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. I Microbiology

Postgraduate Programme

from

Academic Year

2023-2024

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			
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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			
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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	23PS1MBMJ1CBI	Cell Biology
2		MJ II	23PS1MBMJ2PBC	Protein Biochemistry
3		MJ III	23PS1MBMJ3MMI	Medical Microbiology and Immunology
4		MJ IV	23PS1MBMJ4EVB	Evolutionary Biology
5		MJ P1	23PS1MBMJP1	Practicals based on MJ I and MJ II
6		MJ P2	23PS1MBMJP2	Practicals based on MJ III and MJ IV
7		DSE	23PS1MBDSEDVB	Developmental Biology
			23PS1MBDSENAN	Nanobiotechnology
			23PS1MBDSEATB	Advanced Techniques in Biology
8		DSE P	23PS1MBDSEDVBP/ 23PS1MBDSENANP/ 23PS1MBDSEATBP	Practical based on the DSE course chosen.
9		RM	24PS1MBRM	Research Methodology
10	II	MJ I	23PS2MBMJ1VIR	Virology
11		MJ II	23PS2MBMJ2EVM	Environmental Microbiology
12		MJ III	23PS2MBMJ3ESP	Enzymology and Stress Physiology
13		MJ IV	23PS2MBMJ4MBI	Molecular Biology
14		MJ P1	23PS2MBMJP1	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	24PS3MBMJ1OIM	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	24PS3MBMJP1	Practicals based on MJ I and MJ II
24		MJ P2	24PS3MBMJP2	Practicals based on MJ III and MJ IV
25		DSE I	24PS3MBDSE1INS	Instrumentation
			24PS3MBDSE1BIC	Bioinformatics
26		DSEP	24PS3MBDSE1INSP/ 24PS3MBDSE1BICP	Practical based on the DSE course chosen.
27		DSE II	24PS3MBDSE2IPR	Intellectual Property Right
			24PS3MBDSE2SBA	Synthetic Biology and its applications
28	IV	MJ I	24PS4MBMJ1CSV	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 I

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										
I	I	Cell Biology	23PSIMB MJ1CBI	2	30	2	15	20	30	50
I	II	Protein Biochem-istry	23PSIMB MJ2PBC	2	30	2	15	20	30	50
I	III	Medical Microbiology and Immunology	23PSIMB MJ3MMI	2	30	2	15	20	30	50
I	IV	Evolutionary Biology	23PSIMB MJ4EVB	2	30	2	15	20	30	50
I	-	Research Methodology	24PSIMBRM	4	60	4	15	40	60	100
Practical Core Courses										
I	I & II	Practical I (Paper I & II)	23PSIMB MJP1	3	90	-	-	25	50	75
I	III & IV	Practical I (Paper III & IV)	23PSIMB MJP2	3	90	-	-	25	50	75

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
I	DSE I	Developmental Biology	23PS1MBDSEDVB	2	30	2	15	20	30	50
	DSE II	Nanobiotechnology	23PS1MBDSENAN	2	30	2	15	20	30	50
	DSE III	Advanced Techniques in Biology	23PS1MBDSEATB	2	30	2	15	20	30	50
DSE Practical										
I	I/II/III	Practicals based on chosen DSE course	23PS1MBDSEDVBP/ 23PS1MBDSENANP/ 23PS1MBDSEATBP	2	60	-	-	25	25	50

M. Sc. (MICROBIOLOGY) SEMESTER I

COURSE I

COURSE TITLE: Cell Biology

COURSE CODE: 23PSIMBMJICBI

[CREDITS - 02]

Course Learning Outcomes		
After the successful completion of the Course, the learner will be able to: 1. Analyze the functions of cell membrane and cytoskeleton in transport. 2. Exemplify various strategies of cell communication and signaling in plants and animals.		
MODULE I	Membrane structure and transport	NO OF LECTURES - 15
Learning Objectives: 1. To describe the structure of cell membrane and cytoskeleton. 2. To explore the proteins involved in transport of molecules between different organelles. 3. To implement the techniques used to study cell membranes.		
Learning Outcomes After the successful completion of the module the learner will be able to: 1. Explain the structure and components of cell membrane. 2. Describe the process of protein sorting. 3. Critique the techniques used to study cell structure.		
Subtopic	**Title**	**15L**
1.1	Cell membrane structure: Spectrins, Glycophorin, Intracellular Compartments and protein sorting.	2L
1.2	Transport between cellular organelles: Compartmentalization of cells, transport of molecules between the nucleus and cytosol, peroxisomes Endoplasmic reticulum.	6L

	Intracellular vesicular traffic: Endocytosis, exocytosis, transport from the ER through the Golgi apparatus and transport from trans Golgi network to Lysosomes. Transport of proteins in mitochondria and Chloroplast.	
1.3	Cytoskeleton: Cytoskeletal filaments, Microtubules, Actin regulation, molecular motors, cell behavior.	4L
1.4	Cell study: Study of cells under the microscope, Phase contrast, Fluorescence microscopy, Confocal microscopy, and Radioisotopes as Tracers-Techniques like Pulse-Chase.	3L
MODULE II	**Cell communication and signaling**	**NO OF LECTURES - 15**

Learning Objectives:
1. To illustrate the different types of cell junctions and their functions.
2. To explore signal transduction pathways

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

1. Analyze the importance of cell junctions and extracellular matrix in maintaining tissue structure and function.
2. Compare and contrast between different types of receptors involved in cell signaling.
3. Discuss signal transduction pathways in mammals and plants.

Subtopic	Title	15L
2.1	Cell Junctions, Cell Adhesion and the Extracellular Matrix: Cadherins and Cell-Cell Adhesion, Tight Junctions, Gap junctions, Basal Lamina, Integrin and Extracellular Matrix.	5L
2.2	Cell communication: Extracellular signal molecules, nitric oxide gas signal, classes of cell-surface receptor proteins.	2L
2.3	Signaling through enzyme linked cell surface receptors: Docking sites, Ras, MAP kinase, PI-3 kinase, TGF.	5L
2.4	Signaling in plants: Serine / Threonine kinases, role of ethylene, Photoreceptors (phytochromes, cryptochromes and phototropins).	3L

References:

- Albert, Johnson, Lewis, Raff, Roberts & Walter. Molecular Biology of The Cell. 5th

Edition.

- Lodish, Birk and Zipursky, Freeman. Molecular Cell Biology, 8th Edition.
- Alberts, Bray, Hopkin, Johnson, Lewis, Walter. Essential Cell Biology. 3rd Edition.
- Geoffrey M. Cooper and Robert E. Hausman. The Cell: A Molecular Approach. 4th Edition.

Question paper Template
M. Sc. (Microbiology) SEMESTER I
Major Core Course- I

COURSE TITLE: Cell Biology
COURSE CODE: 23PSIMBMJICBI
[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 I

COURSE II

COURSE TITLE: Protein Biochemistry

COURSE CODE: 23PSIMBMJ2PBC

[CREDITS - 02]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Analyze the factors that influence protein stability and folding. 2. Identify the molecular components and machineries involved in protein transport.

MODULE I	Protein folding and Protein Engineering	NO OF LECTURES - 15

Learning Objectives:
1. To elaborate on the features of amino acid and protein structure and folding.
2. To discuss approaches used in protein engineering.

Learning Outcomes
After the successful completion of the module the learner will be able to:
1. Describe the various structural features of amino acid and proteins
2. Evaluate the role of different forces and interactions involved in protein folding.
3. Apply various methods for protein engineering.

