SOMAIYA VIDYAVIHAR

K J Somaiya College of Science & Commerce

Autonomous (Affiliated to University of Mumbai)

Somaiya TRUST

Learning Outcomes based Curriculum Framework

(LOCF)

For

M.Sc. II Microbiology

Postgraduate Programme

from

Academic Year

2024-2025

Vision & Mission

Mission:

- Equip the student with knowledge and skills of their chosen vocation,
- Inculcate values.
- Provide them opportunities for all round growth and prepare them for life.

Vision:

- To equip the students with advanced knowledge and skills in their chosen vocation.
- To provide value-based education and opportunities to students.
- To help them to face challenges in life.
- To nurture a scientific attitude, temperament and culture among the students.
- To continually review, develop and renew the approach to build India of the Founder's dream.

Goals and Objectives:

- To build a strong Academia-Industry bridge.
- To provide flexibility in the courses offered and proactively adapt to the changing needs of students and the society.
- To establish a centre for multidisciplinary activities.
- To mould individuals who would nurture the cultural heritage of our country and contribute to the betterment of the society.

Board of studies in Microbiology

Undergraduate and Postgraduate

	Name	Designation	Institute/Industry
1	Dr. Lolly Jain	Chairperson	Head of the Department K. J. Somaiya College of Science and Commerce, Mumbai
Subject Experts nominated by the Vice-Chancellor			
1	Dr. Pramod Ghogare	Assistant Professor	Head Dept. of Microbiology, SIES College, Sion, Mumbai
Subject experts outside parent University			
1	Dr. Nilima Shivale	Assistant Professor	School of Biotechnology and Bioinformatics D. Y. Patil deemed to be University, Navi Mumbai
2	Dr. Pratibha Shah	Associate Professor	Dept. of Microbiology, K. C. College HSNC University, Mumbai
Other members of the same faculty			
1	Prof. Bela Nabar	Professor	Head. Dept. of Microbiology, C.H.M. College, Ulhasnagar, Thane
2	Prof. Savanta Raut	Professor	Head. Dept. of Microbiology, Bhavans College, Andheri, Mumbai
Representatives from industry/ corporate sector/ allied area			
1	Dr. Vikrant Bhor	Scientist E and Head	Department of Molecular Immunology and Microbiology, ICMR
2	Dr. Dina Saroj	Principal Scientist	Advanced Enzyme Technologies Limited, Mumbai

Meritorious alumnus			
1	Dr. Meenal Dukhande	Associate Professor	Dept. of Microbiology, G. N. Khalsa College, Matunga Mumbai
Faculty of the specialization			
1	Dr. Soniya Shetty	Associate Professor	Dept of Microbiology, K. J. Somaiya College of Science and Commerce
2	Mr. Shabib Khan	Assistant Professor	Dept of Microbiology, K. J. Somaiya College of Science and Commerce
3	Ms. Versha Peghwal	Assistant Professor	Dept of Microbiology, K. J. Somaiya College of Science and Commerce
Experts from outside the College whenever special course of studies are to be formulated (Molecular Biology expert)			
1	Dr. Tejas Chirmade	Senior Research Associate III	Bioanalytical Team, US Vitamins, Govandi Mumbai
Invited Members			
1	Ms. Kiran Surve	Assistant Professor	Dept of Microbiology, K. J. Somaiya College of Science and Commerce
2	Ms. Poonam Shinde	Assistant Professor	Dept of Microbiology, K. J. Somaiya College of Science and Commerce
3	Ms.Tarannoom Khan	Assistant Professor	Dept of Microbiology, K. J. Somaiya College of Science and Commerce
4	Ms. Pooja Nandi	Assistant Professor	Dept of Microbiology, K. J. Somaiya College of Science and Commerce
5	Ms. Dhanashree Tambe	Assistant Professor	Dept of Microbiology, K. J. Somaiya College of Science and Commerce

Foreword

Autonomy reflects efforts for excellence in academic performances, capability of self-governance and enhancement in the quality of education. In the year 2012, the UGC and University of Mumbai conferred the Autonomous Status to K. J Somaiya College of Science and Commerce. Post this recognition and having several accolades to our credit, we made significant changes to our existing syllabi to reflect the changing business, industrial and social needs. A holistic education that provides opportunities to gain and share knowledge, experiment and develop beyond curriculum, is offered at our College.

An Autonomous college carries a prestigious image for the students and the teachers and we have made a collaborative attempt to maintain a high level of quality in the standard of education that we impart.

Structured feedback obtained from the students, alumni and the experts from the industry and the changes suggested by them were duly incorporated in the syllabi. The Board of Studies constituted for each department meets to carry out in depth discussions about different aspects of the curriculum taking into cognizance the recent trends in the discipline.

The IQAC team has facilitated the conduct of a number of workshops and seminars to equip the faculty with the necessary skill set to frame the syllabi and competencies to deliver the same. Training was also provided to employ innovative evaluation methods pertaining to higher cognitive levels of revised Bloom's taxonomy. This has ensured the attainment of the learning outcomes enlisted in the syllabus. Audits are conducted to critically review the practices undertaken in teaching, learning and evaluation. Innovative learning methodologies such as project-based learning, experiential learning and flip- class learning practiced by a committed fleet of faculty and supported by several hands have been our unique outstanding propositions. All efforts have been made to nurture the academic ambitions as well as the skills in co-curricular activities of the most important stakeholder i. e. student.

With sincere gratitude, I acknowledge the constant support and guidance extended by Shri Samir Somaiya, President- Somaiya Vidyavihar, and all the esteemed members of the Governing board and Academic council of the College. I also would like to acknowledge the Heads of the Departments and all the faculty members for their meticulous approach, commitment and significant contribution towards this endeavour for academic excellence.

Dr. Pradnya Prabhu

Principal

Acknowledgement

Syllabus Revision is an essential part of academic sustenance. This year, with the implementation of NEP 2020, we now have the added responsibility of delivering a curriculum that focuses on both- a sound knowledge base along with higher order skills that will support all round development and vocation of the learner. At the outset, I would like to thank our Principal Dr. Pradnya Prabhu for her guidance and support during the curriculum restructuring process. I am also deeply obliged to all the esteemed members of the Board of Studies, for their constructive suggestions and contributions.

Above all, I am indebted to my young and vibrant colleagues in the Department of Microbiology for their sincere and painstaking efforts during the compilation of the restructured syllabus as per NEP 2020 guidelines.

Dr. Lolly Jain

Chairperson

Board of Studies in Microbiology

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Preamble

This Learning Outcome-based Curriculum Framework (LOCF) supports the fundamental principle of providing quality education in India. We endeavour to mould young minds to participate, contribute and add value to every milestone in their path towards academic excellence. The introduction of Choice Based Credit System (CBCS) has maximized the benefits of the newly designed curriculum manifold.

The LOCF will assist teachers to envisage the outcome expected from the learners at the end of the programme. It will help them to strategize their teaching effectively. At the same time, this document will guide the students through the new curriculum and help them acquire all the skills and knowledge sets required for their personal and academic growth. Higher education qualifications such as the Master's degree Programme are awarded on the basis of demonstrated achievement of outcomes and academic standards; and this is the very essence of this curriculum.

Education is one of the most critical yardsticks in any country's development. The new National Education Policy (NEP) 2020 is an essential and comprehensive policy framework that aims to revamp the country's educational system from its foundation and to bring it at par with global standards. The larger aim of this policy is to transform the Indian education system by making it more inclusive, flexible and relevant to the changing needs of the society. Some of the key features of this policy are the introduction of vocational training, elective courses, emphasis on cultural studies, development of global skill sets and the promotion of multilingualism.

The policy seeks to bring about significant changes in the Higher Education structure, such as introducing a four-year undergraduate degree Programme,

establishing multidisciplinary education and research universities, pooled credit banks and creating a National research Foundation to promote and support

research activities in various fields. The new education policy enables every student to get quality education irrespective of their socio-economic background, gender or disability. NEP 2020 enables teachers to use a variety of learning techniques and experiments.

In the current fast paced world, simply cascading the knowledge in the classroom is not sufficient especially when the global requirements keep changing. Every learner should be encouraged to exchange ideas and thoughts in a collaborative approach. This leads to developing an environment which is cognitive in nature and not a one-way information flow. Keeping all this in mind, the curriculum under Learning Outcome-based Curriculum Framework (LOCF) is designed.

1. Introduction

The M.Sc. Microbiology programme is developed keeping in mind the interest of learners to explore and achieve in-depth knowledge and skills in the field of Microbiology. The flexible framework helps to maintain the ethos of Microbiology degree programmes through periodic programme review within a broad framework of agreed/expected graduate attributes, qualification descriptors, programme learning outcomes and course-level learning outcomes. The M.Sc. programme is planned in such a way that it allows flexibility and innovation in programme design, syllabi development, teaching-learning process and quality assessment of student's learning levels. Updating teaching, learning pedagogy and outcome- based education forms the pillars of the programme.

The programme also states the attributes that it offers to inculcate at the post graduation level. The graduate attributes encompass values related to well-being, emotional stability, critical thinking, ethical behaviour and also skills for employability. The programme prepares students for sustainability of their academic growth and lifelong learning.

M.Sc. Microbiology programme offers learners access to fundamental concepts in Microbiology and opens horizons to explore recent trends in the subject. There is substantial scope for interdisciplinary collaborative research with other allied branches of Biology. The programme fosters scientific temperament among the learners and enriches problem solving skills. It is designed to bring out the intellectual potential of the learner and also allow the learner to keep pace with the recent advances in Microbiology.

The postgraduate program offers a diverse range of subjects spanning Semester I and II, encompassing disciplines such as Cell Biology, Immunology, Protein Biochemistry, Evolutionary Biology, and Environmental Microbiology. In Semester III

and IV, students are taught advanced topics like Recombinant DNA Technology, Marine Microbiology and Biofilms, Pharmaceutical Microbiology and Drug Designing, Health Care Biotechnology, Intellectual Property Rights, and Synthetic Biology. The students not only acquire knowledge through these subjects, but also gain proficiency in entrepreneurial skills. This comprehensive approach goes beyond the basics, equipping students with the tools necessary to thrive in a dynamic and competitive field. By integrating a variety of subjects, the programme aims to foster a well-rounded and highly skilled cohort of individuals that can make meaningful contributions to Biotechnology and related industries.

On-the Job training in the curriculum instills team building attitude within students and ensures the building of a strong industry interface. The project evaluation method is designed in such a way that it helps in creating a strong background for the research, skills to generate systematic reports and create effective presentation. The Research project or Dissertation helps the students greatly to improve their understanding of the subject and apply their knowledge to the field.

2. Learning Outcomes-based Curriculum Framework

LOCF focuses on curriculum framework, curriculum aims, learning targets and objectives. The curriculum framework also provides examples of effective learning, teaching and assessment practices. As the curriculum development is a collaborative and an on-going enhancement process, the LOCF instructs periodic reviews and revisions of the curriculum in accordance with the ever changing needs of students, teachers and society.

The framework describes how students are given exposure towards core knowledge of the subject, specialisation, choice based learning and other skill enhancement courses ensuring development of an integrated personality and employability. The template defines expected outcomes for the programme like core competency, communication skills, critical thinking, affective skills, problem-solving, analytical reasoning, research-skills, teamwork, digital literacy, moral and ethical awareness, leadership readiness along with specific learning course outcomes at the starting of each course. The Learning Outcomes based Curriculum Framework (LOCF) for M.Sc. Microbiology will certainly be a valuable document in the arena of outcome-based curriculum design.

2.1 Nature and extent of M.Sc. Microbiology

The M.Sc. Microbiology programme is of two years duration. Each year is divided into two semesters. The total number of semesters are four. The teaching and learning in the M.Sc. Microbiology programme will involve theory classes (lectures) and practicals, on-job training, Research methodology course and six months Internship/Research project.

