five kingdom approach		
	5	Three domain classification of Carl Woese		
	6	Historical development of microbial taxonomy		
II	**Basics of microbial taxonomy**		**12**	**20**
	7	Concept of species and taxa and strain.		
	8	Nomenclature and classification rules.		
	9	Classification systems- Numerical taxonomy or Adansonian classification		
	10	Phenetic and phylogenetic Classification.		
	11	Chemotaxonomy		
III	**Identification of Microorganisms**		**12**	**20**
	12	Various criteria used in bacterial classification- morphological, physiological characteristics		
	13	Metabolic, biochemical characteristics		
	14	Nutritional and Ecological characteristics.		
	15	Molecular characteristics- comparison of proteins, Aminoacid sequencing		
	16	Nucleic acid base composition, Nucleic acid hybridization		
	17	Nucleic acid sequencing		
	18	Ribotyping, 16 S rRNA studies.		
IV	**Microbial Taxonomy -Applications, recent advances and challenges**		**12**	**20**
	19	Importance of microbial taxonomy in various scientific disciplines.		
	20	Emerging trends in microbial taxonomy research		
	21	Challenges in classifying unculturable microorganisms		
	22	Metagenomics and its impact on microbial taxonomy		
V	**Open ended**		**12**	
	1	Bergey's Manual of Systematic Bacteriology: Brief outline- review/assignment.		
	2	Classification systems in fungus and their different classes- review/assignment.		
	3	Classification of protozoa- review/assignment.		
	4	Use of bioinformatics tools for identification of microorganisms		

Books and References:

- Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., Stahl, D. A., & Brock, T. D. (2022). *Brock biology of microorganisms* (16th ed.). Pearson.
- Atlas, R. M. (1997). *Principles of microbiology* (2nd ed.). Wm. C. Brown Publishers.
- Black, J. G., & Black, L. J. (2018). *Microbiology: Principles and explorations* (10th ed.). Wiley.
- Salle, A. J. (2007). *Fundamental principles of bacteriology* (Reprint of the 2nd ed., 6th impression 1943). Envins Press.
- Tortora, G. J., Funke, B. R., & Case, C. L. (2019). *Microbiology: An introduction* (13th ed.). Pearson.

Mapping of COs with PSOs and POs :

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		2		1		3		1		2	
CO2	2	3					2	3	2	1	3	
CO3		2	3			1		3	3	2	2	1
CO4		3		3				3		3		2
CO5			3		3					3	3	

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (30%)
- Practical Assessment
- Endsemester Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	End Semester Examinations
CO 1	✓		✓
CO 2	✓		✓
CO 3	✓	✓	✓
CO 4	✓	✓	✓
CO 5	✓	✓	✓

MBY6EJ 308. BIOSAFETY AND BIOETHICS

Programme	B. Sc. Microbiology				
Course Code	MBY6EJ 308				
Course Title	Biosafety and Bioethics				
Type of Course	Major-Elective				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Nil				
Course Summary	This course introduces students to the ethical aspects of conducting research and practicals, and the safety aspects to be adhered to in labs and research environments, promoting responsible conduct in science.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe various biohazards and biosafety levels.	U	C	Internal Exam, End Semester Exam
CO2	Explain the role of Biosafety guidelines by the Government of India and risk analysis and assessment.	U	C	Internal Exam, End Semester Exam
CO3	Understand the concept of introducing genetically modified organisms (GMOs) and biosafety during industrial production.	U	C	Internal Exam, End Semester Exam
CO4	Discuss the principles of Bioethics and ethical implications of biotechnology.	U	C	Internal Exam, End Semester Exam
CO5	Assess the impact of ethical considerations in the development and application of biotechnological innovations.	An	C	Internal Exam, End Semester Exam

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P)

Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (48+12)	Marks (70)
I	**Biosafety**		**10**	**10**
	1	Introduction to Biosafety , Definition		
	2	Objectives of safety guidelines and biosafety issues		
	3	Safety Cabinets & their types; Primary Containment for Biohazards;		
	4	Biosafety levels of specific microorganisms		
	5	Applications of different levels of Biosafety		
	6	Hazardous materials used in Biotechnology- Handling and Disposal		
II	**Risk Assessment**		**10**	**20**
	7	Physical containment		
	8	Biological containment		
	9	Assessment of risks during laboratory research		
	10	Risk assessment for biotechnology products		
	11	Biosafety Guidelines: Biosafety guidelines and regulations (National and International);Role of Institutional biosafety committee		
III	**Genetically Modified Organisms**		**13**	**20**
	12	Concept of Genetically Modified Organisms(GMOs)		
	13	Egs of genetically modified organisms, plants and animals		
	14	RCGM,GEAC for GMO applications in food and agriculture		
	15	Environmental release of GMOs; Risk analysis, Risk assessment , Risk management and communication		
	16	Genetic manipulations and their ethical issues.		
IV	**Bioethics**		**15**	**20**
	17	Introduction to Bioethics		
	18	Applications of Bioethics		
	19	Human Genome project and its ethical issues.Ethical, legal and social implications of the human genome project.		
	20	Molecular detection of presymptomatic genetic diseases and its importance in health care.		
	21	Ethical issues of Prenatal Diagnosis.		
	22	Ethical issues related to testing of Drugs on Human Volunteers		
V	**Open Ended**		**12**	
	Case studies- Biosafety related incidents			
	Discussion on policies of bioethcs			
	Field trip and site visit			
	Community engagement projects			

Books and References:

1. Bioethics: An introduction for the Biosciences by Ben Mepham
2. Bioethics and Biosafety by Satheesh MK.

Mapping of COs with PSOs and POs :

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3			1			3		1		2	
CO2	2	3					2	3	2	1	3	
CO3	1		3				1		3	2	2	1
CO4		3		3				3		3		2
CO5			3		3					3	3	3

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	End Semester Examinations
CO 1	✓		✓
CO 2	✓	✓	✓
CO 3	✓		✓
CO 4	✓	✓	✓
CO 5	✓	✓	✓

MBY8EJ 401. CELL BIOLOGY

Programme	B. Sc. Microbiology				
Course Code	MBY8EJ 401				
Course Title	Cell Biology				
Type of Course	Major-Elective				
Semester	VIII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4		-	60
Pre-requisites	Nil				
Course Summary	This course offers in-depth knowledge about the function and structure of cells and cellular components. It provides foundational insights into cell theory, cellular processes including cell division and apoptosis, and explores the implications of these processes in ageing and cancer.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the structure and roles of various cellular organelles and molecules.	U	C	Internal Exam, End Semester Exam, Assignment
CO2	Analyze the mechanisms of cell signaling and communication pathways.	An	C	Internal Exam, End Semester Exam, Assignment
CO3	Evaluate the regulation mechanisms of the cell cycle and their implications in cancer.	E	C	Internal Exam, End Semester Exam, Assignment
CO4	Discuss the molecular basis of cell aging and death, including apoptosis and necrosis.	An	C	Internal Exam, End Semester Exam, Assignment
CO5	Critically assess the impact of cellular malfunctions on human health and disease, including cancer.	E	C	Internal Exam, End Semester Exam, Assignment

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (48 +12)	Marks (70)
I	Introduction to Cell Biology		**10**	**10**
	1	Historical perspective		
	2	Cell Theory.		
	3	Prokaryotes, Eukaryotes		
	4	Stem cells		
	5	Overview of techniques in cell biology		
II	Cell and its constituents		**12**	**20**
	6	Plasma membrane: Structure, Functions of plasma membrane. Transport across the membrane.		
	7	Cytoskeleton, Cytoplasm, Structure and functions of Nucleus, Nucleolus, Chromosomes, Nucleosomes, Histones Centrosome		
	8	Mitochondria, Endoplasmic reticulum, Golgi apparatus, Chloroplast, Ribosomes, Peroxisomes, Lysosome, endosomes,		
III	Cell signalling, Cell Division, Cell Cycle and Cancer		**16**	**24**
	9	Signal transduction pathways		
	10	Receptor-ligand interactions		
	11	Intracellular signaling		
	12	Tight junctions and gap junctions		
	13	Different stages of mitosis, Different stages of meiosis.		
	14	Cell cycle components and checkpoints, Role of cyclins and Cdks in cell cycle regulation.		
	15	Cancer - Benign and Malignant. Stages in cancer development and causes. Properties of cancerous cells.		
	16	Oncogenes, Tumour suppressor genes		
IV	Ageing and Cell Death		**10**	**16**
	17	Process of Ageing, Theories of Ageing		
	18	Necrosis, Programmed Cell Death- Apoptosis.		
	19	Difference between necrosis and apoptosis		
	20	Mechanisms of apoptosis		
	21	Bax, Bid, Bcl2 proteins		
	22	Apoptosis in cancer and organ transplants.		
V	Open Ended		**12**	
	Higher level Problem solving sessions			
	Anti-ageing strategies: Discuss the pros and cons			
	The situations around us that leads to cancer development			

Books and References:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). *Molecular Biology of the Cell* (6th ed.). Garland Science.
2. Cooper, G. M., & Hausman, R. E. (2019). *The Cell: A Molecular Approach* (8th ed.). Sinauer Associates.
3. Karp, G. (2019). *Cell and Molecular Biology: Concepts and Experiments* (8th ed.). Wiley.
4. Pollard, T. D., Earnshaw, W. C., Lippincott-Schwartz, J., & Johnson, G. T. (2017). *Cell Biology* (3rd ed.). Elsevier.
5. Lodish, H., Berk, A., Zipursky, S. L., Matsudaira, P., Baltimore, D., & Darnell, J. (2016). *Molecular Cell Biology* (8th ed.). W. H. Freeman.

Mapping of COs with PSOs and POs :

CO	PSO 1	PS O2	PS O3	PSO 4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3			1		2	3	1		2	
CO2	3		3				3		3	2	3	1
CO3		2	3	3				2	3	3	3	2
CO4	1			3	2		1			3	3	2
CO5			3		3					3	3	3

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (30%)
- Practical Assessment
- Endsemester Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5	✓	✓		✓

MBY8EJ 402-CELL AND TISSUE CULTURE

Programme	B. Sc. Microbiology				
Course Code	MBY8EJ 402				
Course Title	Cell and Tissue Culture				
Type of Course	Major-Elective				
Semester	VIII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4		-	60
Pre-requisites	Nil				
Course Summary	This Elective course covers the fundamental aspects of Cell and Tissue Culture, culture media components, types of plant and animal cell culture, applications of plant and animal cell culture technique, transgenic plants and animals. It provides students with theoretical knowledge and helps them to identify the applications of cell culture techniques.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand basic techniques and requirements of tissue culture.	U	C	Internal Exam, Assignments
CO2	Apply techniques to plant and animal cells.	Ap	F	Internal Exam
CO3	Analyze outcomes from culture techniques.	An	C	Internal Exam, Assignments
CO4	Assess the ethical and safety considerations in tissue culture.	E	C	Assignments, End-Sem Exam
CO5	Create experimental protocols for applications.	C	F	Assignments, Projects

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
\# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45+30)	Marks (70)
I	Introduction to Plant and Animal tissue culture		**10**	**15**
	1	Introduction to Plant and Animal tissue culture		
	2	Basic laboratory requirements for tissue culture		
	3	Maintenance of sterile conditions		
	4	Testing the viability of cells and dye exclusion methods		
	5	Types of media used and its formulations.		
II	Animal cell culture		**10**	**15**
	6	Animal cell culture media and its type		
	7	primary culture, cell lines and types- finite cell lines, continuous cell lines,		
	8	monolayer and suspension cultures, organ culture.		
	9	Maintenance of cell lines-Contamination of cell lines, replacement of Medium and Subculture		
III	Plant cell tissue culture		**15**	**25**
	10	Plant cell tissue culture Media components,		
	11	Role of hormones in Plant tissue culture media		
	12	Plant hormones: Auxins, cytokinins, Gibberellins, Abscisic Acid, ethylene.		
	13	Plant tissue culture techniques- explant culture, callus culture		
	14	Cell or suspension culture- filter paper raft nurse tissue technique, micro chamber technique		
	15	Protoplast culture and somatic hybridization		
IV	Applications of Plant and Animal tissue culture		**10**	**15**
	17	Applications of animal tissue culture - Animal cell culture as a substitute for animal experiments,		
	18	Stem cell culture and its applications		
	19	Brief account on Transgenic Plants and Animals		
	20	Applications of plant tissue culture - Somatic embryogenesis, Crop improvement, Clonal propagation, Production of pathogen free plants, Production of seedless plants, synthetic seeds,		
	21	Production of secondary metabolites from plant cell suspension culture		
	22	Brief account on transgenic plants- Herbicide resistant plants, insect-resistant plants.		
V	Open ended		**30**	
	1	Assignments/Seminars on the above topics, Cell Bank, Cryopreservation, Cloning		
	2	Industrial visit to Agricultural Nurseries having plant		

		tissue culture facility		
	3	Lab Visit to animal cell culture facilities, demonstration sessions on cell viability assays in lab, etc		

Books and References:

1. Freshney, R. I. (2005). *Culture of animal cells: A manual of basic technique and specialized applications* (6th ed.). Wiley-Liss.
2. Vidyasekaran, P. (2010). *Genetic engineering, molecular biology, and tissue culture for crop pest and disease management*. Paya Publishing.
3. Ho, C. S., & Wang, D. I. C. (1995). *Animal cell reactors*. Butterworth-Heinemann.
4. Grierson, D., & Covey, S. N. (1988). *Plant molecular biology* (2nd ed.). Chapman and Hall.
5. Glick, B. R., & Pasternak, J. J. (2003). *Molecular biotechnology: Principles and applications of recombinant DNA* (3rd ed.). ASM Press.