Subtopic	Title	15L
1.1	Amino acids: Classification. Titration curve of glycine, Amino acid sequencing.	2L
1.2	Structure of Proteins: Structure of peptide bond, stability of formation of peptide bond, Ramchandran plot, protein structure, factors determining secondary, tertiary, quaternary structures, thermodynamics of folding, role of disulphide bonds, dynamics of globular protein folding, chaperonins motifs and domains, Protein folding diseases: Amyloid diseases and prions.	7L

1.3	Protein Engineering: Adding disulphide bonds, changing asparagine to other amino acids, Reducing the number of free sulfhydryl residues, increasing enzymatic activity, Modifying metal cofactor requirement, Decreasing protease sensitivity, Modifying protein specificity, Increasing enzyme stability and specificity, altering multiple properties.	6L
MODULE II	**Protein transport**	**NO OF LECTURES - 15**

Learning Objectives:
1. To familiarize the learner with signaling and sorting of proteins.

Learning Outcomes
After the successful completion of the module the learner will be able to:
1. Comprehend different protein transport pathways and their specific functions within the cell.

Subtopic	Title	15L
2.1	Protein transport: extracellular protein secretion, drug export system.	2L
2.2	Protein folding: Folding of periplasmic proteins, translocation of folded proteins.	2L
2.3	Protein Translocation: Sec dependent protein Translocation: Sec system, Model for protein export.	2L
2.4	Sec independent protein translocation: Translocation of membrane bound proteins, E. coli SRP system and translocation of folded proteins: TAT system.	3L
2.5	Extracellular protein secretion: Type I pathway (hemolysin secretion by E. coli, type II, type III, type V, autotransporter (type IV), Chaperone usher pathway and protein transport across Gram positive bacteria (overview).	4L
2.6	Folding of periplasmic proteins: Importance of disulphide bonds in folding of periplasmic proteins. Role of thiol redox enzymes in catalyzing the formation of disulphide bonds in the periplasm.	2L

References:

- Mathew, Van Holde and Ahern, Biochemistry 3rd edition. Pearson Education.
- Zubay, G., Wm. C. 1998. Principles of Biochemistry. 4th edition. Brown Publishers.
- Lehninger A.L. Cox and Nelson. 1994. Principles of Biochemistry. CBS publishers and distributors Pvt. Ltd.
- Voet D. and Voet J.G.John Willey and Sons Inc. 1995. Biochemistry, 4th edition
- Pugsley A, 1989. Protein Targeting, Academic press Ist edition.
- Forster BM, Marquis H. Protein transport across the cell wall of monoderm Gram-positive bacteria. Mol Microbiol. 2012 May;84(3):405-13. doi: 10.1111/j.1365-2958.2012.08040.x.

Question paper Template
M. Sc. (Microbiology) SEMESTER I
Major Core Course- II

COURSE TITLE: Protein Biochemistry
COURSE CODE: 23PS1MBMJ2PBC
[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 I

COURSE III

COURSE TITLE: Medical Microbiology and Immunology

COURSE CODE: 23PS1MBMJ3MMI

[CREDITS - 02]

Course Learning Outcomes		
After the successful completion of the Course, the learner will be able to: 1. Investigate various microbial infections. 2. Describe the fundamental mechanisms underlying disorders of the immune system.		
MODULE I	Microbial Infections	NO OF LECTURES - 15
Learning Objectives: 1. To explore strategies for prevention and control of microbial infection. 2. To correlate disease symptoms with causative agents, isolate and identify pathogens.		
Learning Outcomes After the successful completion of the module the learner will be able to: 1. Evaluate the diagnostic methods to detect and identify microbial infections. 2. Develop critical thinking skills in the management of microbial infections.		
Subtopic	**Title**	**15L**
	Microbial Diseases Detailed study of following infections including Etiology, Transmission, Pathogenesis, Clinical Manifestations, Lab Diagnosis, Prophylaxis and Treatment.	
1.1	Viral Diseases	6L

	Dengue, Hepatitis non-A, Chikungunya, Swine-flu	
1.2	Bacterial Diseases Listeriosis, VRE (Vancomycin Resistant enterococci) Leptospirosis, Campylobacter, MOTT (Mycobacteria other than TB), Legionellosis, Conditions caused by *Helicobacter pylori.*	5L
1.3	Parasitic Disease Amoebic dysentery (*Entamoeba histolytica*) Giardiasis (*Giardia lamblia*)	4L
MODULE II	**Immune System and Health**	**NO OF LECTURES - 15**

Learning Objectives:
1. To elaborate on the concept of Immune tolerance and autoimmunity.
2. To analyze the effects of hyperactive immune response in transplant rejection.

Learning Outcomes
After the successful completion of the module the learner will be able to:
1. Explain the different types of Immune tolerance.
2. Evaluate the factors contributing to autoimmunity.
3. Describe the role of the immune system in transplantation.

Subtopic	Title	15L
2.1	Immune tolerance Central Tolerance, Peripheral Tolerance, Tolerance Induction, T- cell Tolerance, B-cell Tolerance, Incomplete Tolerance, Duration of Tolerance	4L
2.2	Autoimmunity Interplaying Factors, Triggering Factors, Mechanisms of Damage, Organ Specific Autoimmune Diseases, Systemic Autoimmune Diseases, Animal Models for Autoimmune Diseases, Proposed Mechanisms for Induction of Autoimmunity, Treatment of Autoimmune Diseases	4L
2.3	Transplantation & Transfusion Immunology Antigens Involved in Graft Rejection, Allorecognition, Graft Rejection-Role of APC's & Effector Cells, Graft v/s Host Diseases, Immunosuppressive Therapies. Blood Transfusion: ABO & Rh Blood Groups, Potential Transfusion Hazards, Transfusion Alternatives.	6L

2.4	Immune-exhaustion and immunosenescence- Alzheimer's disease	1L

References:

- Osborne, B. A., Kindt, T. J., Kuby, J., Goldsby, R. A. 2007. Kuby Immunology. United Kingdom: W. H. Freeman.
- Sulabha Pathak and Urmi Palan, 2011. Immunology-Essential and Fundamental. 3rd edition- Capital publishing company.
- Ananthanarayan & Paniker. 2009. Textbook of Microbiology, 8th edition, University press
- Fahim Halim Khan, 2004. Elements of Immunology. India: Pearson India.

Question paper Template
M. Sc. (Microbiology) SEMESTER I
Major Core Course- III

COURSE TITLE: Medical Microbiology and Immunology
COURSE CODE: 23PS1MBMJ3MMI
[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 I

COURSE IV

COURSE TITLE: Evolutionary Biology

COURSE CODE: 23PSIMBMJ4EVB

[CREDITS - 02]

Course Learning Outcomes		
After the successful completion of the Course, the learner will be able to: 1. Discuss different theories of evolution. 2. Apply the various principles of population genetics.		
MODULE I		**NO OF LECTURES - 15**
Learning Objectives: 1. To discuss the principles, processes and patterns of evolution.		
Learning Outcomes After the successful completion of the module the learner will be able to: 1. Explain the role of variation in evolutionary processes. 2. Apply evolutionary principles to understand the emergence of new species and patterns of biodiversity.		
Subtopic	**Title**	**15L**
	History and development of evolutionary theories.	
1.1	Natural Selection: Charles Darwin and Alfred Wallace, Types and levels of natural selection, Co-evolution Natural evolution (Kimura theory) and Molecular clocks.	3L
1.2	Neo-Darwinism and its importance in prokaryote evolution Modern Synthesis, Controversy (Selectionists Vs Neutralists)	4L
1.3	Molecular Evolution: Spontaneous mutation controversy, evolution of rates of mutation, phylogeny and molecular distances	4L

1.4	Speciation: Sexual and asexual organisms, origin and stability of diversity.	4L
MODULE II	**Population Genetics & Experimental Evolution**	**NO OF LECTURES - 15**

Learning Objectives:
1. To elaborate concepts of population genetics.

Learning Outcomes
After the successful completion of the module the learner will be able to:
1. Appreciate the importance of population genetics in the fields of evolutionary biology.
2. Comprehend the concept of experimental evolution and its importance.