The curriculum will be taught through formal lectures with the aid of PowerPoint presentations, audio-visual tools and other teaching aids can be used as and when required. Wherever possible, RBPT (Research based pedagogical tools) approach will be adopted to make the process of learning more learner-centric. ICT-based teaching-learning tools will be incorporated through which even the mundane aspects could be made more interesting and relevant.

2.2 Programme Education Objectives (PEOs)

The overall aims of master's degree programme in Microbiology are to:

1. Apply the knowledge of different domains of Microbiology to solve issues in the environment and routine life.
2. Evaluate the application of Microbiology in various fields such as, Molecular Biology, Immunology, Genetics, IPR, Synthetic Biology etc.
3. Execute short term/long term research projects incorporating basic and advanced Microbiology techniques under supervision.
4. Obtain a suitable position in an Industry, Academia or pursue a career in research.
5. Display traits of global citizenship,

3. Graduate Attributes in Microbiology

Attributes expected from the postgraduates of M.Sc. Microbiology Programme are:

GA-1. Disciplinary knowledge: Sound knowledge of the fundamentals of Microbiology with emphasis on the knowledge of recent developments in the various fields of Microbiology.

GA-2. Scientific reasoning: Skill set in performing bacteriological techniques.

GA-3. Analytical reasoning: Ability to analyse, think, plan, execute and review experiments and experimental results.

GA-4. Research-related skills: Awareness about research planning and ethical considerations in all the fields.

GA-5. Self-directed learning: Entrepreneurial skills as an offshoot of interaction with several Industry experts.

GA-6. Communication Skills: Expertise in communication skills.

GA-7. Leadership readiness/qualities: Gain life skills such as team work, leadership, patience as a result of group project participation.

4. Qualification descriptors

Upon successful completion of the programme, the learners receive a M.Sc. degree in Microbiology. Microbiology graduates of this department are expected to acquire knowledge of different domains of Microbiology. They will be able to demonstrate practical skills and the ability to apply principles of Microbiology to obtain solutions to domain related problems. This will also establish a concrete base to pursue further research in Microbiology. The postgraduates are thus able to contribute to research and development, Academia, Government and public sectors. Along with the basic prerequisites of the discipline the emphasis would also be to facilitate the holistic development of the learner. A synergistic blend of proper communication skills, inquisitiveness and consistent upgradation of the knowledge would open avenues for academic excellence and greater career heights too.

The list below provides a synoptic overview of possible career paths provided by postgraduate training in Microbiology:

1. Academics

2. Research

3. QC and QA departments in pharmaceutical industries

4. Government or Private Food and Water Testing Laboratories

5. Medical Laboratory Technology

6. Food Packaging and Dairy Microbiology firms

7. Cosmetic industry, Fermentation Industries

8. Entrepreneurial opportunities

Job Roles for M.Sc. Microbiology post-graduate:

After post-graduation, one can seek a professional career as:

1. Laboratory technician in an Instrumentation Laboratory.

2. Manager in a Research Laboratory, Hospitals, Blood Banks and Public Health Sector.

3. QA and QC manager in Pharmaceutical, Cosmetics, Fermentation and other industries.

4. Technician in Food, Dairy, Water testing and Pathology Laboratory.

5. Entrepreneur for small scale/large scale microbial product manufacturing Industries.

6. Scientific officer for research and development.

7. Clinical research analyst, Medical Coding.

8. Scientific journal editors.

9. Assistant professor /Associate professor /Professor.

Higher Education options for M.Sc. Microbiology graduate:

1. Ph.D. in Microbiology/Life Science/Environmental Science/Clinical Microbiology etc

2. MBA, PG Diploma in Medical Laboratory Technology (PGDMLT) or any other relevant PG Diploma.

The learners who complete two years of full-time study of a postgraduate programme will be awarded a Master's degree in Microbiology.

Programme Specific Outcomes (PSOs)

After the successful completion of M.Sc. Microbiology programme, the learner will be able to:

1. Implement the principles of Genetics, Molecular Biology, Cell Biology and Protein biochemistry in the molecular analysis of a living cell.
2. Investigate the molecular changes leading to evolution.
3. Analyze microbial interactions within the ecosystem and formulate sustainable solutions.
4. Apply the concepts of Marine Microbiology in the development of biomimetic materials.
5. Incorporate the principles of Drug designing, cell dynamics and metabolism of organic and inorganic compounds in the domain of Pharmaceutical Sciences.
6. Assess the recent advancements in Health-care biotechnology, Recombinant DNA Technology, Synthetic Biology and its applications in the field of medicine.
7. Develop advanced biotechnological methodologies to address real-world challenges and contribute to advancements in Health-care, Agriculture, and environmental sustainability.

5.1 Course Mapping.

Semester	PSO		I	II	III	IV	V	VI	VII
	Course								
I	MJ 1		√	√		√	√	√	√
	MJ 2		√		√		√	√	√
	MJ 3		√				√	√	√
	MJ 4		√	√	√	√		√	√
	DSE options	I	√	√				√	√
		II	√		√		√	√	√
		III	√		√	√	√	√	√
	RM		√	√	√	√	√	√	√
II	MJ 1		√		√	√	√	√	√
	MJ 2		√		√	√			√
	MJ 3		√		√	√	√	√	√
	MJ 4		√	√		√	√	√	√
	DSE options	I	√		√	√	√		√
		II	√			√	√	√	√
		III	√		√	√			√

	OJT		√		√	√	√	√	√
III	MJ 1		√				√	√	√
	MJ 2		√				√	√	√
	MJ 3		√		√	√	√	√	√
	MJ 4		√				√	√	√
	DSE options	I	√	√	√	√	√	√	√
		II	√	√	√	√	√	√	√
	DSE options	I			√	√	√	√	√
		II	√		√	√	√	√	√
IV	MJ 1		√		√		√	√	√
	MJ 2		√			√	√	√	√
	MJ 3		√	√	√	√	√	√	√
	MJ 4		√		√	√	√	√	√
	RP		√		√	√	√	√	√

RM : Research Methodology Course

RP: Research Project

OJT: On Job Training.

6. Structure of M.Sc. Microbiology programme

The programme consists of two years (two semesters per year). The syllabus is drafted such that all significant theoretical subjects are covered in the initial three semesters with an emphasis on on-the-job training and research project/internship/ apprenticeship work in industry or certified laboratories.

Sem	Major	DSE	RM/OJT/ RIA	Total
1	14	4	RM 4	22
2	14	4	OJT 4	22
3	16	6	-	22
4	8	-	RIA 14	22

- In Semester I, the learner will have four major core courses in Microbiology and allied fields, one discipline specific elective and one 4 credit course on Research Methodology .
- In Semester II, the learner will have four major core courses in applied and advanced microbiology, one discipline specific elective and will have to engage in on-job training for a minimum of 21 days.
- In Semester III the learner has four major core courses in allied and applied microbiology and two discipline specific elective courses.

- In Semester IV the learner has four major core courses in advanced microbiology and Internship/Apprenticeship/Research project and submit a dissertation for the same.

Dissertation should be appreciable, original and of good quality. Assessment of dissertation will be based on an open defense viva voce presentation.

1. Major Core Courses (MJ):

a) A course which is required to be opted by a candidate as a major core course. The course designed under this category aims to cover the basics that a student is expected to imbibe in that particular subject or discipline.

b) There are sixteen Major Core courses (MJ), four each, in semesters I II, III and IV

c) Each Major Core Courses is compulsory.

d) Each Major Core Course consists of 2 credits for theory ie. 30 hours; 2 lectures of each 1 hour per week and 1.5 credits per practical of three hours per week per course in semester I and II.

e) Each Major Core Course consists of 2 credits for theory ie. 30 hours; 2 lectures of each 1 hour per week and 2 credits per practical of 4 hours per week per course in semester III.

f) The purpose of having major core papers is to ensure that the institution follows a minimum common curriculum so as to adhere to common minimum standards with other universities/institutions.

2. Discipline Specific Elective (DSE) :

a) A course is chosen by the candidate from the same stream as an elective out of the three courses offered in semester I and II each. A course is chosen by the candidate from the same stream as an elective out of the two courses offered in semester III for each DSE. Elective course helps the

student to gain a broader understanding of the specialization in the major discipline.

b) There is one DSE course each in semester I, II and two in semester III. The credits assigned are 2 credits for theory ie. 30 hours; 2 lectures of 1 hr each per week and 2 credits for practical of four hours per week in semester 1 and 2. In semester 3, there are 2 credits for theory per course and 1 credit each for the practical OR there are 2 credits for theory per course and 2 credits of practical for one of the course

3. Research Methodology (RM)

a) This is a mandatory course that all postgraduate students of Science have to take.

b) Students are required to achieve understanding of the various nuances of research, how to formulate a research problem, plan the work and execute it effectively. Scientific writing and other skills relevant to research are taught here.

c) This course carries 4 credits (60 - hours in class teaching).

4. On Job Training (OJT)

a) On Job training is introduced as per the guidelines of the National Education Policy (NEP) 2020, which emphasizes the importance of research and internships in postgraduate education. The On-Job training will be mandatory for students with a duration of 120 hours.

b) This seeks to equip students with the ability to gain relevant soft skills such as teamwork, problem-solving, work ethics, adaptability, communication, and time management.

c) This training carries 4 credits. 1 credit corresponds to 30 hours of engagement in a semester.

5. **Research project/Internship/Apprenticeship/ (RIA):**

a) One of the fundamental principles guiding the development of our education system as per NEP 2020 is the fostering of 'outstanding research as a corequisite for outstanding education and development'. with this perspective Research project / Dissertation is a mandatory component of the masters program

b) Here the learner is assigned a research problem related to their field of specialization either within the department or at a premier institute of the country. The learner has to complete their research and present their dissertation at the end of the period.

c) Internship is introduced in semester IV of M.Sc course, having 14 credits. 1 credit of internship corresponds to 30 hours of engagement in a semester.

6.1 Content.

Sr.No	Semester	Course Number	Course Code	Course title
1	I	MJ I	23PSIMBMJICBI	Cell Biology
2		MJ II	23PSIMBMJ2PBC	Protein Biochemistry
3		MJ III	23PSIMBMJ3MMI	Medical Microbiology and Immunology
4		MJ IV	23PSIMBMJ4EVB	Evolutionary Biology
5		MJ PI	23PSIMBMJPI	Practicals based on MJ I and MJ II
6		MJ P2	23PSIMBMJP2	Practicals based on MJ III and MJ IV
7		DSE	23PSIMBDSEDVB	Developmental Biology
			23PSIMBDSENAN	Nanobiotechnology
			23PSIMBDSEATB	Advanced Techniques in Biology
8		DSE P	23PSIMBDSEDVBP/ 23PSIMBDSENANP/ 23PSIMBDSEATBP	Practical based on the DSE course chosen.
9		RM	24PSIMBRM	Research Methodology
10	II	MJ I	23PS2MBMJIVIR	Virology
11		MJ II	23PS2MBMJ2EVM	Environmental Microbiology
12		MJ III	23PS2MBMJ3ESP	Enzymology and Stress Physiology
13		MJ IV	23PS2MBMJ4MBI	Molecular Biology