Mapping of COs with PSOs and POs:

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3						2		1			
CO2	2	3					1	2				
CO3	1	2	3					1	2			
CO4		1	2	3					1	2	3	
CO5			1	2	3					1	2	3

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (30%)
- Practical Assessment
- End semester Exam (70%)

Mapping of COs to Assessment Rubrics :

CO	Internal Exam	Assignments	End Semester Exam
CO1	✓	✓	✓
CO2	✓		✓
CO3	✓	✓	✓
CO4	✓	✓	✓
CO5	✓	✓	

MBY8EJ 403. PLANT PATHOLOGY

Programme	B. Sc. Microbiology				
Course Code	MBY8EJ 403				
Course Title	Plant Pathology				
Type of Course	Major-Elective				
Semester	VIII				
Academic Level	400 - 499.				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Nil				
Course Summary	This course explores the essentials of plant pathology including the mechanisms of disease development, pathogenic interactions, and control methods. It emphasizes bacterial, fungal, viral, and nematode diseases of plants, covering pathogen identification, disease cycle, and modern management strategies.				

Course Outcomes (CO): .

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Define plant diseases and understand the disease cycle and pathogenicity.	U	C	Quizzes, Midterm Exam
CO2	Classify plant diseases and recognize different types of plant pathogens.	R	F	Assignments, End Semester Examinations
CO3	Explain the processes involved in plant disease development including infection and dissemination.	U	C	Instructor-created exams, Quizzes
CO4	Evaluate plant defense mechanisms including induced systemic resistance (ISR) and systemic acquired resistance (SAR).	E	F	Project Evaluation, End Semester Examinations
CO5	Implement strategies for the chemical and biological control of plant diseases.	Ap	F	Practical Assessments, Lab Reports
CO6	Conduct surveys of plant diseases and apply control measures, identifying diseases by their symptoms and causative organisms.	U	F	Quizzes, Final Exam

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (48+12)	Marks (70)
I	**Concepts of plant diseases**		**10**	**15**
	1	Definition of Disease		
	2	Disease cycle and its pathogenicity. Signs and Symptoms associated with Microbial plant diseases		
	3	Classification of plant diseases		
	4	Types of plant pathogens		
	5	Contributions in the field of plant pathology		
II	**Plant Disease development**		**12**	**15**
	6	Infection, Invasion, colonization, Dissemination of pathogens		
	7	Concepts of monocyclic, polycyclic and polyetic diseases		
	8	Disease triangle and Disease pyramid		
	9	Plant defense mechanisms - Physical, Biochemical, ISR and SAR.		
III	**Plant Diseases**		**14**	**25**
	10	Bacterial diseases - Angular leaf spot of cotton, Leaf blight of rice		
	11	Bacterial disease- Crown Gall, Citrus Canker		
	12	Fungal disease- Red rot of sugarcane - *Colletotrichum falcatum*, Wilt of tomato -*Fusarium oxysporum*		
	13	Fungal disease- Early blight of potato -*Alternaria solani*, Wilt of cotton		
	14	Viral diseases- Papaya ring spot, Tomato Yellow Leaf Curl,		
	15	Viral diseases- Banana Bunchy top, Tobacco Mosaic		
	16	Nematode Diseases: Root-Knot Nematode and Cyst Nematode		
IV	**Plant disease management/ Control strategies**		**12**	**15**
	17	Chemical means of Disease control - fungicides, virucides		
	18	Chemical means of Disease control - antibiotics, nematicides		
	19	Biological control of plant diseases - Definition, scope and importance		
	20	Biological control of plant diseases-Biopesticides,		
	21	Biological control of plant diseases-Beneficial insects, and PGPR		
	22	Biological control of plant diseases- Endophytes		
V	**Open ended**		**12**	
	1	Survey of plant diseases around the campus		

	2	Application of chemical/biological control measures by student groups		
	3	Visit to agricultural fields/ agricultural research stations.		
	4	Identify the diseases mentioned in the syllabus with respect to causative organisms and symptoms		
	5	Submit herbarium preparations of any three of the diseases mentioned.		

Books and References:

1. Campbell, R. (1987). *Plant Microbiology*. ELBS Edward Arnold, London.
2. Gupta, V. K., & Paul, T. S. (2004). *Fungi & Plant Diseases*. Kalyani Publishers, New Delhi.
3. Hale, M. E. (1983). *The Biology of Lichen (III Edn.)*. Edward Arnold, London.
4. Deacon, J. (2007). *Fungal Biology (IV Edn.)*. Blackwell Publishing, Ane Books Pvt. Ltd.
5. Agrios, G. N. (2005). *Plant Pathology* (5th ed.). Elsevier Academic Press.
6. Strange, R. N., & Scott, P. R. (2005). *Plant Disease: A Threat to Global Food Security*. Annual Review of Phytopathology.
7. Lucas, J. A., Hawkins, N. J., & Fraaije, B. A. (2015). *The Evolution of Fungicide Resistance*. Advances in Applied Microbiology.
8. Jones, J. D. G., & Dangl, J. L. (2006). *The plant immune system*. Nature.
9. Van Alfen, N. K. (Ed.). (2012). *Encyclopedia of Agriculture and Food Systems*. Elsevier.
10. Horst, R. K. (2013). *Westcott's Plant Disease Handbook* (7th ed.). Springer.

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1	3	2	1	2			3	2	1		3	1
CO2	2	3	1				2	3	2	1		
CO3	3	1	2	1			3	1	2	3	1	
CO4	1	2	3				1	3	2	3	2	
CO5	2	1	3	2	3		2	1	3	2	3	1
CO6	3	2	1	3			3	2	1	2	3	2

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (30%)
- Practical Assessment
- End semester Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	Practical Assessment
CO1	✓			
CO2	✓	✓		
CO3	✓	✓		
CO4			✓	
CO5				✓

MBY8EJ 404. MICROBES IN EXTREME ENVIRONMENT

Programme	B. Sc. Microbiology				
Course Code	MBY8EJ 404				
Course Title	Microbes in extreme environment				
Type of Course	Major-Elective				
Semester	VIII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-		60
Pre-requisites	Nil				
Course Summary	This course delves into the ecological and physiological adaptations of microbes thriving in harsh environments. Students will explore the taxonomy, metabolic strategies, and biotechnological applications of extremophiles.				

Course Outcomes (CO): .

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the ecological importance and basic classifications of extremophiles.	U	C	Internal Exam, End Semester Exam
CO2	Describe the physiological and molecular adaptations that allow extremophiles to thrive in harsh conditions.	U	C	Internal Exam, End Semester Exam
CO3	Analyze the applications of extremophiles in biotechnology and industrial processes.	An	C	Internal Exam, End Semester Exam
CO4	Evaluate the potential for extremophiles in future biotechnological applications, including challenges and ethical considerations.	E	C	Internal Exam, End Semester Exam
CO5	Conduct a critical review of current research on extremophiles, synthesizing findings from recent studies.	An	C	Internal Exam, End Semester Exam

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (48+12)	Marks (70)
I	Introduction to Extremophiles		**12**	**15**
	1	Definition of extremophiles		
	2	Importance of extremophiles		
	3	Classification of extremophiles with examples		
	4	Applications of extremophiles		
	5	Extremophiles in bioremediation and biotechnological applications		
II	Acidophiles and Alkalophiles.		**12**	**15**
	6	Acidophiles – Physiology and molecular adaptation		
	7	Applications and examples of acidophiles		
	8	Alkalophiles – Physiology and molecular adaptations		
	9	Applications and examples of alkalophiles		
III	Thermophiles, hyperthermophiles and psychrophiles		**12**	**25**
	10	Thermophiles - physiology and molecular adaptations		
	11	Applications and distribution of Thermophiles		
	12	Hyperthermophiles - physiology and molecular adaptations		
	13	Applications and distribution of Hyperthermophiles		
	14	Psychrophiles – physiology and molecular adaptation		
	15	Applications and distribution of Psychrophiles		
IV	Halophiles and Barophiles		**12**	**15**
	16	Halophiles – physiology & molecular adaptations		
	17	Applications and distribution of Halophiles		
	18	Barophiles – physiology & molecular adaptations		
	19	Applications and distribution of Barophiles		
	20	Industrial applications of halophiles and barophiles		
	21	Genetic tools and manipulation of extremophiles		
	22	Future perspectives and challenges in extremophile research		
V	Open ended		**12**	
	1	Study on metalophiles, radiophiles, and xenobiotic utilizers		

Books and References:

1. Rothschild, L. J., & Mancinelli, R. L. (2001). Life in extreme environments. Reviews in Microbiology.
2. Horikoshi, K., Antranikian, G., Bull, A. T., Robb, F. T., & Stetter, K. O. (Eds.). (2011). Extremophiles Handbook. Springer.
3. Madigan, M. T., & Marrs, B. L. (1997). Extremophiles. Scientific American.

4. Seckbach, J. (Ed.). (2000). Journey to Diverse Microbial Worlds: Adaptation to Exotic Environments. Springer.
5. Gerday, C., & Glansdorff, N. (Eds.). (2007). Physiology and Biochemistry of Extremophiles. ASM Press.
6. van den Burg, B. (Ed.). (2003). Extremophiles as a Source of Novel Enzymes for Industrial Application. Springer.
7. Barton, L. L., & Northup, D. E. (Eds.). (2011). Microbial Ecology. Wiley-Blackwell.
8. Cavicchioli, R. (Ed.). (2007). Extremophiles: Microbiology and Biotechnology. Horizon Scientific Press.
9. Bell, E. (Ed.). (2012). Life at Extremes: Environments, Organisms and Strategies for Survival. CABI.

Mapping of COs with PSOs and POs :

CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1	3	2	1				3	1	2		2	
CO2	2	3					2	3	2	1	3	
CO3	1		3		2		1		3	2	2	1
CO4		3		3				3		3		2
CO5			3		3					3	3	3

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (30%)
- Practical Assessment
- End semester Exam (70%)

Mapping of COs to Assessment Rubrics :

CO	Internal Exam	Assignment	End Semester Examinations
CO1	✓		✓
CO2	✓	✓	✓
CO3	✓	✓	✓
CO4	✓	✓	✓
CO5	✓	✓	✓

MBY8EJ 405-VIROLOGY AND EMERGING MICROBIAL DISEASES

Programme	B. Sc. Microbiology				
Course Code	MBY8EJ 405/MBY6EJ309				
Course Title	Virology and Emerging microbial diseases				
Type of Course	Major-Elective				
Semester	VI				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites					
Course Summary	This course offers in-depth knowledge on viral isolation, cultivation, and the epidemiology of viral diseases. It focuses on the transmission, treatment, and prevention of viral and emerging microbial diseases, alongside developments in vaccine technology.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the general properties of viruses including structure, classification, and cultivation methods.	U	C	Internal Exam, Assignments
CO2	Analyze the pathogenesis, diagnosis, and prophylaxis of key viral infections.	An	C	Assignments, Internal Exam
CO3	Evaluate the public health impact of emerging viral diseases.	E	C	Assignments, Internal Exam, End Semester Exam
CO4	Apply diagnostic techniques for detecting viral infections.	Ap	F	Internal Exam
CO5	Synthesize strategies for the prevention and control of viral diseases including developments in vaccine technology.	C	F	Assignments, End Semester Exam

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (48 +12)	Marks (70)
I	General properties of viruses		12	**15**
	1	Structure and morphology		
	2	Principles of viral classification		
	3	Different methods of cultivation and isolation of viruses- laboratory requirements for cultivation, embryonated egg inoculation, animal inoculation, permissive and non-permissive hosts or cells, tissue culture cell lines; detection of viral growth in cell culture		
	4	Replication of viruses - lytic and lysogenic cycles		
	5	Viral inclusion bodies - methods of staining and demonstration		
II	Knowledge about medically important DNA and RNA viruses		**12**	**15**
	6	Pathogenesis, laboratory diagnosis and prophylaxis of following infections - small pox, chicken pox, shingles.		
	7	Pathogenesis, laboratory diagnosis and prophylaxis of - infectious mononucleosis, cytomegalo virus		
	8	Pathogenesis, laboratory diagnosis and prophylaxis of - polio, influenza, rabies.		
	9	Pathogenesis, laboratory diagnosis and prophylaxis of - hepatitis, HIV, viral hemorrhagic fever, slow virus diseases.		
	10	Pathogenesis, laboratory diagnosis and prophylaxis of mumps, measles, and rubella		
III	Emerging microbial diseases		**12**	**25**
	11	SARS and Nipah virus		
	12	Ebola virus		
	13	Zika virus		
	14	Yellow fever and Japanese encephalitis		
	15	Dengue, chikun gunya, swine flue		
IV	Viral diagnosis		**12**	**15**
	16	Collection, preservation, transportation, and processing of viral specimen		
	17	Isolation and identification of specimen for viral diagnosis		
	18	Serological diagnosis of viral infection - Paul Bunnel test, haemagglutination and haemagglutination inhibition test, viral neutralization test, immunofluorescence.		
	19	Principles of immunoblotting techniques - southern and northern blotting		
	20	Principles of Luminescence assay, PCR and its applications		

	21	Types of viral vaccines Role of genetic engineering in vaccine development		
V	Open Ended		**12**	
		Visit to virology laboratories		
		Data collection related to viral infection outbreaks		

Reference books:

1. Carter, J., & Saunders, V. (2016). *Virology: Principles and Applications* (2nd ed.). Wiley.
2. Racaniello, V. R. (2019). *Principles of Virology*. ASM Press.
3. Knipe, D. M., & Howley, P. M. (Eds.). (2018). *Fields Virology: Emerging Viruses* (7th ed., Vol. 2). Wolters Kluwer Health/Lippincott Williams & Wilkins.
4. Modrow, S., Falke, D., Truyen, U., & Schätzl, H. (2019). *Molecular Virology*. Springer.
5. Nathanson, N. (Ed.). (2017). *Viral Pathogenesis: From Basics to Systems Biology* (3rd ed.). Academic Press.
6. Zuckerman, A. J., Banatvala, J. E., Schoub, B. D., Griffiths, P. D., & Mortimer, P. (Eds.). (2018). *Principles and Practice of Clinical Virology* (7th ed.). Wiley.