Subtopic	Title	15L
2.1	Biological species: Concept, Mendelian population, models of population growth and variation.	3L
2.2	Population Genetics: Natural Selection, Mutations, Hardy Weinberg equilibrium, Genetic drift, Gene flow, non-random mating, Fitness landscape (Sewall wright – RA Fisher controversy).	7L
2.3	Experimental evolution: Long term evolution experiment – E. coli (Richard Lenski), Multicellularity experiments – Will Ratcliff, designing evolution experiments.	5L

References:

- Scott Freeman, Jon C. Herron. 2007. Evolutionary analysis.
- Daniel L. Hartl and Andrew G. Clark. 2006. Principles of Population Genetics. 4 th Edition.
- Charles Darwin. Origin of species
- Ridley Mark (2004). Evolution. Blackwell Science Limited.

Question paper Template
M. Sc. (Microbiology) SEMESTER I
Major Core Course- IV

COURSE TITLE: Evolutionary Biology
COURSE CODE: 23PSIMBMJ4EVB
[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	-	5	5	5	5	5	25
II	-	5	10	5	5	-	25
Total marks per question	-	10	15	10	10	5	50
% Weightage	-	20	30	20	20	10	100

MSc Microbiology SEMESTER I

Practical I - Core course I and II

Course Code - 23PS1MBMJP1

Course Learning Outcomes
After the successful completion of the course the learner will be able to: 1. Describe the principle and working of advanced Microscopes. 2. Evaluate the effect of different types of dyes on the integrity of cell membrane. 3. Explain the principles of various methods used for estimation of proteins. 4. Investigate the impact of temperature variation on protein structure and stability. 5. Analyze protein structure using bioinformatics tools. 6. Acquire the skills to prepare liposomes for various biochemical applications.
Learning Objectives: 1. To apply various microscopy techniques to study cellular structures and dynamics. 2. To study the integrity of the cell membrane in presence or absence of certain compounds. 3. To understand the acid-base properties of glycine. 4. To employ methods for detection of protein in a given sample. 5. To acquire skills to use online databases.
Learning Outcomes: After the successful completion of the practical the learner will be able to: 1. Compare and contrast between functioning of different types of microscopes. 2. Determine the pKa value of the amino acids. 3. Demonstrate the ability to accurately quantify protein concentrations. 4. Apply various quantitative techniques to measure protein concentration accurately. 5. Describe the structure of protein using online databases. 6. Discuss the applications of liposomes in the field of medicine..

Experiment No	Title of the experiment	Number of hours (Total : 180 hours) 45 hours/course
	Practical I (Core Course I and II)	
1.	Study of cell cytology using Phase contrast Microscopy- Demonstration.	5
2.	Study of Cell structure using Confocal Microscopy- Demonstration.	5
3.	Study of Cell structure using Fluorescence Microscopy- Demonstration.	5

4.	Study of Cell membrane integrity using uptake of neutral red.	15
5.	Estimation of NO (Nitric Oxide) produced by Macrophages	15
6.	Titration curve of glycine.	10
7.	Estimation of amino acids by ninhydrin method.	5
8.	Estimation of protein by Bradford method.	5
9.	To investigate the effect of temperature on protein denaturation (Demonstration).	10
10.	Use of PDB/Pymol/ other databases to study protein structure.	10
11.	Preparation of liposomes (Demonstration).	5

References:

- Lodish, Birk and Zipursky, Freeman. Molecular Cell Biology, 8th Edition.
- Jayaraman. J, Laboratory Manual in Biochemistry, 2nd edition, New age International publication.
- Pawley JB (editor) (2006). Handbook of biological confocal Microscopy (3rd Ed.) Berlin: springer. ISBN0-387-25921-X.
- Nano-structure analysis using Spatially Modulated Illumination microscopy, D. Baddeley, C. Tatram, Y. Weiland, C. Cremer, U.J. Birk in NATURE PROTOCOLS, Vol 2, pp. 2640- 2646 (2007).
- https://www.researchgate.net/publication/229834793_Phase_Contrast_Microscopy/link/60bdd5e1299bf10dffa1d970/download?_tp=eyJjb250ZXhOIjp7ImZpcnNOUGFnZSI6InBIYmxpY2FOaW9uIiwicGFnZSI6InBIYmxpY2FOaW9uIn19
- https://praxilabs.com/en/3d-simulations/in-vitro-neutral-red-uptake-assay-virtual-lab-simulation
- https://royalsocietypublishing.org/doi/pdf/10.1098/rspb.1923.0007
- https://www.ruf.rice.edu/~bioslabs/methods/protein/bradford.html
- Method of Bradford, Anal. Biochem.72:248 (1976); see also Anal. Biochem. 86: 142 (1978).
- Warren. D, Sarina. B, PyMOL User's Guide,Copyright © 2004 DeLano Scientific LLC.

MSc Microbiology SEMESTER I

Practical II - Core course III and IV

Course Code - 23PS1MBMJP2

Course Learning Outcomes
After the successful completion of the course the learner will be able to: **1. Interpret clinical and laboratory findings and formulate accurate diagnoses.** **2. Analyze genetic data to elucidate evolutionary patterns and relationships**
Learning Objectives: 1. To demonstrate proficiency in selecting and applying appropriate diagnostic methods for infectious diseases. 2. To apply population genetics principles to solve problems. 3. To study phylogenetic analysis. 4. To utilize the molecular clock to study evolutionary relationships.
Learning Outcomes: After the successful completion of the module the learner will be able to: 1. Employ different types of kits for diagnosing diseases. 2. Apply the principles of population genetics. 3. Discuss the significance of molecular clocks and phylogenetic analysis in studying evolution.

Practical II (Core Course III and IV)

Experiment No	Title of the experiment	Number of hours (Total : 180 hours) 45 hours/course
1.	Problem solving exercises in medical microbiology based on diseases caused by HIV, MOTT, Chikungunya, Helicobacter	2
2.	Diagnosis for HIV a. CD4 lymphocyte count for AIDS b. ELISA for AIDS	5
3.	Diagnosis for MOTT -Acid Fast staining method.	5
4.	Preparation of LJ medium.	5
5.	Diagnosis of parasites - wet mount of stool sample.	5
6.	Detection of dengue by kit method.	5
7.	MonoSpot Test for diagnosis of Chikungunya	5

	(Demonstration experiments).	
8.	SRID	5
9.	Coombs Test	5
10.	Detection of Rheumatoid arthritis (Kit experiment)	3
11.	Problems on population genetics.	15
12.	Problems on constructing phylogenetic tree and molecular clock.	15
13.	Case studies on evolution.	15

References:

- Benson's Microbiological applications : Laboratory manual in general Microbiology, Short version, Thirteenth edition.
- Practical Lab Manual Norris and Ribbon Volume 1 and 2.
- https://www.cdc.gov/dengue/healthcare-providers/testing/antigen-detection.html
- Epidemiology, diagnosis & treatment of non-tuberculous mycobacterial disease, Indian J Med Res 152, September 2020, pp 185-226 DOI 10.4103/ijmr.IJMR_902_20s.
- Janis Kuby. 6th edition. (2006). Immunology. W.H Freeman.
- Scott Freeman, Jon C. Herron. 2007. Evolutionary analysis.
- Peter. J. Russell. iGenetics: A molecular approach. 2016. Person India.
- Hay. Practical Immunology, 4th Edition. Blackwell Science.