14		MJ PI	23PS2MBMJPI	Practicals based on MJ I and MJ II
15		MJ P2	23PS2MBMJP2	Practicals based on MJ III and MJ IV
16		DSE	23PS2MBDSEIMY	Industrial Microbiology
			23PS2MBDSECAN	Cancer Biology
			23PS2MBDSEECO	Microbial Ecology
17		DSEP	23PS2MBDSEIMYP/ 23PS2MBDSECANP/ 23PS2MBDSEECOP	Practical based on the DSE course chosen.
18		OJT	23PS2MBOJT	On Job Training
19	III	MJ I	24PS3MBMJIOIM	Organic and Inorganic Metabolism
20		MJ II	24PS3MBMJ2RDT	Recombinant DNA Technology.
21		MJ III	24PS3MBMJ3MMB	Marine Microbiology & Biofilms.
22		MJ IV	24PS3MBMJ4PMD	Pharmaceutical microbiology and Drug Designing.
23		MJ PI	24PS3MBMJPI	Practicals based on MJ I and MJ II
24		MJ P2	24PS3MBMJP2	Practicals based on MJ III and MJ IV
25		DSE I	24PS3MBDSEINS	Instrumentation
			24PS3MBDSEBIC	Bioinformatics

26		DSEP	24PS3MBDSEINSP/ 24PS3MBDSEBICP	Practical based on the DSE course chosen.
27		DSE II	24PS3MBDSEIPR	Intellectual Property Right
			24PS3MBDSESBA	Synthetic Biology and its applications
28	IV	MJ I	24PS4MBMJICSV	Chromosome structure and variations
29		MJ II	24PS4MBMJ2HCB	Health Care Biotechnology
30		MJ III	24PS4MBMJ3AMB	Advances in Molecular Biology
31		MJ IV	24PS4MBMJ4PAB	Applications of Plant and Animal Biotechnology
32		RP/INT/A	24PS4MBRIA	ResearchProject/Internship/ Apprenticeship

6.2 Credit distribution for M.Sc. Microbiology.

Semester	Course Number	Course Title	Credits		
			Theory	Practical	Total
I	MJ I	Cell Biology	2	1.5	3.5
	MJ II	Protein Biochemistry	2	1.5	3.5
	MJ III	Medical Microbiology and Immunology	2	1.5	3.5
	MJ IV	Evolutionary Biology	2	1.5	3.5
	DSE	Developmental Biology/Nanobiotechnology/Advanced Techniques in Biology **Students will choose any one of the above**	2	2	4
	RM	Research Methodology	3	1	4
	Total				**22**
II	MJ I	Virology	2	1.5	3.5
	MJ II	Environmental Microbiology	2	1.5	3.5
	MJ III	Enzymology and Stress Physiology	2	1.5	3.5
	MJ IV	Molecular Biology	2	1.5	3.5
	DSE	Industrial Microbiology/Cancer Biology/Microbial Ecology **Students will choose any one of the above**	2	2	4

	OJT	On Job Training	4	-	4
	Total				**22**
III	MJ I	Organic and Inorganic Metabolism	2	2	4
	MJ II	Recombinant DNA Technology	2	2	4
	MJ III	Marine Microbiology & Biofilms	2	2	4
	MJ IV	Pharmaceutical Microbiology and Drug Designing	2	2	4
	DSE I	Instrumentation	2	2	4
		Bioinformatics			
	DSE II	Intellectual Property Right	2	-	2
		Synthetic Biology and its applications			
	Total				**22**
IV	MJ I	Chromosome structure and variations	2	-	2
	MJ II	Health Care Biotechnology	2	-	2
	MJ III	Advances in Molecular Biology	2	-	2
	MJ IV	Applications of Plant and Animal Biotechnology	2	-	2
	RP	Research Project/Internship/ Apprenticeship	-	-	14
	Total				**22**

6.3 Semester Schedule

Semester	Major Core Course (MJ)	Discipline Specific Elective (DSE) any one per semester		Research Methodology	OJT/RP/INT/A
I	Cell Biology	Developmental Biology		RM	-
	Protein Biochemistry	Nanobiotechnology			
	Medical Microbiology and Immunology	Advanced Techniques in Biology			
	Evolutionary Biology	-			
II	Virology	Industrial Microbiology		-	OJT
	Environmental Microbiology	Cancer Biology			
	Enzymology and Stress Physiology	Microbial Ecology			
	Molecular Biology	-			
III	Organic and Inorganic Metabolism	DSE I		-	-
	Recombinant DNA Technology.	Instrument ation	Bioinformatics		
	Marine Microbiology & Biofilms.	DSE II			
	Pharmaceutical microbiology and Drug Designing.	Intellectual Property Right	Synthetic Biology and its applications		

IV	Chromosome structure and variations	-	-	RIA
	Health Care Biotechnology.			
	Advances in Molecular Biology.			
	Applications of Plant and Animal Biotechnology.			

6.4 Course Learning Objectives

The M.Sc. Microbiology program is designed to equip students with a comprehensive understanding of advanced concepts and methodologies in microbiology. Throughout the two-year curriculum, students will develop a strong foundation in fundamental microbiological principles, including the study of microbial genetics, immunology, recombinant DNA technology, health care and pharmaceutical microbiology. They will gain proficiency in laboratory techniques and cutting-edge technologies used in microbiological research. The program places a strong emphasis on fostering critical thinking and analytical skills, enabling students to evaluate and solve complex microbiological problems. Furthermore, students will be exposed to interdisciplinary approaches, preparing them for diverse career paths in academia, industry, and healthcare. Additionally, students will gain insights into the fascinating domain of marine microbiology, studying the unique microbial communities and ecological processes in marine environments.

A key highlight of our M.Sc. Microbiology program is the integration of on-the-job training and research projects. Students will have the opportunity to apply theoretical knowledge in practical settings through internships with leading research institutions, pharmaceutical companies, or healthcare organizations. This hands-on experience will not only enhance their technical skills but also provide valuable insights into real-world microbiological challenges. The research project component of the program allows students to contribute to ongoing research initiatives in areas such as recombinant DNA technology, where they can explore the manipulation and application of genetic material to address critical issues in microbiology. Under the guidance of experienced faculty members, students will gain a deeper understanding of the scientific process, making meaningful contributions to the field. Overall, the combination of rigorous coursework, on-the-job training, and specialized research projects ensures that graduates are well-prepared for successful careers in the dynamic field of microbiology.

Syllabus - M.Sc. Microbiology Semester III

Semes -ter	Course No	Course Title	Course Code	Credits	Period (1hour)	Unit/ Module	Lecture/ Module	Examination		
								Internal marks	External marks	Total Marks
THEORY										
Core Courses										
III	I	Organic and Inorganic Metabolism	24PS3MB MJ1OIM	2	30	2	15	20	30	50
III	II	Recombinant DNA technology	24PS3MB MJ2RDT	2	30	2	15	20	30	50
III	III	Marine Microbiology and Biofilms	24PS3MB MJ3MMB	2	30	2	15	20	30	50
III	IV	Pharmaceutical Microbiology and Drug Designing	24PS3MB MJ4PMD	2	30	2	15	20	30	50
Practical Core Courses										
III	I & II	Practical I (Paper I & II)	24PS3MB MJP1	4	120	-	-	50	50	100
III	III & IV	Practical I (Paper III & IV)	24PS3MB MJP2	4	120	-	-	50	50	100

Discipline Specific Elective (Any one)										
Semester	Course No	Course Title	Course Code	Credits	Period (1hour)	Unit/ Module	Lecture/ Module	Examination		
								Internal marks	External marks	Total Marks
III	DSE I	Instrumentation	24PS3MBDSEINS	2	30	2	15	20	30	50
		Bioinformatics.	24PS3MBDSEBIC							
	PRACTICALS									
	DSE I	Practical's	24PS3MBDSEINSP/ 24PS3MBDSEBICP	2	60	-	-	25	25	50
III	DSE II	Intellectual Property Rights.	24PS3MBDSEIPR	2	30	2	15	20	30	50
		Synthetic Biology and its applications.	24PS3MBDSESBA							

M. Sc. (MICROBIOLOGY) SEMESTER III

COURSE I

COURSE TITLE: Organic and Inorganic metabolism.

COURSE CODE: 24PS3MBMJIOIM

[CREDITS - 02]

Course Learning Outcomes		
After the successful completion of the Course, the learner will be able to: 1. Describe pathways for metabolism of one-carbon and two-carbon compounds. 2. Analyse the variety of ways in which inorganic molecules of nitrogen, sulphur and iron are utilised by prokaryotes.		
MODULE I	Metabolism of one and two carbon compounds.	NO OF LECTURES - 15
Learning Objectives: 1) To describe the pathways for metabolism of one-carbon and two-carbon compounds. 2) To elaborate on the role of different coenzymes associated with one and two-carbon compounds.		
Learning Outcomes After the successful completion of the module the learner will be able to: 1) Describe various metabolic pathways for one-carbon and two - carbon compounds.		
Subtopic	Title	15L
1.1	Metabolism of one carbon compounds:	
	i. The acetyl-CoA pathway:Making acetyl–CoA from CO_2 via the acetyl–CoA pathway, Incorporating acetyl–CoA into cell material	4L
	ii. The acetyl–CoA pathway in *Clostridium thermoaceticum* Autotrophic growth, Carbon monoxide dehydrogenase	
	iii. The acetyl–CoA pathway in methanogens: Acetyl–CoA synthesis from CO_2 and H_2	

	iv. Methanogenesis from CO_2 and H_2 Energy conservation during methanogenesis Unique coenzymes in the Archaea	1L
	v. Methanogenesis from acetate	2L
	vi. Incorporation of acetyl–CoA into cell carbon by methanogens	
	vii. Using the acetyl–CoA pathway to oxidize acetate to CO_2 anaerobically	1L
	viii. The reductive tricarboxylic acid pathway (reductive citric acid cycle)	1L
	ix. Growth on CI Compounds other than CO_2: The Methylotrophs Growth on methane: The serine pathway and ribulose–monophosphate cycle	2L
1.2	**Metabolism of two- carbon compounds:** i) Ethanol- Acetic acid bacteria. ii) Degradation of urate to glyoxylate by *Pseudomonas aeruginosa* and *Pseudomonas acidovorans.* iii) Glycerate pathway, beta hydroxy aspartate pathway. iv) Oxidation of Oxalate by *Pseudomonas oxalaticus.* v) C4 pathway in plants: Synthesis of dicarboxylic acids in plants as carriers of CO_2 into the bundle sheath cells.	4L
MODULE II	**Inorganic metabolism**	**NO OF LECTURES - 15**

Learning Objectives:

To familiarize the learner with the variety of ways in which inorganic molecules of nitrogen, sulphur and iron are utilised by prokaryotes.

Learning Outcomes

After the successful completion of the module the learner will be able to:

1) Differentiate between assimilatory and dissimilatory pathways of nitrate and sulphate reduction.
2) Analyse the differences between pathways for oxidation and reduction of nitrate and sulphate.
3) Describe nitrogen fixation pathway and nitrogenases.
4) Explain symbiotic relation between heterocysts and vegetative cells.
5) Illustrate some of the inorganic pathways with the help of models.

Subtopic	Title	15L
2.1	Assimilation of nitrate.	1L
2.2	Assimilation of sulphate.	1L
2.3	Dissimilatory nitrate reduction.	1L
2.4	Dissimilatory sulphate reduction.	1L
2.5	Nitrogen Fixation: The nitrogen-fixing systems, The nitrogen fixation pathway, Heterocysts.	3L
2.6	Lithotrophy: The lithotrophs (tabulate).	1L
2.7	Ammonia-oxidizing bacteria.	2L
2.8	Nitrite-oxidizing bacteria.	2L
2.9	Sulfur-oxidizing bacteria.	2L
2.10	Iron-oxidizing bacteria.	1L

References:

- White, D. (2007). The biochemistry of prokaryotes. 3rd ed. Oxford University Press
- Gottschalk, G. (1986) Bacterial metabolism. 2nd ed. Springer Publication.

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M. Sc. (Microbiology) SEMESTER III

Major Core Course- I

COURSE TITLE: Organic and Inorganic metabolism.