Mapping of COs with PSOs and POs:

CO	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1				3	1	2		2	1
CO2	2	3		1			2	3	2	1	3	
CO3	3	2	1				3	2	3	2	2	1
CO4	1	2	3				1	2	3	3		2
CO5	2	1		3		3	2	3	1	2	3	1

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (30%)
- Practical Assessment
- End semester Exam (70%)

Mapping of COs to Assessment Rubrics:

CO	Internal Exam	Assignments	End Semester Exam
CO1	✓	✓	
CO2	✓	✓	
CO3	✓	✓	✓
CO4	✓		
CO5		✓	✓

MBY8EJ 406-PLANT-DERIVED ANTIMICROBIALS

Programme	B. Sc. Microbiology				
Course Code	MBY8EJ 406				
Course Title	Plant-Derived Antimicrobials				
Type of Course	Major-Elective				
Semester	VIII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	Nil				
Course Summary	This course delves into the world of plant-derived antimicrobials, exploring their extraction, mechanisms of action, and ethical applications.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the historical and current perspectives on the use of plant-derived compounds as antimicrobial agents.	U	C	Internal Exam, End Semester Exam
CO2	Explain the biochemical mechanisms through which plant-derived antimicrobials act against pathogens.	U	C	Assignments, Internal Exam, End Semester Exam
CO3	Apply laboratory techniques for extracting and testing the efficacy of plant-derived antimicrobials.	Ap	F	Assignments, Internal Exam, End Semester Exam
CO4	Analyze the role of these antimicrobials in various sectors and their potential in addressing global challenges like antibiotic resistance.	An	C	Assignments, Internal Exam, End Semester Exam
CO5	Evaluate the ethical, environmental, and socio-economic factors influencing the use of plant-derived antimicrobials.	E	C	Assignments, Internal Exam, End Semester Exam
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	Unit	Content	Hrs (48+12)	Marks (70)
I	Introduction to Plant-Derived Antimicrobials		**12**	**10**
	1	Definition and significance of plant-derived antimicrobials		
	2	Historical perspectives		
	3	Importance of plant based antimicrobials in traditional medicines		
	4	Plants with antimicrobial property		
II	Chemical Diversity of Plant-Derived Antimicrobials		**12**	**20**
	5	Overview of phytochemicals with antimicrobial properties		
	6	Classification of antimicrobial compounds from plants (phenolics, alkaloids, terpenoids, etc.)		
	7	Plant derived antimicrobial peptides		
	8	Spectral activity against bacteria, fungi, viruses, and parasites		
	9	Sources and distribution		
	10	Extraction techniques		
	11	Purification and isolation		
	12	Factors influencing antimicrobial activity		
III	Mechanisms of Action		**12**	**20**
	13	Chemical nature		
	14	Target sites and mechanism of action.		
	15	Evolution of resistance mechanisms		
	16	Toxicological concerns and safety assessment		
	17	Determination of minimum inhibitory concentration (MIC) and minimum bactericidal/fungicidal concentration (MBC/MFC)		
IV	Applications of Plant-Derived Antimicrobials		**12**	**20**
	18	Medical applications		
	19	Food preservation and safety		
	20	Agricultural applications		
	21	Cosmetics and personal care products		
	22	Synergistic effects and combinational therapies		
	Open Ended		**12**	
	Collection of literature related to plant derived antimicrobials and organize a group discussion on the group and mode of action.			
	Assign students with different plants of medical importance and the entire antimicrobial compounds already reported from that plant to be identified and presented.			

Books and References:

1. Nicoletti, M. (2007). *Medicinal Plants: Chemistry and Properties*. Science Publishers.
2. Muñoz-Torrero, D. (Ed.). (2009). *Plant-Derived Antimicrobials: A Review on Their Antibacterial Mechanisms, Toxicity, and Application*. CRC Press.

3. Srinivasan, R. V. (2011). *Bioactive Compounds from Plants: An Overview*. Wiley.
4. Brahmachari, G. (Ed.). (2012). *Natural Products as Antiviral Agents*. Springer.
5. Sharma, R. (2013). *Phytochemicals: Extraction Methods, Basic Structures and Mode of Action as Potential Chemotherapeutic Agents*. Nova Science Publishers.
6. Brice, R. (Ed.). (2014). *Antimicrobial Agents: Chemistry, Mode of Action, Mechanisms of Resistance, and Clinical Applications*. Wiley.
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8. Rao, V., & Rao, L. G. (Eds.). (2009). *Phytochemicals as Bioactive Agents*. CRC Press.
9. Brar, S. K., & Singh, G. (Eds.). (2016). *Pharmacognosy: Fundamentals, Applications and Strategies*. Academic Press.
10. Crozier, A., Ashihara, H., & Tomás-Barberán, F. (Eds.). (2006). *Plant Secondary Metabolites: Occurrence, Structure and Role in the Human Diet*. Wiley.
11. Kaur, S., & Singh, G. (Eds.). (2015). *Phytochemicals: A Global Perspective of Their Role in Nutrition and Health*. InTech.

Mapping of COs with PSOs and POs :

CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1	3	2	1				3	2	1		2	
CO2	2	3					2	3	2	1	3	
CO3		2	3		1		1	3	3	2	2	1
CO4	1			3	2		1			3		2
CO5			3		3					3	3	3

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (30%)
- Practical Assessment
- End semester Exam (70%)

Mapping of COs to Assessment Rubrics :

CO	Internal Exam	Assignment	End Semester Examination
CO1	✓		✓
CO2	✓	✓	✓
CO3	✓	✓	✓
CO4	✓	✓	✓
CO5	✓	✓	✓

MBY8EJ 407. DEVELOPMENTAL BIOLOGY

Programme	B. Sc. Microbiology				
Course Code	MBY8EJ 407				
Course Title	Developmental Biology				
Type of Course	Major-Elective				
Semester	VIII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	4	-	-	60
Pre-requisites	A basic understanding of biology, cell biology, genetics, and embryonic development				
Course Summary	This developmental biology course comprehensively overviews the fundamental principles governing the development of multicellular organisms. Spanning five units, it covers key topics such as cell division, differentiation, and morphogenesis in animals and plants				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the key concepts and principles of developmental biology.	U	C	Internal Exam, End Semester Exam
CO2	Understand the evolution of cellular processes in developmental biology.	U	C	Assignments, Internal Exam, End Semester Exam
CO3	Master key developmental concepts like fate maps and stem cells.	U	C	Assignments, Internal Exam, End Semester Exam
CO4	Follow the journey from reproduction to organ formation.	U	C	Assignments, Internal Exam, End Semester Exam
CO5	Grasp how bodies develop and grow from patterns to organs.	U	C	Assignments, Internal Exam, End Semester Exam

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (48+12)	Marks (70)
I	Introduction & Basic Concepts of Developmental Biology		**10**	**10**
	1	Historical perspectives	1	
	2	Cellular processes in development: cell division, differentiation, and Morphogenesis	3	
	3	Basic Concepts of Development- Fate maps, Commitment	3	
	4	Differentiation and Totipotency Morphogenic gradient, Stem cells	3	
II	Sexual reproduction		**10**	**10**
	5	Production of gametes, Fertilization	3	
	6	Cleavage and blastulation, Formation of germ layers	3	
	7	Embryonic Development- Gastrulation, Extraembryonic membranes, Neurulation	4	
III	Morphogenesis and organogenesis in animals		**14**	**25**
	8	Cell aggregation and differentiation in *Dictyostellium*	1	
	9	Axis and pattern formation in *Drosophila*	1	
	10	Vulva formation in *Caenorhabdtis elegans*	1	
	11	Eye lens induction, Limb development in vertebrates	2	
	12	Heart development	2	
	13	Kidney development	1	
	14	Differentiation of neurons and development of the nervous system	2	
	15	Development of the reproductive system	2	
	16	Metamorphosis, Regeneration & sex determination	2	
IV	Stem Cells and Developmental Genetics		**14**	**25**
	17	Apoptosis, Extrinsic pathway of apoptosis, Intrinsic pathway of apoptosis, Ageing, Cellular senescence	2	
	18	Basics of stem cell biology, Regeneration in different organisms	1	
	19	Applications of stem cells in medicine	2	
	20	Environmental Influences on Development- Developmental plasticity, Teratogens and developmental disorders, Epigenetic regulation of development	3	
	21	Developmental Genetics- Genetic regulation of development, Homeotic genes and pattern formation	3	
	22	Mutations and developmental disorders	3	
V	Open Ended- Plant Development Biology		**12**	
	1	Gamete production in Angiosperms, Pollination, Fertilization, Embryonic development, Dormancy, Vegetative growth, Floral signals		

Books and References:

1. Wolpert, L., Tickle, C., & Arias, A. M. (2015). *Principles of development* (5th ed.). Oxford University Press.
2. Gilbert, S. F. (2019). *Developmental biology* (12th ed.). Sinauer Associates.
3. Gilbert, S. F., & Barresi, M. J. F. (2016). *Developmental biology* (11th ed.). Sinauer Associates.
4. Slack, J. M. W. (2013). *Essential developmental biology* (3rd ed.). Wiley-Blackwell.
5. Barresi, M. J. F., & Gilbert, S. F. (2018). *Developmental biology* (12th ed.). Sinauer Associates.
6. Wolpert, L. (2011). *Developmental biology: A very short introduction*. Oxford University Press.
7. Moore, K. L., Persaud, T. V. N., & Torchia, M. G. (2018). *The developing human: Clinically oriented embryology* (11th ed.). Elsevier.

Mapping of COs with PSOs and POs :

CO	PSO1	PSO2	PSO3	PSO 4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		2		1		3		2		1	2
CO2	2	3				2	2	3		3		3
CO3		2	3		1	1	3	2	2	2	1	
CO4	1			3	2	1	1		3	3	2	1
CO5		3		3			3	3		3		3

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (30%)
- Practical Assessment
- End semester Exam (70%)

Mapping of COs to Assessment Rubrics :

CO	Internal Exam	Assignment	End Semester Examination
CO1	✓		✓
CO2	✓	✓	✓
CO3	✓	✓	✓
CO4	✓	✓	✓
CO5	✓	✓	✓

MINOR COURSES

No	Course	Sem	Code	Title
1	Minor	I	MBY1MN 100	Introduction to Microbiology
2	Minor	I	MBY1MN 101	Microbial Growth
3	Minor	II	MBY2MN 100	Basic Techniques in Microbiology
4	Minor	II	MBY2MN 101	Bacterial infections and Host defense systems
5	Minor	III	MBY3MN 200	Microbial metabolism
6	Minor	III	MBY3MN 201	Applied Microbiology

MBY1CJ 101/ MBY1MN100. INTRODUCTION TO MICROBIOLOGY

Programme	B. Sc. Microbiology				
Course Code	MBY1CJ 101/ MBY1MN100				
Course Title	Introduction to Microbiology				
Type of Course	Major/Minor				
Semester	I				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Nil				
Course Summary	This introductory course covers the fundamental aspects of microbiology, exploring microbial diversity, structure, function, and its impacts on human and environmental health. It provides students with theoretical knowledge and practical skills fundamental for further studies in microbiology and related fields.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the diversity, morphology, and reproduction of bacteria, fungi, and viruses.	U	C	Internal Exam, Assignment, End Semester Examination
CO2	Explain the historical development and scope of microbiology, including the contributions of key scientists.	U	C	Internal Exam, Assignment, End Semester Examination
CO3	Differentiate the fundamental structures of prokaryotic and eukaryotic cells, and describe the major differences.	An	C	Internal Exam, Assignment, End Semester Examination
CO4	Describe the roles of beneficial and harmful microorganisms in various environments.	U	C	Internal Exam, Assignment, End Semester Examination
CO5	Demonstrate basic microbiological laboratory techniques, including microscopy, staining, and culture methods.	Ap	P	Practical Assessment

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45 +30)	Marks (70)
I	**The Microbial World**		**10**	**15**
	1	Bacterial forms and arrangement of cells.		
	2	Morphology of molds and yeasts		
	3	Sexual and asexual reproduction in fungi.		
	4	Viral morphology and replication processes.		
	5	Structure, lytic cycle, and lysogeny of bacteriophages.		
II	**History of Microbiology**		**10**	**15**
	6	Overview of microbiology's scope and its historical development.		
	7	Debate of Spontaneous generation vs. Biogenesis.		
	8	Contributions of Anton van Leeuwenhoek, Joseph Lister, Paul Ehrlich, and other pioneers.		
	9			
III	**Fundamental Structure of Cell**		**15**	**25**
	10	General structure of prokaryotic and eukaryotic cells and their differences.		
	11	Structures of archaebacteria and eubacteria.		
	12	Detailed analysis of bacterial ultrastructure (e.g., glycocalyx, capsule).		
	13	Composition and structure of gram-positive and gram-negative cell walls.		
	14	Cell membrane structure, function, and composition in bacteria and archaea.		
	15	Cytoplasmic structures (e.g., ribosomes, inclusion bodies).		
	16	Endospore formation and sporulation stages.		
IV	**Beneficial & Harmful Microorganisms**		**10**	**15**
	17	Roles of beneficial soil microbes like PGPR and mycorrhizae.		
	18	Biopesticides and biocontrol agents.		
	19	Beneficial microbes in food industries.		
	20	Application of microbes in pharmaceutical industries.		
	21	Overview of pathogenic bacteria, fungi, protozoa, and viruses.		
	22	Impact of microorganisms on human, animal, and plant health.		
V	**Practical Applications in Microbiology**		**30**	
	1	Introduction to laboratory instruments and safety precautions.		
	2	Common methods of sterilization.		
	3	Microscope maintenance and usage.		