M. Sc. (MICROBIOLOGY) SEMESTER I

COURSE - DSE I

COURSE TITLE: Developmental Biology

COURSE CODE: 23PSIMBDSEDVB

[CREDITS - 02]

Course Learning Outcomes		
After the successful completion of the Course, the learner will be able to: 1. Explain the mechanisms of cell development and its significance 2. Analyze the genetics of embryonic development of model organisms.		
MODULE I	Basics of cell development	NO OF LECTURES - 15
Learning Objectives: 1. To introduce fundamental concepts of embryonic development.		
Learning Outcomes After the successful completion of the module the learner will be able to: 1. Comprehend the different types of cell lineages and stem cells. 2. Illustrate the mechanisms of developmental pathways.		
Subtopic	Title	15L
1.1	Terminology: Cell potency, commitment, specification, induction, competence, determination and differentiation, Cell lineages, stem cells.	3L
1.2	Mechanism of developmental commitment: Autonomous, Conditional and Syncytial specification. Morphogen gradient and morphogenic field, Pattern formation and compartments.	4L
1.3	Morphogenesis and cell adhesion: Differential cell affinity, cadherins and catenin, sorting out of embryonic tissues and cell recognition	5L
1.4	Aging: Senescence, life span and causes of aging.	3L

MODULE II	Developmental genetics of model organisms	NO OF LECTURES - 15

Learning Objectives:
1. To describe the genetic basis of embryonic development.

Learning Outcomes
After the successful completion of the module the learner will be able to:
1. Describe the processes involved in early embryonic development.
2. Analyze the differences in molecular mechanisms involved in sex determination of *D. melanogaster* and *C. elegans.*
3. Explain the different morphogenetic processes involved in the formation of various organs and tissues.

Subtopic	Title	15L
2.1	Cloning Experiments	1L
2.2	Early embryonic development in Animals: Oogenesis and fertilization, The Embryonic Cleavage Divisions and Blastula Formation, Gastrulation and Morphogenesis. Stem Cell Lineages.	3L
2.3	The Genetics of Pattern Formation in *Drosophila.* Body Segmentation, Homeobox Genes	3L
2.4	Programmed Cell Death in Development.	1L
2.5	Characteristics of Model Organism *Drosophila* and *Caenorhabditis*	1L
2.6	Genetic Analysis of Developmental Pathways. Sex Determination in *Drosophila* and *Caenorhabditis*	3L
2.7	Molecular Analysis of Genes Involved in Development. Specification of cell types Organ Formation (eye in *Drosophila*)	2L
2.8	Genetics of whorl development in *Arabidopsis thaliana*	1L

References:

- Michael J.F. Barresi, Scott F. Gilbert. Developmental Biology. 12th Edition.
- D. Peter Snustad & Michael J. Simmons. Principles of Genetics. 3 rd Edition.

- Albert, Johnson, Lewis, Raff, Roberts & Walter. Molecular Biology of The Cell. 5th Edition.
- Benjamin Pierce. Genetics: A Conceptual Approach. 3rd Edition

Question paper Template
M. Sc. (Microbiology) SEMESTER I
DSE - I

COURSE TITLE: Developmental Biology
COURSE CODE: 23PSIMBDSEDVB
[CREDITS - 02]

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

PRACTICAL

COURSE - DSE I

COURSE CODE - 23PSIMBDSEDVB

CREDITS - 02

Course Learning Outcomes
After the successful completion of the course the learner will be able to: 1. Demonstrate basic techniques for working with animal cell cultures.
Learning Objectives: 1. To familiarize with cultivation and working with chick embryos. 2. To cultivate a model organism for genetic studies. 3. To prepare a macrophage culture and check its viability.
Learning Outcomes: After the successful completion of the module the learner will be able to: 1. Evaluate morphogenetic movements in a chick embryo. 2. Cultivate *Caenorhabditis elegans* . 3. Isolate macrophages from a tissue. 4. Perform trypan blue dye exclusion test and determine viability of cell cultures.

Experiment No	Title and Number of Credits	Number of hours Total - 60 hours
1	Observation of morphogenetic movements in chick embryo (Demonstration)	30
2	Cultivation of model organism: *Caenorhabditis elegans*	20
3	Cultivation of macrophage cell line and study of cell viability by trypan blue dye exclusion technique	10

References:

- Michael J.F. Barresi, Scott F. Gilbert. Developmental Biology. 12th Edition.
- D. Peter Snustad & Michael J. Simmons. Principles of Genetics. 3 rd Edition.

M. Sc. (MICROBIOLOGY) SEMESTER I

COURSE - DSE II

COURSE TITLE: Nanobiotechnology

COURSE CODE: 23PS1MBDSENAN

[CREDITS - 02]

Course Learning Outcomes		
After the successful completion of the Course, the learner will be able to: 1. Describe the different methods of synthesis of nanomaterials and their applications. 2. Explore different techniques for analysis of nanomaterials.		
MODULE I	Synthesis and applications of nanomaterials	NO OF LECTURES - 15
Learning Objectives: 1. To describe various methods of synthesis of nanomaterials. 2. To explore the applications of nanomaterials in various fields.		
Learning Outcomes After the successful completion of the module the learner will be able to: 1. Synthesize nanomaterials physical, chemical and biological methods. 2. Apply nanomaterials for different applications.		
Subtopic	**Title**	**15L**
1.1	Introduction to nanomaterials and their properties: Nanoscale systems, nanomaterials, nanoparticles, quantum dots, nanowires, nanotubes, thin films and multilayers.	5L
1.2	Synthesis of nanomaterials Physical method (Physical vapour deposition method), Chemical method (colloids as nanoparticles and their synthesis), Biological and microbiological methods.	5L
1.3	Applications: Nanotechnology and Health: Biosensors, Drug and gene delivery	5L

	systems, Nano-imaging, Cancer diagnosis and treatment. Nanotechnology and environment Nanotechnology and Agriculture	
MODULE II	**Analytical Techniques in Nanobiotechnology**	**NO OF LECTURES - 15**

Learning Objectives:

1. To explain the principle and working of instruments employed for characterizing nanoparticles.

Learning Outcomes

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

1. Employ microscopic, spectroscopic and diffraction techniques for the analysis of Nanoparticles

Subtopic	Title	15L
	Principle and working of:	
2.1	Scanning Probe Microscopes Scanning tunneling microscope (STM), Atomic force microscope (AFM), Scanning near field microscope (SNOM), Magnetic force microscope (MFM).	5L
2.2	Spectroscopy Techniques Optical (Ultraviolet-Visible-Near Infrared), Absorption Spectrometer, UV-Vis-NIR Spectrometer, Infrared Spectrometers, Fourier Transform Infrared Spectrometer, Auger Electron Spectroscopy	6L
2.3	Diffraction Techniques X-Ray Diffraction (XRD) Atomic Scattering Factor Bragg's Law of Diffraction Diffraction from different types of samples Crystal Structure Factor Diffraction from nanoparticles X-ray Diffractometer Dynamic Light Scattering	4L

References:

- Sharon, Madhuri and Maheshwar. 2012. Bio-Nanotechnology: concepts and applications. New Delhi, Ane books Pvt. Ltd.

- Scott R. P.W. 2012, Principles and Practice of Chromatography. Chrom-Ed Book Series. Reese-Scott Partnership.
- McNair H. M. and Miller J. M. 2009 Basic Gas Chromatography. Wiley International
- Kulkarni Sulabha. 2011. Nanotechnology- Principles and Practices. 3rd edition. New Delhi Capital Publishing Company.
- Chattopadhyay K.K. and Banerjee A.N. 2012. Introduction to Nanoscience and Nanotechnology. New Delhi PHI Learning Pvt. Ltd.

Question paper Template
M. Sc. (Microbiology) SEMESTER I
DSE – II

COURSE TITLE: Nanobiotechnology
COURSE CODE: 23PSIMBDSENAN
[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 II

COURSE CODE - 23PSIMBDSENAN

CREDITS - 02

Course Learning Outcomes
After the successful completion of the course the learner will be able to: 1. **Analyze the chemical and biological methods utilized in synthesizing nanoparticles.** 2. **Characterize nanoparticles using different methods.** 3. **Examine the practical applications of nanoparticles across diverse fields such as agriculture, medicine, and others.**
Learning Objectives: 1. To familiarize the learner to different methods of synthesizing nanoparticles. 2. To introduce the learner to various instruments used for characterization of nanoparticles. 3. To study the antimicrobial effect of nanoparticles. 4. To explore the diverse applications of nanoparticles.
Learning Outcomes: After the successful completion of the practical the learner will be able to: 1. Evaluate the advantages and disadvantages of the various methods used for synthesizing nanoparticles. 2. Enhanced skill set in effectively operating and utilizing advanced instruments.