COURSE CODE: 24PS3MBMJ1OIM

[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	-	5	5	5	10	-	25
II	-	5	5	5	10	-	25
Total marks per question	-	10	10	10	20	-	50
% Weightage	-	20	20	20	40	-	100

M. Sc. (MICROBIOLOGY) SEMESTER III

COURSE II

COURSE TITLE: RECOMBINANT DNA TECHNOLOGY

COURSE CODE: 24PS3MBMJ2RDT

[CREDITS - 02]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Describe the application of recombinant microorganisms in addressing industrial and environmental challenges by means of genetic engineering and bioprocessing. 2. Explain the application of protein and nucleic acid therapeutics in the field of medicine.

MODULE I	Industrial and Environmental uses of Recombinant Microorganisms.	NO OF LECTURES - 15

Learning Objectives

1) To introduce the learner to the significance of biological molecules and biopolymers in various industrial applications.
2) To explore the application of genetic engineering in enhancing the biodegradative capabilities of microorganisms for xenobiotic degradation.

Learning Outcomes

After the successful completion of the module the learner will be able to:

1) Describe the application of recombinant technology in the commercial-scale synthesis of biologically significant compounds.
2) Comprehend the principles and techniques of genetic engineering in developing microbial biodegradation pathways.

Subtopic	Title	15L
1.1	Introduction to different types of enzymes and gene isolation strategies.	1L

1.2	Small biological molecules: L-Ascorbic acid, Indigo, amino acids (flavour enhancer), lycopene, antibiotics.	4L
1.3	Biopolymers: Xanthan gum and Polyhydroxyalkanoates.	2L
1.4	Utilization of starch and sugars: Commercial production of fructose and alcohol, increasing alcohol production, increasing fructose production	3L
1.5	Hydrogen production.	1L
1.6	Microbial degradation of xenobiotics: Genetics engineering of biodegradative pathway, plastic degradation.	4L
MODULE II	**Protein and Nucleic acid therapeutics**	**NO OF LECTURES - 15**

Learning Objectives

1) To study the diverse applications of protein and nucleic acid therapeutics in the field of medicine and biotechnology.

Learning Outcomes

After the successful completion of the module the learner will be able to:

1) Explain the application of proteins and nucleic acid therapeutic in treating various human diseases.

Subtopic	Title	15L
2.1	Enzymes: DNase I, Alginate lyase, alpha antitrypsin, Targeting mitochondria.	4L
2.2	Recombinant antibodies: Hybrid Human - Mouse Monoclonal Antibodies, Human monoclonal antibody (Generation of Xenomouse), Anti-HIV and anticancer antibodies.	4L
2.3	Bacteria and therapeutics.	2L
2.4	Nucleic acid as therapeutic: Antisense RNA, Ribozymes, chimeric RNA-DNA molecules. interfering RNAs, Targeting systems	5L

References:

- Glick and Patten: Molecular biotechnology: principles and applications of recombinant DNA, 2010, 4th edition, ASM Press.

- Glick and Patten: Molecular biotechnology: principles and applications of recombinant DNA, 2022, 6th edition, ASM Press.
- Sandy B. Primrose and Richard M. Twyman: Principles of Gene Manipulation and Genomics, 7th edition, Blackwell publishing.
- T.A. Brown: Gene Cloning and DNA Analysis: An Introduction, 6th edition, 2010, Wiley publisher.
- David P. Clark and Nanette J. Pazdernik: Biotechnology, 2nd Edition, 2015, AP cell press.

Question paper Template

M. Sc. (Microbiology) SEMESTER III

Major Core Course- II

COURSE TITLE: Recombinant DNA Technology

COURSE CODE: 24PS3MBMJ2RDT

[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	-	5	10	5	5	-	25
II	-	5	10	5	5	-	25
Total marks per question	-	10	20	10	10	-	50
% Weightage	-	20	40	20	20	-	100

M. Sc. (MICROBIOLOGY) SEMESTER III

COURSE III

COURSE TITLE: MARINE MICROBIOLOGY AND BIOFILMS

COURSE CODE: 24PS3MBMJ3MMB

[CREDITS - 02]

Course Learning Outcomes		
After the successful completion of the Course, the learner will be able to: 1. Describe the organisms in marine habitats, and methods for their enumeration and cultivation. 2. Explore the formation of a biofilm and methods for its management.		
MODULE I	Marine Microbiology	NO OF LECTURES - 15
Learning Objectives 1) To describe the microbial diversity in marine habitats. 2) To explain factors influencing marine organisms. 3) To explore methods for enumeration and cultivation of marine organisms.		
Learning Outcomes After the successful completion of the module the learner will be able to: 1) Cultivate and enumerate marine microorganisms. 2) Explore applications of marine microorganisms. 3) Describe formation and management of a biofilm.		
Subtopic	Title	15L
1.1	Characterization and stratification of the oceans: Brief description of vertical and horizontal zones of marine habitats.	2L
1.2	Extreme Environmental conditions: i) Distinguishing features of marine microbes. ii) Marine life forms: Sulphate reducing bacteria, Magneto-tactic bacteria, Oxygenic and anoxygenic marine photosynthesis, Quorum Sensing in *Vibrio fischeri* and *Vibrio harveyi.*	3L

1.3	Mariculture: Avenues for Research and development relevant to Mariculture.	1L
1.4	Microbial Aspects of Marine Biofouling and Biodeterioration: Marine Microbial Biofilms in brief and microbial induced corrosion	1L
1.5	Methods in Marine Microbiology: i) Techniques of sampling and Remote Sensing. ii) Measurement of specific cell constituents as Biomarkers. iii) Use of Microelectrodes and Biosensors.	3L
1.6	Direct observation and enumeration of microbes: By application of Epifluorescence Light Microscopy, Confocal Laser Scanning Microscopy and Flow Cytometry	1L
1.7	Culture based methods for isolation and identification of microbes: Culture media and growth conditions	1L
1.8	Nucleic acid-based methods: Denaturing Gradient Gel Electrophoresis (DGGE), Terminal Restriction Length Polymorphism (TRFLP) and Fluorescence *in situ* Hybridization (FISH)	1L
1.9	Marine derived Biomimetic materials: Biomimetic mineralization and Biomimetic Artificial Muscles	2L
MODULE II	**Biofilms and their management**	**NO OF LECTURES - 15**

Learning Objectives

1) To describe the formation of a biofilm.
2) To explain management of a biofilm.
3) To explore the quorum sensing observed in biofilm.

Learning Outcomes

After the successful completion of the module the learner will be able to:

1) To evaluate the stages in the formation of a biofilm.
2) To adopt methods for management of a biofilm.

Subtopic	Title	15L
2.1	Structure and properties of biofilms: i) Formation of a biofilm and its Regulation: Role of Multiple Convergent Genetic Pathways: a. Early Attachment Events b. Maturation of the Biofilm c.	4L

	Detachment and return to the Planktonic Growth Mode. ii) Multispecies biofilms: Clinical Relevance e.g. Bacterial vaginosis.	
2.2	Biofilms in plant-associated habitats: i) Phyllosphere: Impact on survival and bacterial interactions, interaction of plants with epiphytic biofilms ii) Rhizosphere: Ubiquity and importance for rhizosphere bacteria, impact of rhizosphere biofilms on plant biology.	3L
2.3	Biofilms from different Environments: i) Impact of environment on biofilm development and its composition. ii) Biofilms in water bodies, prosthetics associated biofilms, human associated biofilms. e.g. – Gut.	3L
2.4	Study of Quorum Sensing: Cell-Cell Communication amongst bacteria in Biofilms.	2L
2.5	Management of Biofilms: i) Biofilm eradication: Use of biocides such as surfactants, enzymes, triclosan, chlorhexidine and quaternary ammonium compounds. ii) Use of other biofilm management methods: Restoration using Probiotics and Prebiotics.	3L

References:

- Munn, C. (2011). Marine Microbiology: Ecology & Applications (2nd ed.). Garland Science. https://doi.org/10.1201/9781136667527.
- David H. Attway & Oskar R. Zabosky (1993). Marine Biotechnology: Volume 1, 2, 3, Plenum Press.
- P. J. Scheuer: Marine. Natural Products, Volume 1 & 2 (1978 and 1980-81). Academic Press.
- O. Kinne: Marine Ecology, (1984). Vol. V. Ocean Management 3&4, John Wiley & Sons,
- R. R. Colwell (ed), (1982). Biotechnology of Marine Science,
- Microbial Biofilms. (2014). Methods and Protocols, Gianfranco Donelli, Springer Protocols Humana Press.
- Bacterial Biofilms. (2008). Tony Romeo, Volume 322, Springer.
- Davies DG, Parsek MR, Pearson J.P. Iglewski BH, Costerton JW, Greenberg EP. (1998).

The involvement of cell-to cell signals in the development of a bacterial biofilm. Science 280. (5361):295–98.

- O'Toole GA, Kolter R. (1998). The initiation of biofilm formation in Pseudomonas aeruginosa WCS365 proceeds via multiple, convergent signalling pathways: a genetic analysis. Mol. Microbiol. 28:449–61
- Morris, C. E. and Monier, J. M. (2003). The ecological significance of biofilm formation by plant-associated bacteria. Annu. Rev. Phytopathol. 41:429–53
- O'Toole, G., Kaplan, H. B. and Kolter, R. (2000). Biofilm formation as microbial development. Annu. Rev. Microbiol. 2000. 54:49–79
- Bacterial biofilms: from the Natural environment to infectious diseases. Nature Reviews Microbiology 2, 95-108 (February 2004).

Question paper Template

M. Sc. (Microbiology) SEMESTER III

Major Core Course- III

COURSE TITLE: Marine Microbiology and Biofilms

COURSE CODE: 24PS3MBMJ3MMB

[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	-	5	5	10	5	-	25
II	-	5	5	10	5	-	25
Total marks per question	-	10	10	20	10	-	50
% Weightage	-	20	20	40	20	-	100

M. Sc. (MICROBIOLOGY) SEMESTER III

COURSE IV

COURSE TITLE: Pharmaceutical Microbiology and Drug Discovery

COURSE CODE: 24PS3MBMJ4PMD

[CREDITS - 02]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Analyze the significance of biopharmaceuticals. 2. Execute microbiological techniques employed in the cosmetic industry. 3. Apply the drug development process. 4. Demonstrate the principles involved in pre-clinical and clinical trials.

MODULE I	Pharmaceutical Microbiology and analytical aspects	NO OF LECTURES - 15

Learning Objectives:

1) To explain the concept of process and method validation.
2) To describe preservation strategies in cosmetic products.
3) To introduce HACCP in the cosmetic industry.

Learning Outcomes:

After the successful completion of the module the learner will be able to:

1) Implement different microbiological techniques used in the cosmetic industry.
2) Apply the validation methods in the cosmetic industries.

Subtopic	Title	15L
1.1	Introduction to pharmaceutical Microbiology and pharmaceutical products.	1L
1.2	Production of Biopharmaceuticals: Upstream and Downstream processing.	3L
1.3	Analytical aspects for pharma, cosmetic products, and Microbiology: HACCP in relation to testing of cosmetic products: Pyrogen test, LAL test.	3L

1.4	Cosmetic Microbiology test methods: i) Anti-microbial Preservation efficiency and microbial content testing. ii) Laboratory evaluation of antimicrobial agents. iii) Method validation and Process validation.	7L
1.5	Preservation strategies: i) Preservation of finished product. ii) Preservation during manufacturing.	1L
MODULE II	**Drug design and discovery**	**NO OF LECTURES - 15**

Learning Objectives:

1) To explain the process of drug designing.
2) Introduce the concept of clinical research, pharmacogenetics and pharmacokinetics.

Learning Outcomes

After the successful completion of the module the learner will be able to:

1) Understand the role of bioinformatics and genomics in the drug discovery process.
2) Describe the process involved in pre-clinical and clinical trials.