Books and References:

1. Atlas, R. M. (1997). Principles of microbiology (2nd ed). Wm. C. Brown Publishers.
2. Black, J. G., & Black, L. J. (2018). Microbiology: Principles and explorations (10th edition). Wiley.
3. Frobisher, M. (Ed.). (1974). Fundamentals of microbiology (9th ed). W. B. Saunders Co.
4. Gladwin, M., Trattler, B., & Mahan, C. S. (2023). Clinical microbiology made ridiculously simple (Edition 9, in color). MedMaster, Inc.
5. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., Stahl, D. A., & Brock, T. D. (2022). Brock biology of microorganisms (Sixteenth edition, global edition). Pearson.
6. Michael J. Pelczar, Chan, E. C. S., Noel R. Krieg, & Merna Foss Pelczar. (2024). Microbiology (5th edition). Affiliated East-West Press Private Limited.
7. Pommerville, J. (2014). Alcamo's fundamental of microbiology (Tenth edition). Jones and Bartlett India Pvt. Ltd.
8. Salle, A. J. (2007). Fundamental principles of bacteriology (Reprint of the 2. ed., 6. impression 1943). Envins Press.
9. Stanier, R. Y. (2003). General Microbiology. (5th ed). Macmillan.
10. Tortora, G. J., Funke, B. R., & Case, C. L. (2019). Microbiology: An introduction (Thirteenth edition). Pearson.
11. Willey, J. M., Sandman, K., Wood, D. H., & Prescott, L. M. (2023). Prescott's microbiology (Twelfth edition, international student edition). McGraw Hill.

Mapping of COs with PSOs and POs:

	PSO1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		2	3		3		2	3		3	
CO2	3			2		3		3	3		2	
CO3	3		3			2		3		2	3	
CO4	2	3				2	3	3		2		
CO5		3	3	3					3	3		

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (10%)
- Practical Assessment (20%)
- Endsemester Exam (70%)

Mapping of COs to Assessment Rubrics :

Course Outcome (CO)	Internal Exam	Assignment	End Semester Examination	Practical Assessment
CO1	✓	✓	✓	
CO2	✓	✓	✓	
CO3	✓	✓	✓	
CO4	✓		✓	
CO5				✓

MBY1MN101-MICROBIAL GROWTH

Programme	B. Sc. Microbiology				
Course Code	MBY1MN101				
Course Title	Microbial Growth				
Type of Course	Minor				
Semester	I				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Nil				
Course Summary	This course introduces the fundamental concepts of microbial growth, exploring the nutritional requirements, environmental factors affecting growth, and the applications of understanding microbial growth in various fields.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand various nutrients for microbial growth.	U	P	Internal Exam, Assignment, Practical Assessment, End Semester Examination
CO2	Analyze various factors influencing microbial growth.	Ap	P	Internal Exam, Assignment, Practical Assessment, End Semester Examination
CO3	List and analyze various nutrient transport mechanisms.	An	P	Internal Exam, End Semester, Practical Assessment, Examination
CO4	Implement the knowledge of microbial growth in practical applications.	Ap	P	Internal Exam, End Semester Examination
CO5	Recognize the application of microbial growth in various fields.	Ap	C	Practical Assessment

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45+30)	Marks (70)
I	**Microbial Nutrition**		**10**	**15**
	1	Nutritional requirements of bacteria- Major and Minor Elements		
	2	Nutritional Types- Autotrophy, Heterotrophy, Chemotrophy, Phototrophy, Lithotrophy and Organotropy		
	3	Major nutritional groups of bacteria		
	4	Acetogenesis		
	5	Methanogenesis.		
II	**Microbial growth**		**10**	**15**
	6	Factors affecting microbial growth. (ph, temperature, oxygen, salinity, radiation etc)		
	7	Classification of microorganisms based on various physical factors.		
	8	Microbial Stress response		
	9	Growth curve and its significance		
III	**Nutrient transportation**		**15**	**25**
	10	Diffusion and Facilitated diffusion .		
	11	Active and Passive transport		
	12	Group translocation		
	13	Iron uptake and Siderophores		
	14	Electrogenic and Electro neutral Transport .		
	15	Role of plasma membrane in nutrient transport		
	16	Role of water activity and Osmosis in nutrient transport		
IV	**Application of Microbial growth**		**10**	**15**
	17	Biotechnology (fermentation processes)		
	18	Food industry (food spoilage, food preservation)		
	19	Environmental Science (Bioremediation)		
	20	Agricultural industry (Biofertilizer, Biopesticides)		
	21	Medicine and Health care (Probiotics and Vaccines)		
	22	Clinical Microbiology (Antimicrobial testing)		
V	**Practical Applications in Microbial growth**		**30**	
	1	Growth Curve		
	2	Effect of pH on microbial growth		
	3	Effect of temperature on microbial growth.		

References

1. Salle, A. J. (2018). *Fundamentals of Bacteriology*. (Latest ed.). [Publisher Information Required].
2. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. (2019). *Microbiology*. (Latest ed.). McGraw-Hill Education.
3. Frobisher, M., Hinsdill, R. D., Crabtree, K. T., & Goodheart, C. R. (2020). *Fundamentals of Microbiology*. (Latest ed.). [Publisher Information Required].

4. Stanier, R. Y., Ingraham, J. L., Wheelis, M. L., & Painter, P. R. (2018). *General Microbiology*. (Latest ed.). Macmillan.
5. Prescott, L. M., Harley, J. P., & Klein, D. A. (2017). *Microbiology*. (9th ed.). McGraw-Hill Education.
6. Brock, T., Madigan, M. T., Martinko, J. M., & Parker, J. (2019). *Brock Biology of Microorganisms* (15th ed.). Pearson.
7. Atlas, R. M., & Bartha, R. (2020). *Microbial Ecology: Fundamentals and Applications* (5th ed.). Benjamin Cummings.
8. Moat, A. G., Foster, J. W., & Spector, M. P. (2018). *Microbial Physiology* (5th ed.). Wiley.
9. Schlegel, H. G., & Zaborosch, C. (2017). *General Microbiology* (7th ed.). Cambridge University Press.
10. Singleton, P. (2021). *Bacteria in Biology, Biotechnology, and Medicine* (7th ed.). Wiley.
11. Paul, E. L., Atiemo-Obeng, V. A., & Kresta, S. M. (Eds.). (2016). *Handbook of Industrial Mixing: Science and Practice*. Wiley.

Mapping of COs with PSOs and POs:

	PSO1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		2	3			3		2	3		3
CO2	3		2				3		3	2		2
CO3	3		3				3		2	3		1
CO4	2	3					2	3	3			2
CO5		3	3	3				3	1	2	3	3

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (10%)
- Practical Assessment (20%)
- End semester Exam (70%)
-

Mapping of COs to Assessment Rubrics :

CO	Internal Exam	Assignment	End Semester Examination	Practical Assessment
CO1	✓	✓	✓	✓
CO2	✓	✓	✓	✓
CO3	✓		✓	✓
CO4	✓		✓	✓
CO5				✓

MBY2CJ 101/ MBY2MN100. BASIC TECHNIQUES IN MICROBIOLOGY

Programme	**B. Sc. Microbiology**				
Course Code	MBY2CJ 101/ MBY2MN100				
Course Title	Basic Techniques in Microbiology				
Type of Course	**Major/Minor**				
Semester	II				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Nil				
Course Summary	This preliminary course introduces the basic techniques used in microbiology. It enables the students to acquire a sound theoretical and practical knowledge on microscopy techniques, staining methods, media and methods for culturing the microorganisms and culture preservation strategies.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Master the use of various microscopy techniques, including electron, phase contrast, and fluorescence microscopy, to analyze microorganisms.	(U)	(P)	Internal Exam, Assignment, End Semester Examinations
CO2	Execute and differentiate between multiple staining techniques, such as Gram, acid-fast, and capsule staining, to identify and classify microbial structures.	(Ap)	(P)	Internal Exam, Assignment, End Semester Examinations
CO3	Prepare, select, and utilize appropriate culture media for the growth of aerobic and anaerobic microorganisms.	(Ap)	(P)	Internal Exam, End Semester Examinations
CO4	Implement isolation and culture techniques to maintain pure microbial cultures and apply preservation methods for long-term use.	(An)	(P)	Internal Exam, End Semester Examinations
CO5	Demonstrate proficiency in microbiological laboratory techniques through practical application and understanding of	(Ap)	(C)	Practical assessments

	theoretical concepts.			

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45 +30)	Marks (70)
I	**MICROSCOPY**		**10**	**15**
	1	Introduction to microscope-resolving power, numerical aperture, oil immersion objective.		
	2	Types of microscopes -bright field, dark field		
	3	Phase contrast, confocal microscopes		
	4	Fluorescent microscopes		
	5	Electron microscopy - TEM and SEM		
	6	Electron microscopy - sample preparation & fixation, labelling & storage of slides.		
II	**STAINING**		**10**	**15**
	7	Mechanism of staining - Basic dyes, Acidic dyes. Bacterial smear preparation and fixation.		
	8	Simple Staining, Differential staining- Gram staining, Acid fast staining,		
	9	Staining specific structures-Endospore staining, Negative staining, Capsule staining, Flagellar staining,		
	10	Fungal staining		
	11	Preparation of permanent slides		
III	**CULTURE MEDIA**		**15**	**25**
	12	Solid and liquid media, simple and complex, synthetic or defined media.		
	13	Selective, enrichment, enriched media		
	14	differential, indicator media, Transport media		
	15	Anaerobic media- thioglycollate medium, Robertson's media.		
	16	Cultivation of anaerobic bacteria -Production of vacuum, displacement of oxygen with other gases, chemical methods, biological methods and reduction of medium.		
IV	**CULTURE METHODS -**		**10**	**15**
	17	Isolation of microbes- Dilution plating and enrichment technique.		
	18	Pure culture techniques-Streak, spread, pour plate methods		
	19	Stab culture, stroke culture and lawn culture.		
	20	Culture preservation strategies-regular subculture, paraffin		

		method, storage in soil, storage in silica gel		
	21	Storage at refrigerator or cold room storage, storage by freeze drying and drying, preservation under liquid nitrogen		
	22	Microbial culture collections		
V	**Practical Applications in Microbiology**		**30**	
	1	Staining procedures for microorganisms		
	2	Microscopic observation of microorganisms		
	3	Culture media prepartion		
	4	Demonstration/research institute visit - dark field, phase contrast, confocal, fluorescent, Electron microscopes		

Books and References:

1. Atlas, R. M. (1997). Principles of microbiology (2nd ed). Wm. C. Brown Publishers.
2. Black, J. G., & Black, L. J. (2018). Microbiology: Principles and explorations (10th edition). Wiley.
3. Frobisher, M. (Ed.). (1974). Fundamentals of microbiology (9th ed). W. B. Saunders Co.
4. Gladwin, M., Trattler, B., & Mahan, C. S. (2023). Clinical microbiology made ridiculously simple (Edition 9, in color). MedMaster, Inc.
5. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., Stahl, D. A., & Brock, T. D. (2022). Brock biology of microorganisms (Sixteenth edition, global edition). Pearson.
6. Michael J. Pelczar, Chan, E. C. S., Noel R. Krieg, & Merna Foss Pelczar. (2024). Microbiology (5th edition). Affiliated East-West Press Private Limited.
7. Pommerville, J. (2014). Alcamo's fundamental of microbiology (Tenth edition). Jones and Bartlett India Pvt. Ltd.
8. Salle, A. J. (2007). Fundamental principles of bacteriology (Reprint of the 2. ed., 6. impression 1943). Envins Press.
9. Stanier, R. Y. (2003). General Microbiology. (5th ed). Macmillan.
10. Tortora, G. J., Funke, B. R., & Case, C. L. (2019). Microbiology: An introduction (Thirteenth edition). Pearson.
11. Willey, J. M., Sandman, K., Wood, D. H., & Prescott, L. M. (2023). Prescott's microbiology (Twelfth edition, international student edition). McGraw Hill.