Experiment No	Title and Number of Credits	Number of hours Total - 60 hours
1	Preparation of Nanosilver by Wet reduction Method (Chemical), using Neem Extract (plants) & Bacteria (Microbiological).	15
2	Characterisation of Nanosilver by UV spectrometry and microscopic methods.	10
3	Antimicrobial effect of Ionic silver and Nanosilver prepared by above methods.	10
4	Study of Nanosilver coated Gauze/textiles for antimicrobial effect on different bacteria.	15
5	Visit to Instrumentation laboratories.	10

References:

- https://medwinpublishers.com/OAJMB/nanoparticles-characterization-biological-synthesi

s-and-applications.pdf

- https://www.thepharmajournal.com/archives/2021/vol10issue8S/PartO/S-10-8-51-977.pdf

M. Sc. (MICROBIOLOGY) SEMESTER I

COURSE - DSE III

COURSE TITLE: Advanced Techniques in Biology

COURSE CODE: 23PSIMBDSEATB

[CREDITS - 02]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Explain different molecular biology methods for isolation, quantification and characterization of proteins and nucleic acids. 2. Comprehend chromatographic and spectrophotometric methods for characterization of proteins and nucleic acids.

MODULE I	Methods in Molecular Biology and Protein Characterization	NO OF LECTURES - 15
Learning Objectives: 1. To discuss the principles and methods used for protein purification and analysis.		
Learning Outcomes After the successful completion of the module the learner will be able to: 1. Perform basic molecular biology techniques. 2. Apply various methods for protein purification.		
Subtopic	**Title**	**15L**
1.1	Introduction: Studies related to DNA, RNA and Protein Principles underlying isolation of biomacromolecules from biological samples.	3L
1.2	Electrophoresis: analysis of DNA, RNA and Protein	4L
1.3	Molecular cloning Isolation of DNA/RNA fragments Introduction to cloning and expression vectors Vector designing	5L
1.4	Recombinant protein: Expression and purification	3L

MODULE II	Advanced Instrumentation: Liquid Chromatography-Mass Spectrometry	NO OF LECTURES - 15

Learning Objectives:
1. To explain principles and applications of LC-MS.

Learning Outcomes
After the successful completion of the module the learner will be able to:
1. Develop the skills required to operate an LC-MS system.
2. Develop the ability to interpret the data of LC-MS.
3. Explore a wide range of applications.

Subtopic	Title	15L
2.1	Principle and working: Liquid Chromatography Mass Spectrometry	6L
2.2	Applications Analysis of Proteins Analysis of Peptides Analysis of Proteomes	9L

References:

- Wilfred M. A. Neissen. Liquid Chromatography- Mass Spectrometry. 3rd edition Taylor and Francis group (Chromatographic Science Series, Volume 97).
- Marie-Isabel Aguilar. HPLC of Peptides and Proteins- Methods and Protocols. Humana Press (Methods in Molecular Biology, Volume 251).
- Sandie Lindsay. High Performance Liquid Chromatography. 2nd Edition. Wiley India edition (Analytical Chemistry by Open Learning).
- John R. Chapman. Mass Spectrometry of Proteins and Peptides. Humana Press (Methods in Molecular Biology, Volume 146).
- Sambrook and Russell. Molecular cloning- A Laboratory manual. 3rd edition, Volume 1, CSHL Press.

Question paper Template
M. Sc. (Microbiology) SEMESTER I
DSE - III

COURSE TITLE: Advanced Techniques in Biology
COURSE CODE: 23PS1MBDSEATB
[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

PRACTICAL

COURSE - DSE III

COURSE CODE - 23PSIMBDSEATB

CREDITS - 02

Course Learning Outcomes
After the successful completion of the course the learner will be able to: **1. Attain proficiency in molecular biology techniques and interpret the results.** **2. Interpret proteomics datasets.**
Learning Objectives: 1. To comprehend the operational principles and application of various molecular biology techniques. 2. To introduce the learner to the steps involved in vector designing. 3. To analyze the structure, function and interactions of proteins within biological systems.
Learning Outcomes: After the successful completion of the practical the learner will be able to: 1. Explain the principle of different electrophoresis techniques. 2. Create vectors for genetic manipulations. 3. Identify specific cellular processes and potential therapeutic targets using proteomic datasets.

Experiment No	Title and Number of Credits	Number of hours Total - 60 hours
1	Agarose gel electrophoresis	15
2	Polyacrylamide gel electrophoresis	15
3	Vector Designing	15
4	Practice with proteomics data set	15

References:

- Sambrook and Russell. Molecular cloning- A Laboratory manual. 3rd edition, Volume 1, CSHL Press.
- S.Harisha. Biotechnology procedures and experiments handbook.3rd edition.2007.Infinity Science Press.
- Molecular Cloning: A lab Manual.Ist Edition.

- GeNei™ Restriction Digestion Teaching Kit.
- HiPer® Plasmid DNA Extraction Teaching Kit.

M. Sc. (MICROBIOLOGY) SEMESTER I

COURSE TITLE: Research Methodology

COURSE CODE: 24PSIMBRM

[CREDITS - 03]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Describe the fundamental concepts of research. 2. Initiate research in alignment with scientific investigation. 3. Apply principles of biostatistics to data analysis. 4. Communicate findings of research in compliance with research ethics.

MODULE I	Research Fundamentals and Ethics	NO OF LECTURES - 15
Learning Objectives: 1. To define research and associated concepts. 2. To describe the types of sampling. 3. To apply a suitable research design to a problem. 4. To discuss aspects of research ethics.		
Learning Outcomes After the successful completion of the module the learner will be able to: 1. Describe research-based terms. 2. Apply a suitable research design to a problem. 3. Implement the guidelines of research ethics.		
Subtopic	**Title**	**15L**
1.1	Meaning and objectives of research: Definition of research, features of a good research study and scientific method, concept of Construct, Postulate, Proposition, Thesis, Hypothesis.	2L
1.2	Sampling and its types: Sampling frame Importance of probability sampling	5L

	Simple random sampling, systematic sampling, stratified random sampling and cluster sampling Problems due to unintended sampling Ecological and statistical population in the laboratory	
1.3	Study designs and variations: Basic, applied, historical, exploratory, experimental and ex- post-facto Case study, diagnostic research, crossover design and case control design Cohort study design and multifactorial design	3L
1.4	Research Ethics: Ethics: definition, moral philosophy, nature of moral judgements and reactions. Scientific conduct: Scientific misconducts: Falsification, fabrication and Plagiarism (FPP), Redundant publications: duplicate and overlapping publications, salami slicing. Publication ethics: definition, introduction and importance of best practices/standards setting initiatives and guidelines: COPE, WAME, etc.	5L
MODULE II	**Research problem, data collection and Scientific writing**	**NO OF LECTURES - 15**

Learning Objectives:
1. To describe laws and principles of research.
2. To elaborate on the types of research.
3. To describe the guidelines for scientific writing.

Learning Outcomes
After the successful completion of the module the learner will be able to:
1. Explain the different types of research.
2. Implement the principles and guidelines related to research.
3. Compile a comprehensive research report.
4. Effectively present research findings before the scientific community.