Subtopic	Title	15L
2.1	Introduction to drug design and discovery.	1L
2.2	Drug designing: Ligand based drug design, structure-based drug design.	2L
2.3	Drug development Process: The impact of genomics and related technologies upon drug discovery - Gene chips, proteomics, structural genomics, pharmacogenetics and initial product characterization.	3L
2.4	Delivery of biopharmaceuticals: Oral delivery systems, pulmonary delivery, nasal, transmucosal and transdermal delivery systems. Preclinical studies: Pharmacokinetics, pharmacodynamics protein pharmacokinetics, tailoring of pharmacokinetic profile, protein mode of action and pharmacodynamics.	4L
2.5	Toxicity studies: Reproductive toxicity and teratogenicity, mutagenicity, carcinogenicity and other tests, clinical trials	3L

	and design, rial size design and study population	
2.6	Drug Regulatory agencies: USFDA, EMA, MHLW and CDSCO.	IL
2.7	Introduction of Indian Pharmacopoeia.	IL

References:

- Stephen P. Denyer, Norman A Hodges, Sean P Gorman. (2006). Pharmaceutical Microbiology (7th ed).
- Philip A. (2006). Cosmetic Microbiology a practical approach (2nd ed).
- Michael E. Swartz, Ira s. krull. (2012). Handbook of analytical validation (Ist ed.)
- Christopher M. Riley and Thomas w. Rosanske.1996. Development and validation of Analytical methods (Ist ed).
- Gary Walsh. (2003). Concept Pharmaceutical biotechnology and applications (2nd ed).Wiley.
- Kristian Stromgaard, Povl Krogsgaard-Larsen, Ulf Madsen. (2016). Textbook of Drug Design and Discovery Edited (5th ed).
- Geetanjali Sengar, Pranab Tripathy. (2012). Drug Regulatory Authorities (mlsu.ac.in).
- Arvind Alopiprasad Pardeshi. (2011). Role and Function of Drug Regulatory Authorities in the Backdrop of Good Governance January SSRN Electronic Journal DOI:10.2139/ssrn.1748629.
- Government of India, Ministry of Health. (2010). Pharmacopoeia of India: (the Indian pharmacopoeia).

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M. Sc. (Microbiology) SEMESTER III

Major Core Course- IV

COURSE TITLE: Pharmaceutical Microbiology and Drug Discovery

COURSE CODE: 24PS3MBMJ4PMD

[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	-	5	5	5	10	-	25
II	-	5	5	5	10	-	25
Total marks per question	-	10	10	10	20	-	50
% Weightage	-	20	20	20	40	-	100

MSc Microbiology SEMESTER III

Practical I - Core Course I and II

Course Code - 24PS3MBMJP1

Course Learning Outcomes
After the successful completion of the course the learner will be able to: **1. Isolate organisms involved in metabolism of C1 compounds and inorganic elements.** **2. Analyze and interpret the genetic material using molecular biology techniques.** **3. Demonstrate the applications of restriction enzymes in genetic engineering.**
Learning Objectives: 1. To Isolate and identify a methylotroph. 2. To isolate different genera of Nitrogen fixers. 3. To perform Micro Kjeldahl technique for Nitrogen estimation. 4. To immobilize whole cells by gel entrapment technique. 5. To utilise selective media for isolation of iron and sulphur oxidizers. 6. To perform agarose gel electrophoresis. 7. To solve problems on restriction mapping.
Learning Outcomes: After the successful completion of the module the learner will be able to: 1. Isolate and identify a *Methylobacterium spp.* 2. Enumerate sulphate reducing bacteria. 3. Isolate various nitrogen fixing bacteria. 4. Perform Micro Kjeldahl technique. 5. Immobilize organisms/enzymes using gel entrapment method. 6. Isolate iron and sulphur oxidizers 7. Discuss the applications of molecular biological techniques in the field of medicine.

Experiment No	Title of the experiment	Number of hours (Total : 240 hours) 60 hours/course
	Practical I (Core Course I and II)	
1.	Enrichment, isolation, and identification of *Methylobacterium.*	10
2.	MPN of sulphate reducing bacteria.	10
3.	Isolation of *Azospirillum.*	5

4.	Immobilization of *Azotobacter.*	10
5.	Isolation of *Cyanobacteria.*	5
6.	Estimation of Nitrogen content by Micro Kjeldahl.	10
7.	Isolation of iron and sulphur oxidizers.	10
8.	Using the mini-prep method to isolate plasmid DNA from the given strain of bacteria & its detection by agarose gel electrophoresis.	23
9.	Restriction-digest the given DNA sample and demonstrate the separation of fragments by performing agarose gel electrophoresis. Interpret the results by comparing with the standard digests provided.	27
10.	Problems on restriction mapping.	10

References:

- GeNei™ Restriction Digestion Teaching Kit.
- HiPer® Plasmid DNA Extraction Teaching Kit.
- Jayaraman. J, Laboratory Manual in Biochemistry, 2nd edition, New age International publication.

MSc Microbiology SEMESTER III

Practical II - Core Course III and IV

Course Code - 24PS3MBMJP2

Course Learning Outcomes
After the successful completion of the course the learner will be able to: 1. Assess the microscopic attributes of diverse microorganisms found in marine water. 2. Examine variations in biofilm formation across distinct environments and investigate the impact of disinfectants on its development. 3. Analyze the diverse methods employed to ensure the safety of personal care products. 4. Develop a phase III clinical trial protocol as per the provided case study. 5. Apply molecular docking techniques to predict and analyze protein-ligand interactions.
Learning Objectives: 1. To enrich and isolate thermophiles and halophiles from marine water. 2. To study the biofilm formation in different environments like soil, water etc. 3. To investigate the impact of disinfectant on biofilm formation. 4. To perform the sterility testing of pharmaceutical products. 5. To determine the efficacy of preservatives by studying the microbial load of cosmetic products. 6. To analyze the characteristics of phase III clinical trials. 7. To apply the AutoDock software for analyzing protein ligand interaction.
Learning Outcomes: After the successful completion of the practical the learner will be able to: 1. Assess the microbial diversity of marine water. 2. Analyze the variation in biofilm formation in different environments and study the different types of microorganisms present. 3. Determine the MIC of a disinfectant. 4. Assure product safety through microbial testing. 5. Explain the protocol of phase III clinical trial. 6. Comprehend the principles and methodologies of molecular docking using AutoDock software.

Practical II (Core Course III and IV)

Experiment No	Title of the experiment	Number of hours (Total : 240 hours) 60 hours/course
1	Enrichment, isolation, and characterization of thermophiles from marine hot springs.	10

2	Enrichment, isolation, and characterization of halophiles from marine saline samples.	10
3	Biofilm visualization (using microtiter plate) by staining a slide immersed in different environments such as soil, water, saliva (to emphasize compositional and structural variations in biofilms from different environments).	20
4	Determination of MIC of disinfectant/antimicrobials with sessile and planktonic bacteria (to show higher resistance of biofilms to antimicrobials as compared to Planktonic cells) quantified using crystal violet assay.	20
5	Report on LAL and Other tests for QC.	5
6	Sterility Testing of pharmaceutical products (Injectible).	15
7	Efficacy testing of preservatives like Parabens.	15
8	Enumeration of microbial load in cosmetic samples.	10
9	Case study – Designing a phase III clinical trial.	10
10	Molecular docking – AutoDock.	5

References:

- Environmental Microbiology: A laboratory Manual. 2nd edition.2004.Elsevier.
- I. Munn, C. (2011). Marine Microbiology: Ecology & Applications (2nd ed.). Garland Science. https://doi.org/10.1201/9781136667527.
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3182663/
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4568995/
- https://npra.gov.my/images/Announcement/Archives/Slides-amv/AMV%20-%20STERILITY%20TEST.pdf
- https://autodock.scripps.edu/

M. Sc. (MICROBIOLOGY) SEMESTER III

COURSE - DSE I

COURSE TITLE: Instrumentation.

COURSE CODE: 24PS3MBDSEINS

[CREDITS - 02]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Describe the concept, principle and working of spectroscopic and chromatographic techniques. 2. Apply the method of spectroscopic and chromatographic techniques for the instrumental analysis of a biomolecule.

MODULE I	Spectroscopic techniques: NMR and X-ray diffraction.	NO OF LECTURES - 15

Learning objectives:

1. To describe the principle of NMR and X-ray diffraction techniques.
2. To discuss the different technical aspects considered in working and applications of the instrument.

Learning outcomes
After the successful completion of the module, the learner should be able:

1. Apply the method of NMR and X-ray diffraction technique for instrumental analysis of a biomolecule.

Subtopic	Title	15L
1.1	Nuclear Magnetic Resonance NMR: i) Principle ii) Pulse-acquire and Fourier transform methods. iii) Nuclear Overhauser effect. iv) 13C NMR. v) Multidimensional NMR. vi) Instrumentation. vii) Applications: Molecular structure. determination, Solution structure of proteins and peptides, Magnetic resonance imaging.	10L

1.2	X-ray diffraction analysis: i) Principle. ii) X-ray diffraction. iii) Instrumentation-sample. iv) Applications: Single-crystal diffraction, Fibre diffraction, Powder diffraction. v)Reading /interpretation of X-ray images.	5L
MODULE II	**Advanced Chromatography**	**NO OF LECTURES - 15**
Learning objectives: 1) To describe the advanced concepts of Chromatographic techniques. 2) To emphasize the significance of advanced techniques of chromatography.		
Learning outcomes **After the successful completion of the module, the learner should be able:** 1) Describe the steps in HPLC, HPTLC, GC. 2) Compare and contrast between the different chromatographic techniques. 3) State the principle and applications of GC-MS.		
Subtopic	**Title**	**15L**
2.1	**High Performance Liquid Chromatography (HPLC):** i) Columns. ii) Application of sample. iii) Mobile phases. iv) Pumps. v) Detectors. vi) Applications.	5L
2.2	**High Performance Thin Layer Chromatography (HPTLC):** i) Principle. ii) Sample preparation. iii) Selection of stationary phase. iv) Sample Application. v) Chromatogram development. vi) Derivatization. vi) Visualization and documentation of chromatograms. vii) Densitometry. viii) Applications.	5L
2.3	**Gas Chromatography (GC):** i) Columns.	3 L

	ii) Sample Application. iii) Mobile phase. iv) Detectors. v) Applications.	
2.4	**High Resolution GC-Concept and Applications:** Principle and instrumentation- GC-MS.	2 L

References:

- Wilson and Walker. (2009). Principles and Techniques of Biochemistry and Molecular Biology. 7th edition.
- Norris and Robbins VA. (1971). Methods in Microbiology. New York: Academic Press London.
- H. R. Bolliger, M. Brenner. (1965). Thin Layer Chromatography, A Laboratory Handbook. Springer Verlag.
- Eike Reich, Anne Schibli. (2006). High Performance Thin Layer Chromatography for the Analysis of Medicinal Plants. Thieme Medical Publishers Inc.
- Advanced-Microscopy Techniques for the Characterization of Cellulose Structure and Cellulose-Cellulase Interactions, Jose M. Moran-Mirabal, http://dx.doi.org/10.5772/56584.

Question paper Template

M. Sc. (Microbiology) SEMESTER III

DSE I

COURSE TITLE: Instrumentation.

COURSE CODE: 24PS3MBDSEINS

[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	-	10	5	5	5	-	25
II	-	10	5	5	5	-	25
Total marks per question	-	20	10	10	10	-	50
% Weightage	-	40	20	20	20	--	100

PRACTICAL

COURSE - DSE I

COURSE CODE - 24PS3MBDSEINSP

CREDITS - 02

Course Learning Outcomes
After the successful completion of the course the learner will be able to: 1. **Apply chromatographic and advanced spectroscopic techniques for analysis of biomolecules**
Learning Objectives: 1. To develop a skill set in handling different advanced chromatographic and spectroscopic techniques.
Learning Outcomes: After the successful completion of the module the learner will be able to: 1. Perform TLC for qualitative analysis of amino acids and sugars. 2. Apply advanced chromatographic and spectroscopic techniques viz. HPLC, HPTLC, GC, NMR and XRD for analysis of biomolecules.