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		2	3	3		3		2	3	3	
CO2	3		3	2	3		3		3	2	3	2
CO3	3		3		2		2		3		3	3
CO4	2	3	3		2		2	3	3		2	
CO5	2		2	3	3		3		2	3	3	

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (10%)
- Practical Assessment (20%)
- Endsemester Exam (70%)

Mapping of COs to Assessment Rubrics :

CO	Internal Exam	Assignment	End Semester Examinations	Practical Assessment
CO1	✓	✓	✓	✓
CO2	✓	✓	✓	✓
CO3	✓		✓	✓
CO4	✓		✓	✓
CO5				✓

MBY2MN101-BACTERIAL INFECTIONS AND HOST DEFENSE SYSTEMS

Programme	B. Sc. Microbiology				
Course Code	MBY2MN 101				
Course Title	Bacterial infections and Host defense systems				
Type of Course	Minor				
Semester	II				
Academic Level	101-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Nil				
Course Summary	This course offers an introductory exploration of the host defense systems of the human body. It covers the basics of immunology and various bacterial infections that affect humans, focusing on the mechanisms of infection, disease transmission, and the body's immunological responses.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the basics of microbial infections, focusing on bacterial pathogens, and understand the human body's primary defense mechanisms against these pathogens.	U	C	Internal Exam, End Semester Exam, Practical Assessments
CO2	Demonstrate practical skills in microbiological techniques such as staining, culture methods, and identifying bacterial pathogens.	Ap	P	Assignments, Internal Exam, Practical Assessments
CO3	Explain the mechanisms of immune response to bacterial infections, including the role of antibodies and the complement system.	U	C	Assignments, Internal Exam, End Semester Exam
CO4	Analyze case studies on bacterial infections to understand disease transmission, symptoms, and preventive measures.	An	C	Case Study Evaluation, Internal Exam
CO5	Evaluate the effectiveness of different antimicrobial treatments and vaccines against bacterial pathogens through theoretical and practical approaches.	E	P	Assignments, Internal Exam, Practical Assessments

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45+30)	Marks (70)
I	**Introduction to infection and diseases**		**10**	**10**
	1	Types of infections		
	2	Types of diseases .		
	3	Sources of infections		
	4	Mode of transmission of infection.		
	5	Reservoirs, carriers and vectors of communicable diseases.		
	6	Role of WHO in pandemic alerts		
II	**Bacterial infections**		**15**	**20**
	7	Staphylococcus aureus		
	8	Streptococci and Neisseria		
	9	Clostridium botulinum and Clostridium tetani		
	10	Salmonella typhi and Vibrio cholerae		
	11	Mycobacterium tuberculosis		
III	**Defense system**		**10**	**20**
	12	Immunity- Innate and acquired		
	13	Active and passive, Natural and artificial. Local immunity and Herd immunity		
	14	Disease prevention and control-controlling the reservoir, interruption of transmission, Immunisation etc.		
	15	Principles of active , passive and combined immunisation. Indian Immunisation schedule.		
	16	Cells and organs of immune system		
IV	**Basics of immunology**		**10**	**20**
	17	Antigens and its type		
	18	Antibody structure and its classification		
	19	Antigen Antibody reactions		
	20	Complement System		
	21	Monoclonal and polyclonal antibodies. Hubridoma		
	22	Hypersensitivity and autoimmunity		
V	**Practical Applications** 1. IMViC reactions of bacteria 2. Widal Test/ASO Test/RA test 3. Blood grouping 4. Differential count of Leucocytes		**30**	

Books and References:

1. Abbas, A. K., & Lichtman, A. H. (2010). *Basic Immunology: Functions and Disorders of the Immune System*. Saunders Elsevier.
2. Janeway, C. A., et al. (2011). *Immunobiology: The Immune System in Health and Disease*. Garland Science.
3. Roitt, I., Brostoff, J., & Male, D. (2001). *Immunology*. Mosby.

4. Brooks, G. F., et al. (2012). *Medical Microbiology*. McGraw-Hill.
5. Kuby, J. (2013). *Immunology* (7th ed.). W.H. Freeman and Company.
6. Ingraham, J. L., & Ingraham, C. A. (2004). *Introduction to Microbiology* (3rd ed.). Brooks/Cole.
7. Alexopoulos, C. J., Mims, C. W., & Blackwell, M. (1996). *Introductory Mycology* (4th ed.). Wiley.
8. Ananthanarayan, R., & Paniker, C. K. J. (2013). *Textbook of Microbiology* (9th ed.). Orient Longman.

Mapping of COs with PSOs and POs :

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		2		1		3	1	2	1	2	1
CO2	2	3		2	1		2	3	3	2	3	1
CO3		2	3	1		1	1	3	2	2	2	1
CO4	1			3	2		1	3	3	3	3	2
CO5			3		3			3		3	3	3

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (10%)
- Practical Assessment (20%)
- End semester Exam (70%)

Mapping of COs to Assessment Rubrics:

CO	Internal Exam	Assignment	Practical Assessments	End Semester Examination
CO1	✓		✓	✓
CO2	✓	✓	✓	
CO3	✓	✓		✓
CO4	✓			✓
CO5	✓	✓	✓	

MBY3CJ 202. MICROBIAL METABOLISM

Programme	B. Sc. Microbiology				
Course Code	MBY3CJ 202/MBY3MN 200				
Course Title	Microbial Metabolism				
Type of Course	Major/Minor				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Nil				
Course Summary	This introductory course covers the fundamental aspects of Microbial Metabolism. It involves converting nutrients into energy and essential biomolecules like ATP, crucial for microorganism survival. Key pathways like glycolysis and the Krebs cycle drive energy production. Microbes adapt to diverse environments by utilizing various carbon and nitrogen sources. Understanding microbial metabolism is vital for biotechnology, industry, and environmental solutions.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Explain the nutritional requirements and types of bacteria based on energy, carbon, and electron sources.	U	F	Internal Exam, Assignment, End Semester Exam
CO2	Describe key metabolic pathways, including respiration and fermentation in microbial systems.	U	C	Internal Exam, Assignment, End Semester Exam
CO3	Analyze chemoheterotrophic and chemolithotrophic metabolism, focusing on energy production mechanisms.	An	C	Internal Exam, End Semester Exam
CO4	Evaluate microbial metabolic strategies in environmental adaptation and biotechnological applications.	E	M	Internal Exam, End Semester Exam
CO5	Perform and interpret experiments related to microbial growth curves, biofilm formation, and metabolic pathways.	Ap	P	Practical Assessment
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P)				

Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45+30)	Marks (70)
I	**Nutritional requirements of bacteria**		**10**	**15**
	1	C, electron, energy, and minerals. Nutritional types of bacteria- based on the requirement and their combinations		
	2	Modes of bacterial nutrition.		
	3	Transport of nutrients by bacteria		
	4	Passive, active and group translocation		
	5	Symport, antiport and uniport, electrogenic and electroneutral transport, transport of iron		
II	**Chemoheterotrophic Metabolism - Aerobic Respiration**		**10**	**15**
	6	Concept of aerobic respiration		
	7	Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway. TCA cycle.		
	8	Electron transport chain		
	9	Components of respiratory chain, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation		
III	**Chemoheterotrophic Metabolism- Anaerobic respiration and fermentation**		**15**	**20**
	10	Anaerobic respiration with special reference to dissimilatory nitrate reduction		
	11	Fermentation - Alcohol fermentation		
	12	Pasteur effect;		
	13	Lactate fermentation		
	14	Homofermentative		
	15	Concept of linear and branched fermentation pathways.		
	16	Heterofermentative pathways		
IV	**Chemolithotrophic and Phototrophic Metabolism**		**10**	**20**
	17	Introduction to aerobic and anaerobic chemolithotrophy		
	18	Hydrogen oxidation (definition and reaction) and methanogenesis (definition and reaction).		
	19	Introduction to phototrophic metabolism		
	20	Groups of phototrophic microorganisms		
	21	Anoxygenicvs. oxygenic photosynthesis with reference to photosynthesis in green bacteria		
	22	Purple bacteria and cyanobacteria.		
V	**Practical Applications in Microbiology**		**30**	
	1	Growth curve of bacteria		
	2	Carbohydrate fermentation by different microbes		
	3	Thermal death point, Thermal death time		

Reference :

- Madigan, M. T., &Martinko, J. M. (2014). *Brock Biology of Microorganisms* (14th ed.). PrenticeHall International Inc.
- Moat, A. G., & Foster, J. W. (2002). *Microbial Physiology* (4th ed.). John Wiley & Sons.
- Reddy, S. R., & Reddy, S. M. (2005). *Microbial Physiology*. Scientific Publishers India.
- Gottschalk, G. (1986). *Bacterial Metabolism* (2nd ed.). Springer Verlag.
- Stanier, R. Y., Ingrahm, J. I., Wheelis, M. L., & Painter, P. R. (1987). *General Microbiology* (5th ed.). McMillan Press**.**

Mapping of COs with PSOs and POs:

	PSO1	PSO 2	PSO 3	PSO4	PSO 5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		2	3		3	2	3		3		
CO2	3		2	3	3	3	3	2	1			
CO3	3	3		2	3	2	3	1			2	
CO4	2	3		3		3	3	2	2			
CO5		3	3	3		1	2	3	3			

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (10%)
- Practical Assessment (20%)
- End semester Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Practical Assessment	End Semester Exam
CO1	✓	✓		✓
CO2	✓	✓		✓
CO3	✓			✓
CO4	✓			✓
CO5			✓	

MBY3MN201-APPLIED MICROBIOLOGY

Programme	B. Sc. Microbiology				
Course Code	MBY3MN201				
Course Title	APPLIED MICROBIOLOGY				
Type of Course	**Minor**				
Semester	111				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites					
Course Summary	This course introduces students to the application of microbiology in various fields such as air, water, food, and industrial microbiology. Students will learn about microbial interactions with the environment, methods for controlling microbial growth, and the role of microbes in industrial processes.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the significance of air, water, and food microbiology in public health.	U	C	Internal Exam, Assignments
CO2	Describe the microbial processes and their control in industrial microbiology.	U	C	Internal Exam, Assignments, Practical Assessments
CO3	Apply techniques for analyzing and controlling microbial contamination in various environments.	Ap	P	Practical Assessments, Project Evaluation
CO4	Analyze methods of food preservation and the role of microorganisms in food spoilage and foodborne diseases.	An	C	Internal Exam, End Semester Exam
CO5	Evaluate the impact of microbial biotechnology in the development of industrial products.	E	C	Internal Exam, Project Evaluation

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45+30)	Marks (70)
I	**Air microbiology**		6	
	1	Air microflora- sources, factors affecting air microflora	1	
	2	Enumeration of microorganisms in air- settling under gravity, centrifugation, impingement, filtration, electrostatic precipitation.	3	

	3	Air borne diseases - bacterial, fungal and viral	2	
II	**Water microbiology**		**12**	**15**
	4	Factors affecting microbial population in natural water- temperature, light, hydrogen concentration, pressure, salinity, nutrients, turbidity.	2	
	5	Purification of water - aeration, sedimentation, coagulation, flocculation, sand filtration.	3	
	6	Wate water treatment - primary, secondary and tertiary stages	3	
	7	Disinfection of drinking water	1	
	8	Bacteriological techniques for examination of water potability- MPN	1	
	9	Indicator organisms, BOD	2	
III	**Food microbiology**		**14**	**25**
	10	Food as a substrate for microorganisms	1	
	11	Microorganisms important in food microbiology - molds, yeast, bacteria.	2	
	12	Contamination of foods	2	
	13	Spoilage of food - chemical changes caused by microorganisms	2	
	14	Spoilage of milk, meat and fish	3	
	15	Methods of food preservation - physical and chemical preservatives.	2	
	16	Food poisoning - bacterial	2	
IV	**Industrial microbiology**		**13**	**15**
	17	Advantages of microbial processs over chemical process	1	
	18	Fermentor - basic function, structure and working	2	
	19	Culture systems - batch, continuous anf fed-batch	1	
	20	Production of - penicillin, vitamin-B12, citric acid and baker's yeast, SCP	5	
	21	Steroid biotransformation	1	
	22	Downstream process	3	
V	**Practical Applications in applied microbiology**		**30**	
	1	Study of air microflora		
	2	Water potability test - MPN method		
	3	BOD		
	4	Aerobic mesophilic count of milk and fish		
	5	MBRT		

Reference Books :

1. Brock, T. D., Madigan, M. T., Martinko, J. M., & Parker, J. (2020). *Brock Biology of Microorganisms* (16th ed.). Pearson.
2. Singleton, P., & Sainsbury, D. (2020). *Dictionary of Microbiology and Molecular Biology* (4th ed.). Wiley.
3. Tortora, G. J., Funke, B. R., & Case, C. L. (2019). *Microbiology: An Introduction* (13th ed.). Pearson.
4. Prescott, L. M., Harley, J. P., & Klein, D. A. (2018). *Microbiology* (9th ed.). McGraw-Hill Education.
5. Atlas, R. M. (2010). *Principles of Microbiology* (2nd ed.). Mosby.
6. Madigan, M. T., & Martinko, J. M. (2015). *Brock Biology of Microorganisms* (15th ed.). Pearson.