Subtopic	Title	15L
2.1	Hypothesis, theory and Scientific law: Development, structure, conditions, sources, formulation and explanation of hypothesis. Structure, identification, elements, classification and functions of theory. Scientific laws and principles.	4L

2.2	Methods and techniques of data collection: Types of data collection methods. Methods of primary data collection: (Observation/ Experimentation / questionnaire/ interviewing/ case / pilot study methods). Methods of secondary data collection (internal/ external).	3L
2.3	Schedule method: Features.	1L
2.4	Types of Research: Pure and applied research. Descriptive and explanatory research. Qualitative and quantitative approaches. Philosophy of research and validity of research. Various functions that describe characteristics of research such as systematic, valid, verifiable, empirical and critical approach.	3L
2.5	Scientific Writing: Report writing and presentation: Types of research reports Guidelines for writing a report: Report format and appendices Miscellaneous information (How to write a dissertation?) Poster and Oral presentations. Introduction to indexed and non-indexed research journals, databases in Microbiology and allied domains- Scopus, Pubmed etc., h-index, i10 index.	4L
MODULE III	**Use of Biostatistics in Research**	**NO OF LECTURES - 15**
Learning Objectives: 1. To describe principles and tools of biostatistics. 2. To apply statistical tools for data analysis.		
Learning Outcomes After the successful completion of the module the learner will be able to: 1. Explain different concepts of biostatistics. 2. Implement the methods of biostatistics for data analysis and validation.		
3.1	Introduction to Biostatistics and its Significance in Research: Terminologies used and different tests as per the data	1L
3.2	Measures of Central Tendencies: Revision of Mean, Median, and Mode with grouped and ungrouped data, Geometric mean and Harmonic mean.	3L

3.3	Measures of Variation: Range, Quartile Deviation, Standard Deviation, Coefficient of Variation. Concept of Standard error.	2L
3.4	Introduction to Skewness and Kurtosis: Brief interpretation of the data on the basis of Skewness and Kurtosis. Concept of Parametric and Non-Parametric tests.	1L
3.5	Concept of Variables and types of Scales: Nominal, Ordinal, Interval and Ratio scales.	1L
3.6	Basic principles of Testing of Hypotheses: Null and Alternate Hypothesis Type I and Type II errors Level of Significance Two-tailed and One-Tailed Tests p-value Approach Concept of Statistical table	2L
3.7	Parametric test – T test: Testing of Hypothesis concerning Means.	1L
3.8	Non-Parametric test-Chi square test: Test of Difference of more than two Proportions Test of Goodness of Fit	1L
3.9	Analysis of Variance-ANOVA One-way ANOVA	1L
3.10	Correlation and Regression: Correlation Analysis- Karl Pearson's Coefficient of Correlation, Spearman's co-efficient Linear Regression	2L

References:

- Kothari, C.R. (1985). Research Methodology- Methods and Technique. New Delhi, Wiley Eastern Limited.
- Das, S.K. (1986). An Introduction to Research. Kolkata, Mukherjee and Company Pvt. Ltd.
- P. Chaddah, (2018). Ethics in Competitive Research: Do not get scooped; do not get plagiarized. ISBN:978-9387480865.

- National Academy of Sciences, National Academy of Engineering and Institute of Medicine. (2009). On being a Scientist: A Guide to Responsible.Conduct in Research. (3rd ed.). National Academies Press.
- Resnik, D.B. (2011). What is ethics in research and why is it important?
- National Institute of Environmental Health Sciences, 1-10. Retrieved from
- https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm
- Misra R.P. (1989). Research Methodology: A Handbook. New Delhi, Concept Publishing Company.
- Kumar, R. (2005). Research Methodology-A Step-by-Step Guide for Beginners. (2nd ed.). Singapore, Pearson Education.
- Katz J.M., (2009). From Research to Manuscript: A guide to Scientific writing. USA, Springer Science.
- Veer Bala Rastogi. (2015). Biostatistics. (3rd revised edition) Medtech Publisher.
- Rosner B.A. (2011). Fundamentals of Biostatistics. Cengage Learning.
- Panneerselvam R. (2012). Research Methodology. New Delhi, PHI Learning Pvt. Ltd.
- Bhattacharya, D.K. (2006). Research Methodology. (2nd ed.). New Delhi Excel Books.
- Khan, Irfan Ali. (2008). Fundamentals of Biostatistics. Ukaaz Publications.

Question paper Template
M. Sc. (Microbiology) SEMESTER I

COURSE TITLE: Research Methodology
COURSE CODE: 24PSIMBRM
[CREDITS - 04]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	-	5	5	5	5	5	25
II	-	5	5	5	5	5	25
III	-	10	5	5	5	-	25
IV	-	10	5	5	5	-	25
Total marks per question	-	30	20	20	20	10	100
% Weightage	-	30	20	20	20	10	100

PRACTICAL

COURSE - Research Methodology

COURSE CODE - 24PSIMBRM

CREDIT - 01

Course Learning Outcomes
After the successful completion of the course the learner will be able to: 1. Demonstrate proficiency in writing literature review. 2. Develop skills in drafting clear and concise research project proposals. 3. Design and implement data collection exercises relevant to the research project and manage logistical challenges. 4. Analyze data set using MS-Excel. 5. Appraise the applications of R- programming. 6. Evaluate the significance of academic integrity through the Turnitin software.
Learning Objectives: 1. To acquire the ability to identify relevant scientific literature pertaining to a research topic. 2. To attain practical skills in designing and conducting data collection exercises relevant to a research project. 3. To develop proficiency in performing data analysis using Microsoft Excel. 4. To introduce the learner with the R programming language and its applications in data analysis. 5. To comprehend the applications of turnitin software.
Learning Outcomes: After the successful completion of the practical the learner will be able to: 1. Demonstrating proficiency in identifying, summarizing and synthesizing key findings from existing research studies. 2. Develop proficiency in collecting data using an appropriate method as per the research objectives. 3. Examine the practical applications of MS-Excel in data analysis. 4. Apply R-programming for statistical computing. 5. Evaluate the originality of written work through Turnitin software.

Experiment No	Title and Number of Credits	Number of hours
1.	Review of scientific literature, writing a Research Project Proposal (Summary, problem statement, rationale of study, objectives, study design, statistical analysis, and timeline)	8

	and presentation (Oral/Poster presentation).	
2.	Data collection exercises.	2
3.	Analysis of data using MS- Excel (Descriptive Statistics), and manual problem solving based on Geometric and Harmonic mean.	2
4.	Data analysis: R programming.	2
5.	Hand-on session on checking the extent of plagiarism-use of Turnitin.	1

References:

- Kothari, C.R. (1985). Research Methodology- Methods and Technique. New Delhi, Wiley Eastern Limited.
- Panneerselvam R. (2012). Research Methodology. New Delhi, PHI Learning Pvt. Ltd.
- https://www.researchexperts.in/turn-it-in-plagiarism-report-checker/?campaignid=19802710705&adgroupid=146857550557&creative=650843250366&keyword=anti%20plagiarism%20software%20online&adposition=&matchtype=p&network=g&device=c&gad_source=1&gclid=CjwKCAjwrcKxBhBMEiwAIVF8rJ4qTdVlnysB-oOtqwcgJ_SAqiSoADf9CjuT57MOfjUHExPuYKEt5xoCEfcQAvD_BwE

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

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)	50	25	75	30	3
Practical 2 (Paper III and IV)	50	25	75	30	3

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 II

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										
II	I	Virology	23PS2MBMJ1VIR	2	30	2	15	20	30	50
II	II	Environmental Microbiology	23PS2MBMJ2EVM	2	30	2	15	20	30	50
II	III	Enzymology and Stress Physiology	23PS2MBMJ3ESP	2	30	2	15	20	30	50
II	IV	Molecular Biology	23PS2MBMJ4MBI	2	30	2	15	20	30	50
Practical Core Courses										
II	I & II	Practical I (Paper I & II)	23PS2MBMJP1	3	90	-	-	25	50	75
II	III & IV	Practical I (Paper III & IV)	23PS2MBMJP2	3	90	-	-	25	50	75