Experiment No	Title and Number of Credits	Number of hours Total - 60 hours
1	TLC of amino acids and sugars- sample preparation, working, interpretation.	10
2	HPLC-sample preparation, working, interpretation Demonstration.	10
3	HPTLC sample preparation, working, interpretation Demonstration.	10
4	GC sample preparation, working, interpretation Demonstration.	10
5	Visit to observe NMR and X-ray diffraction.	20

References:

- Wilson And Walker's Principles and Techniques of Biochemistry And Molecular Biology. 2018

M. Sc. (MICROBIOLOGY) SEMESTER III

COURSE - DSE I

COURSE TITLE: Bioinformatics

COURSE CODE: 24PS3MBDSEBIC

[CREDITS - 02]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Appraise the applications of bioinformatics in various fields. 2. Apply different tools and databases for protein structure visualization.

MODULE I	Introduction to bioinformatics & biological databases.	NO OF LECTURES - 15

Learning Objectives:

1) To identify the diverse applications of bioinformatics in various fields.
2) To familiarize the students with major biological databases and their relevance in bioinformatics research.
3) To solve sequence alignment problems and interpret the results.

Learning Outcomes

After the successful completion of the module the learner will be able to:

1) Recognize and explain the applications of bioinformatics.
2) Access and retrieve data from major biological databases.
3) Select and execute appropriate methods for sequence alignment.

Subtopic	Title	15L
1.1	Introduction to bioinformatics. i) Historical overview ii) Applications iii) Major databases iv) Molecular biology & Bioinformatics	1L
1.2	Introduction to biological (Nucleic acid and amino acid) databases: i) Types of databases.	5L

	ii) Biological databases: Primary, Secondary and specialized databases. iii) Information retrieval from biological databases (Entrez, genbank, SRS).	
1.3	Alignment of Pairs of Sequences: i) Biological Motivation of Alignment Problems. ii) Methods of sequence alignment (Dot Matrix, Dynamic Programming, Heuristics methods). iii) Using Scoring matrices (PAM, BLOSSUM, GONNET).	5L
1.4	Alignment of Multiple Sequences: i) Methods of multiple sequence alignment (SP, progressive, Iterative methods). ii) Evaluating multiple alignments & applications.	4L
MODULE II	**Molecular phylogenetics & protein analysis.**	**NO OF LECTURES - 15**

Learning Objectives:

1) To describe different methods of phylogenetic analysis.
2) To discuss the principles behind FASTA and BLAST algorithms for sequence similarity searching.
3) To explore protein structure databases & utilize tools for protein structure visualization.

Learning Outcomes

After the successful completion of the module the learner will be able to:

1) Construct and interpret phylogenetic trees.
2) Describe the impact and benefits of filtering and gapped BLAST in sequence alignment.
3) Classify proteins based on structural characteristics.
4) Align protein structures and apply classification methods.

Subtopic	Title	15L
2.1	Molecular Phylogenetics: i) Introduction to phylogenetic trees. ii) Methods of phylogenetic analysis. iii) Tree evaluation and problems in phylogenetic analysis.	4L
2.2	**Tools for similarity search & sequence alignment:** i) FASTA algorithm. ii) BLAST algorithm. iii) Filtering & gapped BLAST.	3L

2.3	Protein classification & Structure visualization: i) Protein structure & classification. ii) Protein structure databases (PDB, Swiss-Prot, NCBI). iii) Protein structure visualization databases & tools. iv) Protein structure alignment. v) Protein classification approaches.	5L
2.4	Protein Identification & characterization.	1L
2.5	Primary & Secondary structure analysis & prediction.	2L

References:

- Paul Higgs & Teresa Attwood. (2005). Bioinformatics and Molecular Evolution. Third edition. Blackwell Publication.
- Andreas Baxevanis. (2007). Bioinformatics: A Practical guide. Second edition. Wiley-Interscience.
- Jin Xiong. (2006). Essential Bioinformatics. Third edition. Cambridge University Press.

Question paper Template

M. Sc. (Microbiology) SEMESTER III

DSE I

COURSE TITLE: Bioinformatics

COURSE CODE: 24PS3MBDSEBIC

[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	-	5	5	5	10	-	25
II	-	5	5	5	10	-	25
Total marks per question	-	10	10	10	20	-	50
% Weightage	-	20	20	20	40	--	100

PRACTICAL

COURSE - DSE I

COURSE CODE - 24PS3MBDSEBICP

CREDITS - 02

Course Learning Outcomes
After the successful completion of the course the learner will be able to: 1. **Apply computational tools and software for biological data analysis.** 2. **Interpret and analyze biological data sets using bioinformatics approaches.**
Learning Objectives: 1. To appraise the importance of bioinformatics in biological research and its interdisciplinary nature. 2. To analyze biological sequences (DNA, RNA, protein) using computational methods to identify patterns, motifs, and functional domains. 3. To apply various bioinformatics tools and software packages for sequence alignment, motif finding, and phylogenetic analysis.
Learning Outcomes: After the successful completion of the module the learner will be able to: 1. Demonstrate competency in accessing, querying, and utilizing bioinformatics databases to support their research and analysis. 2. Apply bioinformatics tools and software to analyze biological data sets, including sequence alignment, motif discovery, and phylogenetic analysis.

Experiment No	Title and Number of Credits	Number of hours Total - 60 hours
1.	Biological databases: Gene bank, EMBL, DDBJ, flybase, HIV database, OMIM, SRS, TAIR.	20
2.	Sequence Alignment databases: Clustal W & types, Bio perl.	20
3	Protein structure analysis: PDB, Swiss-prot, FSSP,PIRCATH, SCOP.	20

References:

- National Center for Biotechnology Information (https://www.ncbi.nlm.nih.gov/)
- The Universal Protein Resource (UniProt) (https://proteininformationresource.org/)
- Clustal Omega multiple sequence alignment program

(https://www.ebi.ac.uk/jdispatcher/msa/clustalo)

- Online Mendelian Inheritance in Man (OMIM) (https://www.omim.org/)
- The Arabidopsis Information Resource (TAIR) (https://www.arabidopsis.org/)

M. Sc. (MICROBIOLOGY) SEMESTER III

COURSE - DSE II

COURSE TITLE: INTELLECTUAL PROPERTY RIGHTS

COURSE CODE: 24PS3MBDSEIPR

[CREDITS - 02]

Course Learning Outcomes		
After the successful completion of the Course, the learner will be able to: 1) Apply intellectual property law principles to real problems. 2) Demonstrate the knowledge and understanding of appropriate procedures for obtaining intellectual property protection.		
MODULE I	Basics of IPR.	NO OF LECTURES - 15
Learning Objectives: 1) To identify the different types of intellectual property rights. 2) To explain the importance of intellectual property rights in safeguarding innovations and creations.		
Learning Outcomes After the successful completion of the module the learner will be able to: 1) Differentiate between different types of intellectual properties. 2) Apply their knowledge of IPR to real world scenarios.		
Subtopic	Title	15L
1.1	Introduction: Concept of intellectual property and intellectual property system in India.	01
1.2	Patents: Concept of Patent, Patent act 1970 and its salient features, Product/Process Patents, Duration of Patents, Elements of Patentability, Non- Patentable Subject Matter, Procedure for Filing of Patent application and types of patent application.	04
1.3	Trademark: Definition, types, procedure for registration.	02
1.4	Copyright: Definition, classes of copyrights, criteria and infringement of copyright, non - copyright work, copyright board and its functions.	03

1.5	Industrial design: Features, eligibility criteria, famous industrial designs, Non-Protectable Industrial Designs in India, Procedure for Registration of Industrial Designs.	03
1.6	Geographical indications.	02
MODULE II	**IPR treaties and safety concerns of biotechnology**	**NO OF LECTURES - 15**

Learning Objectives:

1) To familiarize the learner with the legal framework governing intellectual property at national and international level.

Learning Outcomes:

After the successful completion of the module the learner will be able to:

1) Discuss the key IPR treaties in biotechnology.
2) Explain the scope of the patent and the associated safety concerns.

Subtopic	Title	15L
2.1	Treaties: Paris Convention, Patent Cooperation Treaty (PCT) , Budapest Treaty, Madrid protocol, Berne convention, TRIPS agreement and WIPO, GATT	08
2.2	Scope of patent in biotechnology: patenting in different countries, patenting life forms.	02
2.3	Safety concerns related to the use of GM foods: Food ingredients produced by genetically modified organisms: recombinant chymosin, tryptophan, bovine somatotropin. Concerns about the safety of consuming genetically modified foods. Concerns about the impact of genetically modified organisms on the environment.	05

References:

- David Kline and kappos.(2021). Introduction to Intellectual Property. Openstax.
- V.K. Ahuja.(2017).Law relating to intellectual property rights (3rd edition.).LexisNexis.
- Rupendra Tiwari, Mamta Bhardwaj.(2021). Intellectual property: A Primer for Academia. Punjab chandigarh University.
- Glick and Patten: Molecular biotechnology : principles and applications of recombinant DNA, 2010, 4th edition, ASM Press.

M. Sc. (MICROBIOLOGY) SEMESTER III

COURSE - DSE II

COURSE TITLE: SYNTHETIC BIOLOGY AND ITS APPLICATIONS.

COURSE CODE: 24PS3MBDSESBA

[CREDITS - 02]

Course Learning Outcomes		
After the successful completion of the Course, the learner will be able to: 1. Explain the fundamental principles and key concepts of synthetic biology. 2. Discuss the applications of synthetic biology and assess the benefits and risks associated.		
MODULE I	Fundamentals of Synthetic Biology.	NO OF LECTURES - 15
Learning Objectives: 1. To discuss the fundamental concepts and historical evolution of synthetic biology. 2. Evaluate the utility of different tools in synthetic biology.		
Learning Outcomes After the successful completion of the module the learner will be able to: 1. Demonstrate proficiency in experimental techniques by constructing gene circuits using logic gates.		
Subtopic	Title	15L
1.1	Introduction to synthetic biology	2L
1.2	History of synthetic biology: i) Toggle Switch, Repressilator, Autoregulatory circuits. ii) Modular riboregulatory, Two-input AND gate, Multicellular pattern formation. iii) Edge detection circuit.	3L
1.3	Relationship between system and synthetic biology.	1L

1.4	**The Engineering Cycle**	1L
1.5	**Biodesign:** i) Top - Down approach. ii) Bottom – Up approach. iii) System level design. iv) Device level design. v) Logic devices: OR, AND, NOT and NOR logic gates.	6L
1.6	**Tools in synthetic biology.**	2L
MODULE II	**Applications of Synthetic Biology.**	**NO OF LECTURES - 15**

Learning Objectives:

1) To analyze diverse applications of synthetic biology in various fields, including medicine, industry and agriculture.

Learning Outcomes

After the successful completion of the module the learner will be able to:

1) Evaluate the impact of synthetic biology on addressing challenges in healthcare and environmental sustainability.

Subtopic	Title	15L
2.1	Tissue engineering: Production of cultured meat.	2L
2.2	Engineered bacterial cells: Diagnosis and treatment of cancer, diabetes and gastro-intestinal diseases.	2L
2.3	Synthetic biology in drug delivery.	2L
2.4	Biofuel production using engineered microorganisms.	2L
2.5	Biosynthesis of therapeutic drugs.	2L
2.6	Medical applications of cell free synthetic biology	2L
2.7	Production of designer crops	3L

References:

- Synthetic Biology: Scope, applications and implications, Royal Academy of Engineering, 2009.