Mapping of COs with PSOs and POs:

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	1	2	1		2	1	3		3	2
CO2	3	1	2		2		3	2	2	1	3	1
CO3	1	2	3			1	2	3	2	3	2	
CO4		3	1	3			1	2	3	2	1	3
CO5	2		3	1	3			1	2	3	3	2

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (10%)
- Practical Assessment (20%)
- End semester Exam (70%)

Mapping of COs to Assessment Rubrics :

CO	Internal Exam	Assignments	Practical Assessments	End Semester Examination
CO1	✓	✓		✓
CO2	✓	✓	✓	✓
CO3			✓	✓
CO4	✓		✓	✓
CO5	✓			✓

GENERAL FOUNDATION COURSES

No	Course	Sem	Code	Title
1	GFC-MDC	I	MBY1FM 105	Microorganisms in Daily life
2	GFC-MDC	II	MBY2FM 106	Applied Microbiology
3	GFC-VAC	III	MBY3FV 108	Microbial soild waste management
4	GFC-VAC	IV	MBY4FV 110	Fermented Foods
5	GFC-SEC	V	MBY5FS 112	Entrepreneurial Microbiology
6	GFC-SEC	VI	MBY6FS 113	Clinical Microbiology

MBY1FM 105-MICROORGANISMS IN DAILY LIFE

Programme	B. Sc. Microbiology				
Course Code	MBY1FM 105				
Course Title	Microorganisms in Daily life				
Type of Course	MDC				
Semester	I				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	-	-	45
Pre-requisites	Nil				
Course Summary	This course offers an introduction to the invisible world of microorganisms and their profound effects on our daily lives. From the food we eat to the environment we inhabit, microorganisms play essential roles that are often overlooked. Students will gain an understanding of the basic biology of microorganisms, their ecological importance, and their applications in medicine, industry, and environmental management.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the fundamental characteristics and classifications of microorganisms.	U	F	Internal Exam, End Semester Exam
CO2	Explain the role of microorganisms in human health, including their impact on disease and immunity.	U	C	Internal Exam, Assignments
CO3	Discuss the beneficial applications of microorganisms in food production, biotechnology, and industry.	U	C	Assignments, End Semester Exam
CO4	Evaluate the environmental impact of microorganisms in ecosystems, biodegradation, and waste management.	An	C	Internal Exam, End Semester Exam
CO5	Identify and analyze the challenges and future prospects of microbial applications in addressing global issues.	An	C	Assignments, End Semester Exam

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (33+12)	Marks (50)
I	**Introduction to Microbiology**		**5**	**10**
	1	The Microbial World: An overview of microorganism types and their roles.		
	2	Cellular Structures of Microorganisms: Differences between prokaryotes and eukaryotes.		
	3	Basic Microbial Genetics: Introduction to microbial DNA and gene functions.		
	4	Microbial Growth: Factors affecting microbial growth and reproduction.		
	5	Environmental Microbiology: Roles of microorganisms in ecosystems.		
II	**Microorganisms and Human Health**		**10**	**15**
	6	Pathogenic Microorganisms: Bacteria, viruses, and fungi that cause diseases.		
	7	Antibiotics and Antibiotic Resistance: Mechanisms and implications.		
	8	The Human Microbiome: Beneficial effects of microorganisms on human health.		
	9	Immunology Basics: How the body defends itself against microbial infections.		
	10	Vaccines: Role of microorganisms in vaccine development.		
	11	Emerging Infectious Diseases: New challenges in microbial infections.		
III	**Applied Microbiology**		**10**	**15**
	12	Food Microbiology: Microorganisms in food production and spoilage.		
	13	Industrial Microbiology: Use of microbes in the production of chemicals and pharmaceuticals.		
	14	Agricultural Microbiology: The role of microbes in agriculture and soil fertility.		
	15	Bioenergy: Microbial production of biofuels.		
	16	Bioremediation: Microorganisms used in pollution control and cleanup.		
	17	Bioremediation of oil spills and heavy metal contamination		
IV	**Ethical and Social Implications of Microbiology**		**8**	**10**
	18	Biotechnology in Microbiology: Genetic modification of microorganisms.		

	19	Bioethics: Ethical issues in the manipulation of microbial life.		
	20	Public Health: Microbiology in the context of public health policy.		
	21	Microorganisms in Biowarfare: Historical and current perspectives.		
	22	Future of Microbiology: Innovations and upcoming research fields.		
V	**Open Ended**		**12**	
	1			

Books and References:

1. Atlas, R. M., & Bartha, R. (2021). *Microbial ecology: Fundamentals and applications* (5th ed.). Benjamin Cummings.
2. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. (2020). *Brock biology of microorganisms* (16th ed.). Pearson.
3. Tortora, G. J., Funke, B. R., & Case, C. L. (2021). *Microbiology: An introduction* (14th ed.). Pearson Education.
4. Willey, J. M., Sherwood, L. M., & Woolverton, C. J. (2017). *Prescott's microbiology* (10th ed.). McGraw-Hill Education.
5. Black, J. G. (2018). *Microbiology: Principles and explorations* (10th ed.). Wiley.

Mapping of COs with PSOs and POs :

CO	PSO1	PSO2	PSO3	PSO 4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1				3	2	1		2	
CO2	2	3		1			2	3	2	1	3	
CO3	1		3	2			1		3	2	2	1
CO4		1	2	3				2		3	1	2
CO5				3	2	1		1	2		3	3

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (30%)
- Practical Assessment
- End semester Exam (70%)

Mapping of COs to Assessment Rubrics :

CO	Internal Exam	Assignment	End Semester Exam
CO1	✓		✓
CO2	✓	✓	✓
CO3	✓	✓	✓
CO4		✓	✓
CO5	✓	✓	✓

MBY2FM 106. APPLIED MICROBIOLOGY

Programme	B. Sc. Microbiology				
Course Code	MBY2FM106				
Course Title	APPLIED MICROBIOLOGY				
Type of Course	**MDC**				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	-		45
Pre-requisites					
Course Summary	This course provides an introduction to various fields of microbiology, focusing on the application of microbes in food, air, water, and industrial processes. Students will gain foundational knowledge about microbial ecology, the principles of microbial growth, and their practical applications.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the types and roles of microorganisms in air, understanding their sources, distribution, and methods of sampling.	U	C	Internal Exam, Assignments
CO2	Explain the ecological and microbiological aspects of aquatic environments, including water purification processes.	U	C	Internal Exam, Assignments
CO3	Analyze the factors influencing microbial growth in food and discuss methods of food preservation.	An	C	Internal Exam, End Semester Exam
CO4	Outline the basic principles and applications of industrial microbiology, focusing on fermentors and industrially important microorganisms.	U	C	Internal Exam, Assignments
CO5	Evaluate the impact of microorganisms on food substrates, detailing the processes of spoilage and fermentation.	An	C	Internal Exam, End Semester Exam

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (33+12)	Marks (50)
I	Microbiology of air		5	10
	1	Atmospheric layers, organisms in air, distribution and sources		
	2	Indoor and outdoor air; droplet nuclei, aerosol and infectious dust		
	3	Microbiological sampling of air -gravity slide, plate exposure and filtration		
II	Aquatic microbiology		8	10
	4	Distribution of microorganisms in aquatic environment - fresh water, estuarine and marine water systems		
	5	Factors influencing growth and distribution - temperature, light, turbidity etc		
	6	Purification of water - aeration, sedimentation, coagulation, flocculation, sand filtration		
	7	Disinfection of drinking water		
	8	Bacteriological techniques for examination of water		
	9	Concept of indicator organisms		
III	Food microbiology		10	15
	10	Food as a substrate for microorganisms- types of microorganisms in food		
	11	Sources of contamination of foods		
	12	Factors influencing microbial growth in food - extrinsic and intrinsic		
	13	Microbial examination of food- viable colony count		
	14	Fermented foods - bread, idli,cheese		
	15	Spoilage of different foods - meat, fish and egg		
	16	Methods of food preservation - physical and chemical preservatives.		
IV	Industrial microbiology		10	15
	17	Fermentor - basic function, structure and working		
	18	Types of fermentors - batch, fed-batch and continuous		
	19	Industrially important microorganisms		
	20	Primary screening techniques		
	21	Secondary screening techniques		
	22	Production of - penicillin, vitamin-B12, and baker's yeast		
V	Open Ended		12	
	Case study analysis- Food/water infection outbreaks			
	Air quality management strategies			
	Discussion on fermented food products			

Reference Boks:

1. Madigan, M. T., Martinko, J. M., Bender, K. S., Buckley, D. H., & Stahl, D. A. (2017). *Brock Biology of Microorganisms* (15th ed.). Pearson Education.
2. Willey, J., Sherwood, L., & Woolverton, C. J. (2017). *Prescott's Microbiology* (10th ed.). McGraw-Hill Education.
3. Tortora, G. J., Funke, B. R., & Case, C. L. (2018). *Microbiology: An Introduction* (13th ed.). Pearson Education.
4. Atlas, R. M. (2010). *Principles of Microbiology* (2nd ed.). Mosby Year Book.
5. Singleton, P., & Sainsbury, D. (2020). *Dictionary of Microbiology and Molecular Biology* (4th ed.). Wiley.
6. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. (1993). *Microbiology: Concepts and Applications*. McGraw-Hill.

Mapping of COs with PSOs and POs:

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3						3		2		2	1
CO2	2						2		2		3	
CO3	3	3					3		3	3	2	
CO4		3		3			1	3		3		2
CO5			3		3					3	3	3

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (30%)
- Practical Assessment
- End semester Exam (70%)

Mapping of COs to Assessment Rubrics:

CO	Internal Exam	Assignments	End Semester Examination
CO1	✓	✓	
CO2	✓	✓	
CO3	✓		✓
CO4	✓	✓	
CO5	✓		✓

MBY3FV 108 MICROBIAL SOLID WASTE MANAGEMENT

Programme	B. Sc. Microbiology				
Course Code	MBY3FV 108				
Course Title	Microbial soild waste management				
Type of Course	VAC				
Semester	III				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	-	-	45
Pre-requisites	Nil				
Course Summary	This course introduces students to the principles and practices of microbial solid waste management with a focus on environmental microbiology. Students will gain knowledge about various types of solid waste, their sources, impacts on the environment and human health, and innovative microbial-based solutions for waste treatment and resource recovery.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand basic concepts and principles of solid waste management.	U	C	Quizzes, Internal Exam
CO2	Identify different types of waste and describe their impacts on the environment and public health.	U	F	Assignments, Internal Exam
CO3	Describe basic waste treatment, recycling, and resource recovery methods.	U	C	Assignments, End Semester Exam
CO4	Recognize the importance of policies, community involvement, and education in waste management.	U	C	Internal Exam, End Semester Exam
CO5	Discuss future trends and innovations in waste management.	U	F	Quizzes, End Semester Exam

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (33+12)	Marks (50)
I	**Introduction to Solid Waste Management**		**5**	**10**
	1	Overview of Solid Waste Management - Definitions and importance.		
	2	Types of Solid Waste - Characteristics and sources.		
	3	Environmental Impact of Solid Waste - Basics of ecological effects.		
	4	Health Impacts of Solid Waste - Introduction to public health concerns.		
	5	Principles of Sustainable Waste Management - Introduction to the 3Rs (Reduce, Reuse, Recycle).		
II	**Solid Waste Collection and Treatment**		**10**	**10**
	6	Waste Collection Techniques - Basic methods and practices.		
	7	Waste Segregation and Storage - Importance and methods.		
	8	Overview of Waste Treatment Methods - Landfill, Incineration, and Composting.		
	9	Recycling Basics - Processes and benefits.		
	10	Introduction to Resource Recovery - Simple techniques for material recovery.		
	11	Composting - Basic principles and methods.		
III	**Solid Waste Policies and Public Health**		**10**	**10**
	12	Waste Policy and Regulation - Overview of governmental policies.		
	13	Community Involvement in Waste Management - Role of public participation.		
	14	Waste Management and Public Health - Basic connections and preventive measures.		
	15	Case Studies on Waste Management Strategies - Simple examples from various regions.		
	16	Challenges in Waste Management - Common issues and potential solutions.		
IV	**Future Trends in Waste Management**		**8**	**10**
	17	Innovations in Recycling - New trends in material recycling.		
	18	Advances in Biological Treatment Techniques - Basic introduction to new biotechnologies.		
	19	Phytoremediation - Using plants in waste management (simple overview).		
	20	Role of Education in Waste Management - Importance of awareness and training.		
	21	Future Challenges and Opportunities - Discussion on upcoming trends.		
	22	Review and Course Wrap-up - Recap of key concepts and forward look.		