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
II	DSE I	Industrial Microbiology	23PS2MBDSEIMY	2	30	2	15	20	30	50
	DSE II	Cancer Biology	23PS2MBDSECAN	2	30	2	15	20	30	50
	DSE III	Microbial Ecology	23PS2MBDSEECO	2	30	2	15	20	30	50
DSE Practical										
II	I/II/III	Practicals based on chosen DSE course	23PS2MBDSEIMYP/ 23PS2MBDSECANP/ 23PS2MBDSEECOP	2	60	-	-	25	25	50
On Job Training										
II	OJT	-	23PS2MBOJT	4	120	-	-	50	50	100

M. Sc. (MICROBIOLOGY) SEMESTER II

COURSE I

COURSE TITLE: Virology

COURSE CODE: 23PS2MBMJIVIR

[CREDITS - 02]

Course Learning Outcomes		
After the successful completion of the Course, the learner will be able to: 1. Elaborate on the various aspects of phage genetics and virus-call interactions. 2. Discuss infections caused by significant plant and animal viruses.		
MODULE I	Bacteriophage genetics	NO OF LECTURES - 15
Learning Objectives: 1. To introduce the concept of genetic mapping in viruses. 2. To describe the life cycle and genetic regulation mechanisms in bacteriophages.		
Learning Outcomes After the successful completion of the module the learner will be able to: 1. Infer results of mapping experiments to locate relative positions of genes. 2. Explain the life cycle of T7 phage.		
Subtopic	**Title**	**15L**
1.1	Life cycle of phage T7 and Lambda Virus-cell interaction, Cellular receptors and virus entry, Virus morphogenesis, mechanism of host cell damage, cellular gene expression. Phage T7: Organization of the T7 genes (overview), life cycle, Regulation of transcription. Developmental regulation of lambda.	5L
1.2	Bacteriophage genome: Phage phenotypes Genetic recombination in phages, Genetic fine structure mapping, Deletion mapping. Genes within genes: Bacteriophage ΦX174. Constructing phage vectors- phage display vectors, suicide vectors, combining phage vectors and transposons.	7L

1.3	Gene Transfer in Bacteria Drug resistance, transduction and Mapping.	3L
MODULE II	**Plant and animal viruses**	**NO OF LECTURES - 15**

Learning Objectives:
1. Discuss the structure and life cycle of plant and animal viruses.
2. Describe the medical significance and control of plant and animal viruses.

Learning Outcomes
After the successful completion of the module the learner will be able to:
1. Analyze the various aspects of plant and animal viral infections.
2. Describe the various control measures for infections by plant and animal viruses.

Subtopic	Title	15L
2.1	Introduction: Plant virus life cycles, Plant satellite viruses and satellite Nucleic acids, Viroids.	2L
2.2	Structure, genome, Lifecycle, pathogenesis, transmission, symptoms and diagnosis of: Citrus Tristeza Virus (CTV). .Pox virus: Vaccinia, orthopox virus, variola virus. Herpes Virus: varicella Zoster and simplex virus.	6L
2.3	Control of viruses and emerging viruses: viral vaccine, antivirals, virus control, interferon, novel chemotherapeutics.	3L
2.4	Viruses and Cancer: retrovirus, DNA tumour virus, adenovirus, HCC.	4L

References:

- James.D.Watson, Tania A Baker et al, 2004.Molecular Biology of the gene 4th and 5 th edition. Pearson
- D. Peter Snustad & Michael J. Simmons, 2012. Principles of Genetics 6th edition.
- Pierce, B.A.2012. Genetics- A Conceptual Approach. 4th Edition. W. H. Freeman.
- Lewin, B. 2007. Genes-IX. Jones and Bartlett Publishers.
- Luria. General Virology. 3rd edition.
- BOS, I. Longman, Introduction to Plant Virology. London.
- BOS, I. Longman. Animal Virology. Academic Press.

- Knight C. Springer Verlag, Chemistry of Viruses.
- Dulbecco and Giasberg, Virology. Harper and Ravi Publications.
- Edward Birge. Bacterial and Bacteriophage Genetics
- Teri Shors. 2009. Understanding Viruses. Jones and Bartlett publications.

Question paper Template
M. Sc. (Microbiology) SEMESTER II
Major Core Course- I

COURSE TITLE: Virology
COURSE CODE: 23PS2MBMJIVIR
[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 II

COURSE II

COURSE TITLE: Environmental Microbiology

COURSE CODE: 23PS2MBMJ2EVM

[CREDITS - 02]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Describe applications of microorganisms in bioremediation. 2. Summarize various approaches used in bioremediation and biodegradation of recalcitrant compounds and hydrocarbons.

MODULE I	Bioremediation and Biodegradation	NO OF LECTURES - 15
Learning Objectives: 1. To describe the role of microorganisms in degradation of recalcitrant compounds. 2. To summarize the degradation pathways for aromatic compounds and polymers.		
Learning Outcomes After the successful completion of the module the learner will be able to: 1. Evaluate the roles of microorganisms in bioremediation. 2. Illustrate the degradation pathways of aromatic compounds.		
Subtopic	**Title**	**15L**
1.1	Bioremediation: Types, processes, importance and its limitations. Technique in Bioremediation.	2L
1.2	Recalcitrant compounds: Petroleum contamination, Nitroaromatic compounds.	3L
1.3	Degradation of polymers: cellulose, lignin and lignocelluloses and xenobiotics.	2L
1.4	Degradation of aromatic and alicyclic compounds Important organisms, use of mixed cultures, common pathways of	3L

	aromatic degradation (catechuate and protocatechuate), aerobic and anaerobic degradation of aromatic compounds.	
1.5	Biotransformation of polycyclic aromatic hydrocarbons (PAHs): Naphthalene, anthracene, hydrocarbons, halogenated aliphatics (pathways).	5L
MODULE II	**Environment Management and Safety Concerns**	**NO OF LECTURES - 15**

Learning Objectives:
1. To elaborate on various technological applications for food processing of waste and their disposals.
2. To classify various wastes based on source and type.
3. To comprehend biosafety guidelines.

Learning Outcomes
After the successful completion of the module the learner will be able to:
1. Discuss various waste management approaches from the perspective of sustainable development.
2. Perform risk assessment for biohazardous materials.

Subtopic	Title	15L
2.1	Solid waste management: Biodegradable waste from kitchen, abattoirs and agricultural fields and their recycling by aerobic composting or biomethanation. Non-biodegradable waste like plastics, glass, metal scrap and Building materials Plastic recycling, metal recycling.	4L
2.2	Hazardous waste management: Hazardous waste from paint, pesticides and chemical industries and their composition, Probable means to reduce these wastes through Common Effluent Treatment Plants.	3L
2.3	Electronic waste management: Recovery of precious metals from electronic waste resources.	1L
2.4	Biomedical waste management	1L
2.5	Biohazards: Introduction, levels of biohazards, Risk assessment, proper cleaning procedures.	2L
2.6	Biosafety: Historical background and introduction, need of biosafety levels, biosafety guidelines for GMOs and LMOs.	3L

	Role of Institutional biosafety committee. RCGM, GEAC, etc. for GMO applications in food and agriculture. Environmental release of GMOs. Overview of national regulations and relevant international agreements. Eco- labeling, ISO 22000, Generally Recognized as Safe (GRAS)	
2.7	Introduction to Biocatalysis	1L

References:

- Ronald L. Crawford and Don L Crawford. 2005. Principles and Applications by 6th ed.
- B.D. Singh. 2010. Environmental Biotechnology. 4th ed. Kalyani publications
- R.C. Dubey.2007. A textbook of Biotechnology. 5th ed. S. Chand & Company Pvt. Ltd.
- Allan Scragg. 2008. Environmental Biotechnology. 2nd ed. Pearson education.
- H. V. Jadhav. 2002. Environmental management. Vipul Prakashan.
- R. S. Ambasht. 1998 Modern trends in ecology and environment. Backhuys Publishers.
- M. H. Fulekar. 2013. Industrial hygiene and safety. I K International Publishing House Pvt. Ltd.