- Synthetic Biology: Macmillan Publishers Limited, Vol – 12, 2014.
- Applications of synthetic biology in medical and pharmaceutical fields- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10173249/pdf/41392_2023_Article_1440.pdf
- Bottom up approach - https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6100601/#:~:text=A%20well%2Dknown%20example%20for,contrary%2C%20started%20with%20nonliving%20matter.
- Production of cultured meat https://www.tandfonline.com/doi/full/10.1080/23311932.2017.1320814?scroll=top&needAccess=true

Evaluation Pattern – Core Courses.

External Evaluation - Semester End Examination 30 marks.

Duration – One and Half hours.

Question No	Module	Marks with option	Marks without option	Minimum marks for passing	Credit /Module	Total Credits/Paper
I	I	25	15	12	1	2
2	II	25	15		1	

Internal Evaluation - 20M

Pattern of Evaluation	Marks/Paper	Minimum marks for passing
Objective-MCQ, Short answer test, Assignments, Model making, PowerPoint presentations, Review writing, Case study etc.	20	8

Evaluation Pattern – Practical.

Practical Paper	External (Sem End) Marks	Internal (CIE) Marks	Total Marks	Minimum marks for passing	Credits
Practical I (Paper I and II)	60	40	100	40	4

Practical 2 (Paper III and IV)	60	40	100	40	4

Evaluation Pattern – DSE Course

External Evaluation - Semester End Examination 30 marks.

Duration – One and Half hours.

Question No	Module	Marks with option	Marks without option	Minimum marks for passing	Credit/ Module	Total Credits/Paper
1	I	25	15	12	1	2
2	II	25	15		1	

Internal Evaluation - 20M

Pattern of Evaluation	Marks/Paper	Minimum marks for passing
Objective-MCQ, Short answer test, Assignments, Model making, PowerPoint presentations, Review writing, Case study etc.	20	8

Evaluation Pattern – Practical.

Practical Paper	External (Sem End) Marks	Internal (CIE) Marks	Total Marks	Minimum marks for passing	Credits

DSE Practical	25	25	50	20	2

Syllabus – M.Sc. Microbiology Semester IV

Semester	Course No	Course Title	Course Code	Credits	Period (Ihour)	Unit/ Module	Lecture/Module	Examination		
								Internal marks	External marks	Total Marks
THEORY										
Core Courses										
IV	I	Chromosome structure and variations	24PS4MBMJICSV	2	30	2	15	20	30	50
IV	II	Health Care Biotechnology	24PS4MBMJ2HCB	2	30	2	15	20	30	50
IV	III	Advances in Molecular Biology	24PS4MBMJ3AMB	2	30	2	15	20	30	50
IV	IV	Application of Plant and Animal Biotechnology	24PS4MBMJ4PAB	2	30	2	15	20	30	50
IV		Internship/ Research project	24PS4MBRIA	14	420	-	-	-	-	350

M. Sc. (MICROBIOLOGY) SEMESTER IV

COURSE I

COURSE TITLE: Chromosome structure and Variations

COURSE CODE: 24PS4MBMJICSV

[CREDITS - 02]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1) Recognize and explain changes in chromatin structure. 2) Comprehend the structure and characteristics of organelle DNA in mitochondria and chloroplasts. 3) Summarize the types of chromosome rearrangement and its consequences.

MODULE I	Chromosome structure and organelle DNA	NO OF LECTURES - 15
Learning Objectives: 1) To explain the eukaryotic DNA Packaging. 2) To identify and describe several classes of sequence variations in DNA.		
Learning Outcomes After the successful completion of the module the learner will be able to: 1) Describe the packaging of eukaryotic chromosomes. 2) Elaborate the significance of mitochondria and chloroplasts DNA.		
Subtopic	**Title**	**15L**
1.1	**Eukaryotic Chromosome:** Chromatin, Nucleosome, and High order Chromatin structure.	3L
1.2	**Changes in chromatin structure:** polytene chromosome, DNASE I hypersensitivity, epigenetic changes associated with chromatin modifications.	2L
1.3	**Centromeres and Telomeres:** Structure and characteristics.	1L
1,4	**Several Classes of Sequence Variations.**	2L
1.5	**Organelle DNA:** i) Mitochondria and Chloroplast structure.	7L

	ii) Endosymbiotic theory. iii) Uniparental inheritance of organelle-encoded traits. iv) Mitochondrial genome. v) Evolution of mitochondria. vi) Damage to mitochondrial DNA is associated with aging. vii) Chloroplast genome. viii) Evolution of chloroplast.	
MODULE II	**Chromosome variations**	**NO OF LECTURES - 15**

Learning Objectives:

1) To identify different types of chromosome mutation and their underlying mechanisms.
2) To recognize the various consequences of chromosome rearrangements.

Learning Outcomes:

After the successful completion of the module the learner will be able to:

1) Comprehend the concepts of chromosome rearrangement and its effects on humans.
2) Differentiate aneuploidy and polyploidy.

Subtopic	Title	15L
2.1	Chromosome morphology and types of chromosome mutation.	2L
2.2	Chromosome rearrangement: Chromosome duplication and segmental duplication, Chromosome deletion, Chromosome inversion, Translocation.	7L
2.3	Fragile sites and copy number variations, mitochondrial DNA copy number variations.	1L
2.4	Aneuploidy: Types, effects of aneuploidy and aneuploidy in humans.	3L
2.5	Concept of Uniparental disomy and mosaicism.	1L
2.6	Types of polyploidy.	1L

References:

- Pierce, B. A. (2017). Genetics: A Conceptual Approach.5th edition United States: W. H. Freeman.

- Russell, P. J. (2006). iGenetics: a molecular approach.3rd edition United Kingdom: Pearson/Benjamin Cummings.
- Watson, J. D. (2014). Molecular Biology of the Gene. 7th edition United Kingdom: Pearson.
- Klug, W. S., Cummings, M. R. (2003). Concepts of genetics. 11th edition Italy: Prentice Hall.

Question paper Template

M. Sc. (Microbiology) SEMESTER IV

Major Core Course- I

COURSE TITLE: Chromosome structure and Variations

COURSE CODE: 24PS4MBMJ1CSV

[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	-	5	5	5	10	-	25
II	-	5	5	5	10	-	25
Total marks per question	-	10	10	10	20	-	50
% Weightage	-	20	20	20	40	-	100

M.Sc. (MICROBIOLOGY) SEMESTER IV

COURSE II

COURSE TITLE: Health care Biotechnology

COURSE CODE: 24PS4MBMJ2HCB

[CREDITS - 02]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Analyze the types of immunization and their purpose. 2. Evaluate the recent trends in development of vaccines. 3. Elaborate on different genetic disorders and their screening methods. 4. Describe the concept of gene therapy and its applications.

MODULE I	Recent developments in vaccines	NO OF LECTURES - 15

Learning Objectives:

1) To differentiate between active and passive immunization methods.
2) To analyse strategic considerations in vaccination programs.
3) To describe the various types of vaccines and their mechanisms of action.

Learning Outcomes

After the successful completion of the module the learner will be able to:

1) Explain the purpose of immunization and its impact on disease prevention.
2) Distinguish between active and passive immunization methods and understand when each is appropriate.
3) Classify vaccines into different types and explain how they elicit an immune response.

Subtopic	Title	15L
1.1	Immunization and routes of administration.	1L
1.2	Types of vaccines: Inactivated vaccines, attenuated vaccines, Purified macromolecules as vaccines, recombinant antigen and vector vaccines.	2L
1.3	Recent trends in vaccines: i) Subunit vaccines: HSV, *Influenza,Streptococcus & S.aureus.*	12L

	ii) Peptide vaccines: FMD & Malaria. iii) Genetic immunization: DNA vaccines: *Shigella, Influenza* and *Zika* virus. iv) Engineered attenuated vaccines: HSV, Cholera & *Leishmania spp.* v) Vector vaccines: Vaccines directed against viruses (Dengue) & bacteria (Tuberculosis). vi) mRNA vaccine - COVID.	
MODULE II	**Application and ethics of genetic technology**	**NO OF LECTURES - 15**

Learning Objectives:

1. To explain the concept of gene therapy and its potential in treating genetic disorders.
2. To explore emerging trends in gene therapy.
3. To explain the forensic applications of DNA fingerprinting.

Learning Outcomes:
After the successful completion of the module the learner will be able to:

1. Evaluate the various screening techniques for genetic disorders.
2. Comprehend the ethical dilemmas associated with genetic testing.
3. Elaborate the principles and applications of gene therapy
4. Apply the principles of DNA fingerprinting in forensic applications.

Subtopic	Title	15L
2.1	Genetic disorders and screening: i) Prenatal Genotyping for Mutations in the β- Globin Gene ii) Prenatal Diagnosis: Chorionic villus sampling, amniocentesis, pre-implantation diagnosis and sickle-Cell Anaemia iii)Single Nucleotide Polymorphisms and Genetic Screening iv) DNA Microarrays and Genetic Screening v) Genetic counselling and ethical dilemmas	5L
2.2	Treating Disorders with Gene Therapy: i) Gene Therapy for Severe Combined Immunodeficiency (SCID) ii) Problems and Failures in Gene Therapy iii) The Future of Gene Therapy: New Vectors and Target-Cell Strategies iv) Ethical Issues and Gene Therapy	5L

2.3	DNA Fingerprints: i) Minisatellites (VNTRs) and Microsatellites (STRs). ii) Forensic Applications of DNA Fingerprints.	3L
2.4	Genome Projects Use of Recombinant DNA technology: The Human Genome Project: An overview The Ethical, Legal, and Social Implications (ELSI) Program After the Genome Projects.	2L

References:

- Janis Kuby. (2006). Immunology. Sixth edition. W.H Freeman.
- Glick & Patten. (2022). Molecular biotechnology. Sixth edition. Wiley. ASM Press Washington, DC.
- William S. Klug & Michael R. Cummings. (2002). Concept of Genetics. Seventh Edition. Pearson.
- J.D. Watson & A.A Caudy. (2006). Third edition. Recombinant DNA. W.H Freeman.

Question paper Template

M. Sc. (Microbiology) SEMESTER IV

Major Core Course- II

COURSE TITLE: Health Care Biotechnology

COURSE CODE: 24PS4MBMJ2HCB

[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	-	10	5	5	5	-	25
II	-	10	5	5	5	-	25
Total marks per question	-	20	10	10	10	-	50
% Weightage	-	40	20	20	20	-	100

M. Sc. (MICROBIOLOGY) SEMESTER IV

COURSE - III

COURSE TITLE: Advances in Molecular Biology

COURSE CODE: 24PS4MBMJ3AMB

[CREDITS - 02]

Course Learning Outcomes:		
After the successful completion of the Course, the learner will be able to: 1. Analyse and select suitable eukaryotic expression vectors for specific applications. 2. Evaluate high throughput technologies in molecular biology.		
MODULE I	Molecular Biotechnology	NO OF LECTURES - 15
Learning Objectives: 1) To explain the regulation for controlling gene expression in eukaryotes. 2) To differentiate between yeast expression vectors. 3) To understand the key features of mammalian expression vectors.		
Learning Outcomes After the successful completion of the module the learner will be able to: 1) Apply strategies to increase protein production and understand the principles of large-scale production. 2) Demonstrate the ability to distinguish between the features and components of various vectors.		
Subtopic	Title	15L
1.1	Manipulation of gene expression in prokaryotes: i) Gene expression from strong and regulatable promoters *(lac, trp, pL, geneIO).* ii) Increasing protein production. iii) Large scale system. iv) Fusion protein: Use of fusion protein, cleavage of fusion protein, surface display. v) Increasing protein stability and facilitating protein production.	7L

	vi) Overcoming oxygen limitation. vii) Limiting biofilm formation. viii) DNA integration into the chromosome.	
1.2	Heterologous Protein Production: i) General features of eukaryotic expression vectors. ii) Fungus based expression system: YEps, YIps, YACs. *ii) Pichia pastoris* expression system. iv) Baculovirus insect cell expression system. v) Mammalian expression vector.	5L
1.3	Directed Mutagenesis: i) Oligonucleotide directed mutagenesis with M13 DNA. ii) Oligonucleotide directed mutagenesis with plasmid DNA. iii) PCR amplified oligonucleotide directed mutagenesis and error prone PCR.	3L
MODULE II	**Techniques in Molecular Biology.**	**NO OF LECTURES - 15**

Learning Objectives:

1) To understand the principles and advantages of microarray technology.
2) To evaluate the role of metagenomics in studying microbial genetic diversity.