V	**Open Ended**		**12**	10
	1	PPreparation of composting pits/Biogas plants/Landfills etc		
	2	Waste management policies and execution-discussion		

Books and References:

1. Tchobanoglous, G., Theisen, H., & Vigil, S. (1993). *Integrated Solid Waste Management: Engineering Principles and Management Issues*. McGraw-Hill.
2. Vesilind, P. A., Worrell, W., & Reinhart, D. (2002). *Solid Waste Engineering*. Brooks/Cole.
3. Williams, P. T. (2005). *Waste Treatment and Disposal*. John Wiley & Sons.
4. Diaz, L. F., de Bertoldi, M., Bidlingmaier, W., & Stentiford, E. (2007). *Compost Science and Technology*. Elsevier.
5. Kreith, F., & Tchobanoglous, G. (2002). *Handbook of Solid Waste Management*. McGraw-Hill Professional.
6. Kaza, S., Yao, L., Bhada-Tata, P., & Van Woerden, F. (2018). *What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050*. Urban Development Series. World Bank.

Mapping of COs with PSOs and POs :

CO	PSO1	PSO2	PSO3	PSO 4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1		1			3	2	1		2	1
CO2	2	3	1				2	3	2	1	1	
CO3	1	2	1	1			1	2	1	2	1	
CO4	2	1	2		1		2	1	2	1	2	1
CO5	1	1	1	2			1	1	1	2	2	2

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (30%)
- Practical Assessment
- End semester Exam (70%)

Mapping of COs to Assessment Rubrics :

CO	Internal Exam	Assignment	End Semester Exam
CO1	✓		✓
CO2	✓	✓	✓
CO3	✓	✓	✓
CO4	✓	✓	✓
CO5			✓

MBY4FV110. FERMENTED FOODS

Programme	B. Sc. Microbiology				
Course Code	MBY4FV110				
Course Title	Fermented Foods				
Type of Course	VAC				
Semester	IV				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	-	-	45
Pre-requisites	Nil				
Course Summary	This course offers an introduction to the world of fermented foods, highlighting their historical significance, health benefits, and the microorganisms that play a crucial role in their production. Students will learn about the production processes of various fermented dairy, meat, vegetable products, and beverages, with a focus on the applied microbiological aspects.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the basic concepts of fermented foods and their health benefits.	U	C	Internal Exam, Assignments
CO2	Describe the production and microorganisms involved in fermented dairy products.	U	C	Internal Exam
CO3	Outline the fermentation processes for meat and vegetable products.	U	C	Internal Exam, Assignments
CO4	Explain the production methods and microbiology of fermented beverages and cereals.	U	C	Assignments, End-Semester Exam
CO5	Assess the nutritional benefits and microbiological aspects of various fermented foods.	U	C	Internal Exam, Assignments, Projects

*- Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
#- Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (33+12)	Marks (50)
I	**Basic concepts of fermented food**		**5**	**10**
	1	History of fermented foods		
	2	Properties of fermented food.		
	3	Different microorganisms involved in fermentation		
	4	Starter and non-starter cultures		
	5	Health Benefits of fermented foods		
II	**Fermented Dairy products**		**10**	**15**
	6	Cheese		
	7	Buttermilk, Curd		
	8	Yogurt		
	9	Sour cream, Kefir		
	10	Brief account of Microorganisms involved and steps in the production		
	11	Nutritional Benefits of fermented dairy products		
III	**Fermented Meat and vegetables**		**8**	**10**
	12	Fermented sausage		
	13	Sauerkraut		
	14	Kimchi		
	15	Fermented pickles		
	16	Brief account of Microorganisms involved and steps in the production		
IV	**Fermented Beverages and Cereal products**		**10**	**15**
	17	Beer fermentation Types. Microorganisms involved and steps in production.		
	18	Wine fermentation.		
	19	Fermented Cereal products- Bread		
	20	Idli		
	21	Types of Microorganisms involved and steps in production.		
	22	Definition of Probiotics and prebiotics.		
V	**Open Ended**		12	
	Visit to food processing industries			
	Survey and analysis on fermented food products in the market			

Books and References:

1. Hutkins, R. W. (2019). *Microbiology and Technology of Fermented Foods* (2nd ed.). Wiley-Blackwell.
2. Adams, M. R., & Moss, M. O. (2018). *Food Microbiology* (4th ed.). Royal Society of Chemistry.
3. Frazier, W. C., & Westhoff, D. C. (2016). *Food Microbiology* (5th ed.). McGraw-Hill Education.
4. Robinson, R. K. (2017). *Dairy Microbiology Handbook* (3rd ed.). Wiley.

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO6	PO 1	PO 2	PO 3	PO 4	PO 5	PO6
CO1	3		2				2		1			
CO2		3		2			1	2				
CO3	1		3					1	2			
CO4			1	3	2			3	1	2		
CO5		1			3	2	1		2	3		

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (30%)
- Practical Assessment
- End semester Exam (70%)

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO1	✓	✓		✓
CO2	✓			✓
CO3	✓	✓		✓
CO4		✓		✓
CO5	✓	✓	✓	✓

MBY5FS 112. ENTREPRENEURIAL MICROBIOLOGY

Programme	B. Sc. Microbiology				
Course Code	MBY5FS 112				
Course Title	Entrepreneurial Microbiology				
Type of Course	SEC				
Semester	V				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	-	-	45
Pre-requisites	Knowledge in Basic Microbiology Techniques and Managerial Economics				
Course Summary	This course aims to blend microbiology with entrepreneurship, teaching students how to turn scientific discoveries into marketable products. It covers the journey from concept to commercialization, focusing on creating sustainable and cost-effective solutions using microbial technologies.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the entrepreneurial landscape and the role of microbiology in entrepreneurship.	U	C	Internal Exam, Assignments
CO2	Analyze the process of product development from microbial resources.	An	C	Internal Exam, End Semester Exam
CO3	Evaluate market dynamics and strategies for commercializing microbiological products.	An	C	Case Studies, Internal Exam
CO4	Discuss the regulatory and ethical frameworks relevant to microbial entrepreneurship.	U	C	Internal Exam, Assignments
CO5	Critically examine case studies of successful microbial enterprises.	E	C	Internal Exam, Case Studies

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
\# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (33 +12)	Marks (50)
I	**Entrepreneurship in Microbiology**		**5**	**8**
	1	Entrepreneurial society: Development and activity		
	2	Institutions involved in entrepreneurial development		
	3	Government contributions to entrepreneurs		
	4	Risk assessment in entrepreneurship		
	5	Entrepreneur development frameworks		
II	**Microbial Products and Innovation**		**5**	**8**
	6	Bread baking and fermentation processes		
	7	Rye bread, San Francisco dough Bread		
	8	Idli and dosa fermentation details		
	9	Fermented fish products: Ngari, Hentak, Tungtap, Gnuchi		
	10	Patenting: Basics and history		
III	**Cultivation and Utilization of Microbial Processes**		**10**	**14**
	11	Mushroom cultivation techniques		
	12	Cultivation of Agaricus campestris and Agaricus bisporus		
	13	Alcoholic products and their cultural significance		
	14	Production processes of Apong, Kodokojaanr, Xajpani		
	15	Grape wine and other fruit wines		
IV	**Advanced Entrepreneurial Practices in Microbiology**		**13**	**20**
	16	Market analysis and commercialization strategies		
	17	Intellectual property rights in microbiology		
	18	Fermentation economics		
	19	Bioentrepreneurship: Scope, challenges, and opportunities		
	20	Innovation and sustainable business models in microbiology		
	21	Case studies of successful microbiology-based businesses		
	22	Future trends and opportunities in microbial entrepreneurship		
V	Ethical and Regulatory Considerations in Microbiology Entrepreneurship		**12**	
	Patent filing for microbial products			

Books and References:

1. Bell JR (2010) Handbook of bioentrepreneurship (Book Review). N Engl J Entrep 13:1–2
2. Bogoro SE (2015) Entrepreneurship for development. Convocation lecture delivered at the 2nd convocation ceremony of the Kaduna. State University Kaduna
3. Eniola AA (2018) Entrepreneur-SME manager traits and sources of financing. In: Ratten V, Dana LP, Honyenuga B (eds) African entrepreneurship: challenges and opportunities for doing business, 1st edn. Springer, Cham
4. Life Science Austria (2017) The international Biotech & Medtech Business Plan Handbook Austria Wirtschafts service GesellschaftmbH
5. Prescott LM, Harley JP, Klein DA (2005) Microbiology, 6th edn. McGraw Hill Publishers, New York. pp. 2 and 12
6. Rama VS (2009) Job prospects in microbiology.
7. Shimasaki CD (2009) The business of bioscience what goes into making a biotechnology product? Springer, pp 9–26
8. Steven MF, Uma SK (2014) Licensing the technology: biotechnology commercialization strategies using university and Federal labs. In: Biotechnology entrepreneurship. Elsevier, pp 185–206
9. Stanbury, P.F, and Whitekar. A. (1999), Principles of Fermentation Technology, 2nd Edition. Butterworth-Heinemann: Oxford.
10. Stockholm, K.T.H., Sven-OlofEnfors, and Lena Haggstrom. (2000), Bioprocess Technology: Fundamentals and Applications, Royal Institute of Technology: Sweden.
11. Ashton Acton, Q., (2012). Biological Pigments– Advances in Research and Application. Scholarly Editions: Atlanta, Georgia.

Mapping of COs with PSOs and POs :

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1		2		2	1	3		2	
CO2	3	2		1	3		3	2	2	1	3	
CO3	1	3		2		3	1	3	3	2	3	2
CO4		2	3		1	2		3	2	3	1	3
CO5	3		2	3		1	3	2	3	3	3	3

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (30%)
- Practical Assessment
- End semester Exam (70%)

Mapping of COs to Assessment Rubrics :

CO	Internal Exam	Assignments	Case Studies	End Semester Examination
CO1	✓	✓		✓
CO2	✓			✓
CO3	✓		✓	
CO4	✓	✓		✓
CO5	✓		✓	

MBY6FS 113. CLINICAL MICROBIOLOGY

Programme	B. Sc. Microbiology				
Course Code	MBY6FS 113				
Course Title	Clinical Microbiology				
Type of Course	SEC				
Semester	VI				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	-	-	45
Pre-requisites	Nil				
Course Summary	This course introduces the fundamentals of clinical microbiology, emphasizing laboratory safety, diagnostic techniques, pathogen identification, and understanding the microbial etiology of diseases. It equips students with the knowledge to perform and interpret microbiological tests and to understand the clinical implications of microbial infections.				

Course Outcomes (CO): .

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Identify the basic principles of laboratory safety and biological agent classification.	U	F	Quizzes, Internal Exam
CO2	Describe standard practices for specimen collection, transport, and processing.	U	F	Assignments, Internal Exam
CO3	Recognize the normal microbial flora and its role in human health and disease.	U	C	Assignments, Practical Assessments
CO4	Distinguish between various types of infectious diseases using clinical examples.	U	F	Internal Exam, End Semester Exam
CO5	Outline basic diagnostic techniques used in clinical microbiology.	U	F	Assignments, End Semester Exam

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (33+12)	Marks (50)
I	Microbiology laboratory safety		**5**	**10**
	1	Biological Safety Cabinets; Biocontainment, Biosafety Levels; Biosafety guidelines		
	2	biosafety concerns at the level of individuals, institutions		
	3	Laboratory and associated infections		
	4	Good microbiological practices		
	5	Classification of biological agents based on hazards. Mailing of biohazardous materials		
II	Diagnostic cycle		**10**	**10**
	6	General concepts for specimen collection, transport and processing		
	7	Infection control , Emerging infections		
	8	Quality assurance & quality control in microbiology, Accreditation of laboratories		
	9	Normal microbial flora of the human body		
III	Etiology, pathogenesis and laboratory diagnosis		**10**	**10**
	10	Blood Stream infections		
	11	Respiratory Tract infections		
	12	Central Nervous System infections		
	13	Gastrointestinal Tract infections		
	14	Urinary Tract infections & Genital Tract infections		
	15	Sexually transmitted diseases.		
	16	Nosocomial infections.		
IV	Infections of different sites		**8**	**10**
	17	Skin, soft tissue and wound infections		
	18	Burn infections. Infections of sinuses, bone and bone marrow.		
	19	Infections of eye and ear		
	20	Pyogenic infections		
	21	Infections in immunocompromised and immunodeficient patients		
	22	Infections in foetus and neonates.		
V	Open Ended		12	10
	1	Serodiagnosis of infectious diseases		
	2	Molecular techniques in diagnostic microbiology.		
	3	Automation in Microbiology		
	4	Laboratory control of antimicrobial therapy		
	5	Immunoprophylaxis,		
	6	Immunity in infections		

Books and References

1. Lennette, E. H., Balows, A., Hausler, W. J., Jr., & Shadomy, H. J. (Eds.). (1985). Manual of clinical microbiology (4th ed.). American Society for Microbiology.
2. Blair, J. E., Lennette, E. H., & Truant, J. P. (1970). Manual of clinical microbiology. American Society for Microbiology.
3. Gradwohl, R. B. H., Sonnenwirth, A. C., & Jarett, L. (1980). Gradwohl's clinical laboratory methods and diagnosis (8th ed.). Mosby.
4. Topley, W. W. C., Wilson, G. S., Parker, M. T., & Collier, L. H. (1990). Topley and Wilson's principles of bacteriology, virology and immunology (8th ed.). Edward Arnold.
5. Mukherjee, K. L. (2010). Medical laboratory technology (2nd ed.). Tata McGraw-Hill Education.
6. Sood, R. (1999). Medical laboratory technology: Methods and interpretations (5th ed.). Jaypee Brothers Medical Publishers.
7. Cheesbrough, M. (2006). District laboratory practice in tropical countries (2nd ed.). Cambridge University Press.
8. Mackie, T. J., McCartney, J. E., & Collee, J. G. (1989). Mackie & McCartney practical medical microbiology (13th ed.). Churchill Livingstone.
9. Black, J. G. (1999). Microbiology: Principles and explorations (4th ed.). Prentice Hall International.
10. Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2006). Kuby immunology (6th ed.). W.H. Freeman.
11. Forbes, B. A., Sahm, D. F., Weissfeld, A. S., & Bailey, W. R. (2007). Bailey & Scott's diagnostic microbiology (12th ed.). Elsevier Mosby.