Learning Outcomes

After the successful completion of the module the learner will be able to:

1) Comprehend the principles and working of NGS technology for high-throughput DNA sequencing.
2) Apply metagenomics approaches to analyse the genetic makeup of mixed microbial population

Subtopic	Title	15L
2.1	Variation of PCR: Hot Start PCR, Multiplex PCR, Nested PCR, Touchdown PCR and Quantitative PCR.	3L
2.2	Microarray Technology: Principle, technique and its applications.	2L
2.3	Next generation sequencing: Principle and Working of sequencing technology.	3L
2.4	Metagenomics: Technique and working.	2L
2.5	Metaproteomic: Principle, working and Top down and bottom-up approaches.	2L

2.6	Metatranscriptomics: Principle and working.	2L
2.7	Metabolomics: Principle and applications.	1L

References:

- Sambrook, J. and Russell, D.W. (2001) Molecular Cloning: A Laboratory Manual. 3rd Edition, Vol. 1, Cold Spring Harbor Laboratory Press, New York.
- Microarray and its applications, Rajeshwar Govindarajan, Jeyapradha Duraiyan, and Murugesan Palanisamy, Articles from Journal of Pharmacy & Bioallied Science.
- Illumina sequencing technology, Microbiology Research International Vol. 10(3), pp. 25-31, November 2022 DOI: 10.30918/MRI.103.22.022 ISSN: 2354-2128 Review
- Metagenomics: Kukurba KR, Montgomery SB. RNA Sequencing and Analysis. Cold Spring Harb Protoc. 2015 Apr 13;2015(11):951-69. doi: 10.1101/pdb. top084970. PMID: 25870306; PMCID: PMC4863231.
- Proteomics: Concepts and applications in human medicine Safa Al-Amrani, Zaaima Al-Jabri, Adhari Al-Zaabi, Jalila Alshekaili, Murtadha Al-Khabori *World J Biol Chem* 2021; 12(5):
- Kukurba KR, Montgomery SB. RNA Sequencing and Analysis. Cold Spring Harb Protoc. 2015 Apr 13;2015(11):951-69. doi: 10.1101/pdb. top084970. PMID: 25870306; PMCID: PMC4863231.
- Brown, T. A. (2018). Genomes 4. United States: CRC Press

Question paper Template

M. Sc. (Microbiology) SEMESTER IV

Major Core Course- III

COURSE TITLE: Advances in Molecular Biology

COURSE CODE: 24PS4MBMJ3AMB

[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	-	5	10	5	5	-	25
II	-	5	10	5	5	-	25
Total marks per question	-	10	20	10	10	-	50
% Weightage	-	20	40	20	20	-	100

M. Sc. (MICROBIOLOGY) SEMESTER IV

COURSE IV

COURSE TITLE: Applications of Plant and Animal Biotechnology.

COURSE CODE: 24PS4MBMJ4PAB

[CREDITS - 02]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Evaluate the mechanisms and applications of transgenesis in plants. 2. Appraise the mechanisms and applications of transgenesis in animals.

MODULE I	Plant Biotechnology	NO OF LECTURES - 15

Learning Objectives:

1) To evaluate the different methods of generating transgenic plants
2) To discuss the application of transgenesis to get better varieties of plants.

Learning Outcomes

After the successful completion of the module the learner will be able to:

1) Analyze the significance of different methods of transgenesis in plants.
2) Illustrate applications of transgenesis in plants.

Subtopic	Title	15L
1.1	Plant transformation with Ti plasmid of *Agrobacterium tumefaciens*:Ti plasmid derived vector systems, Chloroplast engineering	2L
1.2	Use of reporter genes in transformed plant cells.	1L
1.3	Manipulation of gene expression in plants: i) Transient gene expression. ii) Plant promoters. iii) Manipulation of genes in plants. iv) Facilitating protein purification. v) Protein glycosylation. vi) Gene stacking.	6L

	vii) CRISPR - Based Directed Evolution. viii) Polycistronic Gene expression.	
1.4	Producing marker free transgenic plants.	1L
1.5	Fungus and bacteria resistant plants: Transgenic plants, RNAi and CRISPR/Cas.	2L
1.6	Phytoremediation: Fruits and flowers - Flavr Savr Tomato, Lowering Ethylene Levels and CRISPR Mutants.	3L
MODULE II	**Animal Biotechnology**	**NO OF LECTURES - 15**

Learning Objectives:

1) To evaluate the different methods of generating transgenic animals.
2) To recognize the application of transgenic animals as models of human diseases.
3) To apply gene drives for eradication of vector transmitted diseases

Learning Outcomes

After the successful completion of the module the learner will be able to:

1) Summarize the transgenic animal methodologies.
2) Critique the application of transgenic animals as models of human diseases
3) Appraise the use of gene drives for eradication of vector transmitted diseases.

Subtopic	Title	15L
2.1	Transgenic animal methodologies: i) DNA microinjection method. ii) Retroviral Vector method. iii) Engineered Embryonic Stem Cell Method. iv) Somatic Cell Nuclear transfer for transgenic Livestock. v) Genome editing with the CRISPR-Cas System. vi) Conditional gene modification with the Cre-loxP recombination system. vii) Gene knockdown by RNA Interference.	8L
2.2	Transgenic animal models of human diseases: i) Mouse model of Alzheimer's disease. ii) Duchenne Muscular dystrophy. iii) Zebrafish melanoma model.	3L
2.3	Eradication of vector transmitted diseases: i) Malaria vector population suppression. ii) Dengue fever virus-resistant mosquitoes. iii) Reversal Drives.	4L

References:

- Plant Biotechnology: The genetic manipulation of plants, 2005, A. Slater, N. Scott & M. Fowler, Oxford Univ Press, Oxford.
- Glick and Patten: Molecular biotechnology: principles and applications of recombinant DNA, 2022, 6th edition, ASM Press.
- Introduction to Plant Biotechnology (3rd Edtn), H.S. Chawla.
- Roberta Smith, Plant Tissue Culture: Techniques and Experiments,2nd Edtn, Academic Press, 2000.
- H. K. Das (ed), Textbook of Biotechnology, Wiley India,2004.
- J. H. Hammond, P. Mcgarvey, and V. Yusibov (eds), Plant Biotechnology, Springer Verlag, Heidelberg, 2000.
- B. B. Buchanan, W. Gruissen and R. L. Jones (eds), Biochemistry and Molecular Biology of Plants, American Society of Plant Biology, Rockville, USA, 2000.
- Plant Biotechnology and Agriculture: Prospects for the 21st Century, Arie altman, Paul Michael Hasegawa,
- Plant Biotechnology and Genetics: Principles, Techniques & Applications, Stewart, C. Neal, June 2008,John Wiley &Sons
- Sandy B. Primrose and Richard M. Twyman: Principles of Gene Manipulation and Genomics, 7th edition, Blackwell publishing.

Question paper Template

M. Sc. (Microbiology) SEMESTER IV

Major Core Course- IV

COURSE TITLE: Applications of Plant and Animal Biotechnology

COURSE CODE: 24PS4MBMJ4PAB

[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	-	5	10	5	5	-	25
II	-	5	10	5	5	-	25
Total marks per question	-	10	20	10	10	-	50
% Weightage	-	20	40	20	20	-	100

Evaluation Pattern – Core Courses

External Evaluation - Semester End Examination 30 marks.

Duration – One and Half hours.

Question No	Module	Marks with option	Marks without option	Minimum marks for passing	Credit/ Module	Total Credits/Paper
1	I	25	15	12	1	2
2	II	25	15		1	

Internal Evaluation - 20M

Pattern of Evaluation	Marks/Paper	Minimum marks for passing
Objective-MCQ, Short answer test, Assignments, Model making, PowerPoint presentations, Review writing, Case study etc.	20	8

8. Teaching learning process

The pedagogic methods adopted, involve direct lectures, remedial sessions, as well as technology- supported presentations. We believe that education is interactive and all sessions between students and teachers are based upon reciprocity and respect.

I) The lectures (of 1 hr duration) delivered to one whole class at a time systematically deal with the themes of the syllabus. This constitutes the core of the teaching learning process. The students are provided with bibliographic references and encouraged to visit college library for reference, so that they could be more interactive and ask more relevant questions in the class. This also helps to obtain knowledge beyond the boundaries of the syllabi.

2) Wherever needed, teachers use audio-video based technology devices (e. g. Power Point, YouTube videos) to make their presentations more effective. Some courses require that students see a documentary or feature film and course themes are structured so that discussions of these will further enhance the critical engagement of students with ideas introduced in their textual materials.

3) Remedial coaching, bridge courses, on-job training, research projects and field visits are adopted to enhance the scope of learning for the learners. Remedial sessions are conducted to offer assistance on certain advanced topics. Bridge courses facilitate the development of a concrete basis for the topics to be learnt in the coming academic year. On-job training facilitates hand-on training on new trends and techniques in Microbiology. Research projects and field-visits help in inculcating scientific temperament and critical thinking among the learners.

9. Assessment Method.

Evaluation Pattern: Theory

- Assessments are divided into two parts: Continuous Internal Evaluation (CIE) and Semester End Examination (SEE).
- The continuous assessment of 20M/course is conducted by the department. The CIE is taken at regular intervals in the form of Seminar presentations, MCQ based tests, Paper Summary writing etc.
- The Semester End Examination shall be conducted by the College at the end of each semester for 30M/course. Duration: 1 and ½ hours.

Examination Paper Pattern

Question No	Module	Marks with option	Marks without option.
1	I	5M x 5Q = 25M	5M x 3Q = 15M
2	II	5M x 5Q = 25M	5M x 3Q = 15M

Each question will have five sub questions a, b, c, d, e and out of which any three should be answered.

Evaluation pattern: Practical

- Assessments are divided into two parts: Continuous Internal Evaluation (CIE) and Semester End Practical Examination (SEE) only for semester III as follows:

Practical Paper	External (Sem End) Marks	Internal (CIE) Marks	Total Marks
Practical I (Core Course I and II)	50	50	100
Practical II (Core Course III and IV)	50	50	100
DSE	25	25	50

10. Programme and Course Code Format.

The course is coded according to following criteria:

1. First two numbers in each course code indicates year of implementation of syllabus (23- year of implementation is 2023-24)
2. Third letter 'P' designates postgraduate
3. Fourth letter 'S' designates Science discipline and the digit followed is for semester number (S1 – 1st Semester)
4. Letter 'MB' is for Microbiology discipline (MB-Microbiology). This forms the programme code 23PSMB. For the further course codes programme code is amended as follows:
5. To represent Major Core Course (MJ) followed by course number digit (1/2/3/4) and three lettered code representing the title of the course.
6. To represent Minor Stream Course (MN) followed by course number digit (1/2/3/4) and three lettered code representing the title of the course.
7. For Discipline Specific elective course code, (DSE) alphabets followed by a digit (1/2) followed by three letters specifying the course title are used.
8. 'P' followed by digit indicates practical course number. (Practical course number will be added for semesters only where there is more than one course.