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1	2	1		1			2	1			1	
CO2	1	2		1			1	2	1			
CO3	2	1	1				1	1	1	2	1	
CO4	1	2	2				1	2	1	1		1
CO5	1	1	2	1			1	1	2	1	1	

Correlation Levels: 1-Slightly / Low, 2-Moderate / Medium, 3-Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Continuous Assessment (30%)
- Practical Assessment
- End semester Exam (70%)

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	End Semester Exam
CO1	✓		✓
CO2	✓	✓	✓
CO3	✓	✓	
CO4			✓
CO5		✓	✓

University of Calicut
I Semester B.Sc. (CUFYUGP) Microbiology Honors Degree Examinations October 2024
MBY1CJ 101/ MBY1MN100: Introduction to Microbiology (credits: 4)
Maximum Time: 2 hours **Maximum Marks: 70**

Section A *(Answer All. Each question carries 3 marks)* (Ceiling 24 marks)

1. Define bacterial cell arrangement and provide examples.
2. Describe the morphological features of fungi, focusing on molds and yeasts.
3. Discuss the concept of spontaneous generation and its historical significance
4. Explain the contributions of Anton van Leeuwenhoek to microbiology.
5. Explain the structure and function of the gram-positive bacterial cell wall.
6. Differentiate between archaebacteria and eubacteria.
7. What is the role of beneficial microbes in the food industry?
8. What is the lytic cycle of bacteriophages? Explain briefly.
9. Discuss the role of mycorrhizae in agriculture.
10. What are biocontrol agents, and how do they function in microbial management?

Section B *(Answer All. Each question carries 6 marks)* (Ceiling: 36 Marks)

11. Discuss the differences between prokaryotic and eukaryotic cell structures, giving relevant examples.
12. Explain the process of sporulation in bacteria and the role of endospores in survival.
13. Describe the historical significance of Joseph Lister and Paul Ehrlich's contributions to microbiology.
14. Explain the structure and function of bacterial cell membranes.
15. Discuss the roles of beneficial microorganisms in the pharmaceutical industry.
16. Explain the structure and function of cytoplasmic components such as ribosomes and inclusion bodies in bacteria.
17. What are the applications of biopesticides in agriculture, and how do they contribute to sustainable farming?
18. Discuss the impact of pathogenic microorganisms on human and plant health, provide examples.

Section C *(Answer any one. Each question carries 10 marks)* (1x10=10 Marks)

19. Provide a detailed explanation of bacterial ultrastructure, including cell wall, membrane, and cytoplasmic structures.

20. Describe the roles of microorganisms in various ecosystems, focusing on their beneficial and harmful effects on the environment.

Rubrics Table for Introduction to Microbiology Question Paper

Question No.	Marks	CO	PSO	CL	Rubric Criteria
1	3	CO1	PSO1	Remember (R)	Define bacterial cell arrangements correctly with examples.
2	3	CO1	PSO1	Understand (U)	Describe fungal morphology (molds/yeasts) with accuracy.
3	3	CO2	PSO2	Understand (U)	Explain spontaneous generation and debates, ensuring historical accuracy.
4	3	CO2	PSO5	Remember (R)	Correctly list contributions of Anton van Leeuwenhoek.
5	3	CO3	PSO1	Understand (U)	Differentiate archaebacteria from eubacteria, emphasizing key differences.
6	3	CO3	PSO1	Understand (U)	Explain gram-positive cell wall structure thoroughly.
7	3	CO4	PSO5	Understand (U)	Describe microbes' roles in the food industry with relevant examples.
8	3	CO1	PSO1	Remember (R)	Outline the lytic cycle of bacteriophages clearly and concisely.
9	3	CO4	PSO6	Understand (U)	Discuss how mycorrhizae benefit agriculture with clear examples.
10	3	CO4	PSO6	Remember (R)	Identify biocontrol agents and their basic role.
11	6	CO3	PSO1	Analyze (An)	Compare prokaryotic and eukaryotic cells, highlighting key differences.
12	6	CO3	PSO3	Understand (U)	Describe sporulation and the function of endospores accurately.
13	6	CO2	PSO5	Understand (U)	Explain contributions of Joseph Lister and Paul Ehrlich to microbiology.
14	6	CO3	PSO1	Understand (U)	Explain bacterial membrane structure and function comprehensively.
15	6	CO4	PSO5	Understand (U)	Discuss applications of microbes in the pharmaceutical industry.
16	6	CO3	PSO1	Understand (U)	Describe cytoplasmic structures (ribosomes/inclusion bodies) thoroughly.
17	6	CO4	PSO6	Apply (Ap)	Explain biopesticides and their agricultural applications with examples.
18	6	CO4	PSO6	Understand (U)	Discuss how harmful microbes affect humans and plants, giving examples.
19	10	CO3	PSO1, 5	Analyze (An)	Provide detailed analysis of bacterial ultrastructure, covering key components.
20	10	CO4	PSO6	Analyze (An)	Analyze the roles of microorganisms in the environment, both beneficial and harmful.

University of Calicut
I Semester B.Sc. (CUFYUGP) Microbiology Honors Degree Examinations October 2024
MBY1MN101: Microbial Growth (credits: 4)
Maximum Time: 2 hours **Maximum Marks: 70**

Section A *(Answer All. Each question carries 3 marks)* (Ceiling 24 marks)

1. Define microbial growth and describe the phases of the bacterial growth curve.
2. What is bacterial generation time, and why is it important in microbiology?
3. Explain how pH affects microbial growth.
4. Describe how temperature influences microbial growth.
5. List the key environmental factors that influence microbial growth.
6. What is the difference between psychrophiles, mesophiles, and thermophiles based on their temperature preferences?
7. Explain the role of microbial enzymes in industrial fermentation processes.
8. What is selective media, and why is it used in microbiological studies?
9. Discuss the role of oxygen in the growth of aerobic and anaerobic bacteria.
10. What are the main methods used to measure microbial growth?

Section B *(Answer All. Each question carries 6 marks)* (Ceiling: 36 Marks)

11. Compare the different phases of the microbial growth curve and their significance.
12. Explain the methods used to measure microbial growth, including both direct and indirect methods.
13. Discuss the role of microbes in the fermentation process and their industrial applications.
14. How do microorganisms contribute to bioremediation? Provide examples.
15. Describe the classification of microbes based on their oxygen requirements, with examples.
16. Explain how nutrient availability affects microbial growth and metabolism.
17. What adaptations do microorganisms have to survive in extreme environments, such as high salt concentrations or high temperatures?
18. How do continuous culture systems differ from batch culture systems in industrial microbiology?

Section C *(Answer any one. Each question carries 10 marks)* (1x10=10 Marks)

19. Discuss the significance of the microbial growth curve in food preservation and industrial fermentation processes.
20. Explain how environmental factors, such as pH and temperature, are controlled in industrial microbiology and bioremediation.

Rubrics Table

Q No.	Marks	CO	PSO	CL	Rubric Criteria
1	3	CO1	PSO1	Remember (R)	Define microbial growth and describe the phases of the bacterial growth curve.
2	3	CO1	PSO1	Remember (R)	Explain bacterial generation time and its significance in microbiology.
3	3	CO2	PSO3	Understand (U)	Explain how pH affects microbial growth with examples.
4	3	CO2	PSO1	Understand (U)	Describe the effect of temperature on microbial growth with clear examples.
5	3	CO4	PSO5	Understand (U)	List the key factors influencing microbial growth, emphasizing environmental conditions.
6	3	CO2	PSO1	Understand (U)	Differentiate psychrophiles, mesophiles, and thermophiles based on temperature.
7	3	CO4	PSO5	Understand (U)	Explain the role of microbial enzymes in fermentation and industrial applications.
8	3	CO4	PSO5	Apply (Ap)	Describe the use of selective media in microbiology with examples.
9	3	CO3	PSO1	Understand (U)	Discuss how oxygen availability affects aerobic and anaerobic bacteria growth.
10	3	CO5	PSO3	Apply (Ap)	Explain the methods to measure microbial growth, including direct and indirect methods.
11	6	CO1	PSO1	Analyze (An)	Compare the phases of microbial growth and explain their industrial relevance.
12	6	CO5	PSO3	Apply (Ap)	Describe techniques to measure microbial growth accurately with examples.
13	6	CO4	PSO5	Apply (Ap)	Discuss the role of microbes in fermentation processes and their applications.
14	6	CO4	PSO6	Analyze (An)	Analyze the contribution of microbes to bioremediation with relevant examples.
15	6	CO3	PSO1	Analyze (An)	Classify microbes based on oxygen requirements, giving examples of each type.
16	6	CO2	PSO1	Analyze (An)	Analyze the impact of nutrient availability on microbial metabolism and growth.
17	6	CO4	PSO6	Analyze (An)	Explain the adaptations of microorganisms to extreme environments, such as high salt or heat.
18	6	CO4	PSO7	Apply (Ap)	Compare continuous and batch culture systems in industrial microbiology.
19	10	CO4	PSO5	Analyze (An)	Discuss the role of the microbial growth curve in food preservation and fermentation processes.
20	10	CO5	PSO6	Analyze (An)	Explain how pH and temperature are controlled in industrial and bioremediation settings.

University of Calicut
I Semester B.Sc. (CUFYUGP) Microbiology Honors Degree Examinations October 2024
MBY1FM 105: Microorganisms in Daily Life (credits: 3)
Maximum Time: 1.5 hours **Maximum Marks: 50**

Section A *(Answer All. Each question carries 2 marks)* (Ceiling: 16 marks)

1. What are microorganisms? Give examples.
2. What are the differences between prokaryotes and eukaryotes?
3. How do microorganisms help in food production?
4. Define pathogenic microorganisms and give two examples.
5. What is antibiotic resistance? Why is it a concern?
6. Explain the term "bioremediation" and its environmental importance.
7. What role do microorganisms play in vaccine development?
8. List two applications of microorganisms in biotechnology.
9. What is the human microbiome, and why is it important?
10. What are the ethical concerns related to genetic modification of microorganisms?

Section B *(Answer All. Each question carries 6 marks)* (Ceiling: 24 Marks)

11. Discuss the role of microorganisms in food spoilage and methods to prevent it.
12. How do microorganisms contribute to the production of biofuels?
13. Explain how the human body defends itself against microbial infections.
14. . Describe the role of microorganisms in soil fertility and agriculture.
15. What are the mechanisms by which microorganisms cause diseases?

Section C *(Answer any one. Each question carries 10 marks)* (1x10=10 Marks)

16. . Evaluate the importance of microorganisms in the ecosystem, focusing on biodegradation and waste management.

17. . Identify and analyze the challenges and future prospects of microbial applications in addressing global issues.

Rubrics Table

Question No.	Marks	CO	PSO	CL	Rubric Criteria
1	2	CO1	PSO1	Remember (R)	Define microorganisms and provide relevant examples.
2	2	CO1	PSO1	Understand (U)	Explain the differences between prokaryotes and eukaryotes.
3	2	CO3	PSO5	Understand (U)	Describe the role of microorganisms in food production.
4	2	CO2	PSO1	Remember (R)	Define pathogenic microorganisms with examples.
5	2	CO2	PSO1	Understand (U)	Explain antibiotic resistance and its implications.
6	2	CO4	PSO6	Understand (U)	Explain bioremediation and its importance for the environment.
7	2	CO2	PSO5	Understand (U)	Describe the role of microorganisms in vaccine development.
8	2	CO3	PSO5	Understand (U)	List two applications of microorganisms in biotechnology.
9	2	CO2	PSO5	Understand (U)	Define the human microbiome and explain its significance.
10	2	CO4	PSO6	Understand (U)	Discuss ethical concerns related to genetically modifying microorganisms.
11	6	CO3	PSO5	Analyze (An)	Discuss the role of microorganisms in food spoilage and prevention methods.
12	6	CO3	PSO5	Understand (U)	Explain the contribution of microorganisms to biofuel production.
13	6	CO2	PSO1	Understand (U)	Explain how the human body defends against microbial infections.
14	6	CO3	PSO5	Analyze (An)	Describe the role of microorganisms in soil fertility and agriculture.
15	6	CO2	PSO1	Understand (U)	Explain the mechanisms by which microorganisms cause diseases.
16	10	CO4	PSO6	Analyze (An)	Evaluate the role of microorganisms in biodegradation and waste management.
17	10	CO5	PSO6	Analyze (An)	Analyze the challenges and future prospects of microbial applications.