Question paper Template
M. Sc. (Microbiology) SEMESTER II
Major Core Course- II

COURSE TITLE: Environmental Microbiology
COURSE CODE: 23PS2MBMJ2EVM
[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 II

COURSE III

COURSE TITLE: Enzymology and Stress Physiology

COURSE CODE: 23PS2MBMJ3ESP

[CREDITS - 02]

Course Learning Outcomes		
After the successful completion of the Course, the learner will be able to: 1. Analyze the kinetic parameters of enzyme catalysis and enzyme inhibitions. 2. Describe the molecular mechanisms of responses to different stress signals.		
MODULE I	Enzymology	NO OF LECTURES - 15
Learning Objectives: 1. To analyze the kinetic parameters of enzyme catalysis. 2. To evaluate different types of enzyme inhibitions.		
Learning Outcomes After the successful completion of the module the learner will be able to: 1. Apply the principles of enzyme kinetics to understand the behavior of enzymes. 2. Evaluate different types of enzyme inhibitions.		
Subtopic	**Title**	**15L**
1.1	Principles of enzymology: Factors governing catalytic power and enzyme specificity, catalytic efficiency. Binding energy and weak interactions and solving of problems.	2L
1.2	Mechanisms of enzyme catalysis: General acid-base, Covalent and Metal Ion catalysis.	1L
1.3	Enzyme kinetics: Michaelis-Menten, Lineweaver-Burk equation derivation, plots and solving of problems. Introduction to Adair equation.	3L
1.4	Kinetic parameters: Comparison of enzyme activities and solving problems.	1L

1.5	Multisubstrate enzymes: Properties and reactions: Random, ordered and Ping-pong.	2L
1.6	Enzyme inhibition: Reversible inhibition (Competitive inhibition, Uncompetitive inhibition, Mixed inhibition), equation derivation, solving of problems Irreversible inhibition and Suicide inactivators, HIV enzyme inhibitors Example of enzymatic reactions: Chymotrypsin and Lysozyme	4L
1.7	Reversible covalent modification: Concept and solving of problems.	1L
1.8	Drug design and catalytic antibodies: Basic concept and applications.	1L
MODULE II	**Signaling and Stress Physiology**	**NO OF LECTURES - 15**

Learning Objectives:
1. To evaluate the adaptations of microbes to various environmental stresses.
2. To comprehend the mechanisms involved in cell-to-cell communication and stress response.

Learning Outcomes
After the successful completion of the module the learner will be able to:
1. Describe the two-component signaling system.
2. Assess the impact of stress physiology on the behavior of cells.

Subtopic	Title	15L
2.1	Introduction to two-component signaling systems: Response by facultative anaerobes to anaerobiosis, nitrate and nitrite, nitrogen supply.	3L
2.2	Effect of oxygen and light: Response to oxygen and light in purple photosynthetic bacteria, response to osmotic pressure and temperature, response to potassium ion and external osmolarity, response to carbon sources.	4L
2.3	Synthesis of virulence factors: response to temperature, pH, nutrient, osmolarity and quorum sensors, chemotaxis.	3L
2.4	Bacterial response to environmental stress- heat-shock response, oxidative stress.	2L

2.5	Bacterial development and quorum sensing: Myxobacteria, bioluminescence, systems similar to LuxR/LuxI in non-luminescent bacteria, biofilms.	2L
2.6	VBNC	1L

References:

- White, David. 2000. The Physiology and Biochemistry of Prokaryotes. United Kingdom:Oxford University Press.
- Nelson, D. L., Cox, M. M., Lehninger, A. L. 2000. Principles of Biochemistry. New York: Worth Publishers.
- Doelle, H. W. 1975. Bacterial Metabolism. India: Academic Press.
- Atlas, R. M., Bartha, R. 1993. Microbial ecology: fundamentals and applications. Austria: Benjamin/Cummings Publishing Company.

Question paper Template
M. Sc. (Microbiology) SEMESTER II
Major Core Course- III

COURSE TITLE: Enzymology and Stress Physiology
COURSE CODE: 23PS2MBMJ3ESP
[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 II

COURSE IV

COURSE TITLE: Molecular Biology

COURSE CODE: 23PS2MBMJ4MBI

[CREDITS - 02]

Course Learning Outcomes		
After the successful completion of the Course, the learner will be able to: 1. Describe the mechanisms under gene expression and its regulation. 2. Explain the role of various proteins and enzymes involved in DNA repair.		
MODULE I	Gene expression	NO OF LECTURES - 15
Learning Objectives: 1. To discuss the process of transcription and translation in eukaryotes. 2. To explain control of gene expression in prokaryotes and eukaryotes.		
Learning Outcomes After the successful completion of the module the learner will be able to: 1. Explain the control of gene expression at various levels. 2. Elaborate on the different factors in eukaryotic transcription 3. Describe the mechanisms of RNA modification.		
Subtopic	**Title**	**15L**
1.1	Molecular mechanism of Transcription in eukaryotes: RNA molecules and processing. Post transcriptional processing- structure of mRNA, pre –mRNA processing, addition of 5'cap, addition of Poly (A) tail, RNA splicing, RNA editing. Small RNA molecules: RNA interference, types, processing and function of sn, si and miRNAs. Molecular mechanism of Translation in eukaryotes: Post translational modification of proteins.	7L
1.2	Regulation of gene expression; Control of gene expression in prokaryotes: Genes & regulatory elements, Levels of gene regulation.	8L

	DNA binding proteins: Leucine zipper and zinc fingers, homeodomain, helix-turn-helix motif. Antisense RNA molecules, Riboswitches Control of gene expression in eukaryotes: Regulation through modification of gene structure- DNase I hypersensitivity, histone modifications, chromatin remodeling. DNA methylation. Regulation through transcriptional activators, Co-activators, repressors, enhancers and insulators. Regulation through RNA processing & degradation Regulation through RNA interference.	
MODULE II	**Gene recombination and repair**	**NO OF LECTURES - 15**

Learning Objectives:
1. To discuss the molecular mechanism of recombination.
2. To explain various repair mechanisms in prokaryotes and eukaryotes.
3. To describe the diseases caused due to defects in DNA repair mechanisms.

Learning Outcomes
After the successful completion of the module the learner will be able to:
1. Summarize the process of homologous recombination.
2. Justify the role of DNA repair mechanisms.
3. Correlate the defects in DNA repair with inherited disorder.

Subtopic	Title	15L
1.1	Recombination Homologous recombination in eukaryotes. Mating type switching. Genetic consequences of the mechanism of Homologous recombination.	7L
1.2	DNA repair mechanisms: Base-excision, Direct reversal, Nucleotide excision, Recombination repair, SOS repair, Translesion DNA synthesis.	6L
1.3	Inherited human diseases with defects in DNA repair.	2L

References:

- Benjamin Pierce. 2012. Genetics: A Conceptual Approach. 4th Edition

- Russell, P.J. 2014. iGenetics- A Molecular Approach,3rd Edition.
- Watson. 2004. Molecular biology of the gene 5th edition.
- Lewin, B. 2007. Genes-IX, Jones and Bartlett Publishers.
- D. Peter Snustad & Michael J. Simmons. 2012. Principles of Genetics, 6th edition.

Question paper Template
M. Sc. (Microbiology) SEMESTER II
Major Core Course- IV

COURSE TITLE: Molecular Biology
COURSE CODE: 23PS2MBMJ4MBI
[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 II

Practical I - Core Course I and II

Course Code -23PS2MBMJP1

Course Learning Outcomes
After the successful completion of the course the learner will be able to: 1. **Discuss the principle of transduction.** 2. **Describe the technique of cultivating animal viruses.** 3. **Explore the diverse organisms present in mangroves soil.** 4. **Investigate the degradation of polyaromatic hydrocarbons.**
Learning Objectives: 1. To introduce the learner to different mechanisms of gene transfer. 2. To design an enrichment strategy to selectively isolate cellulose, lignin and xylose degraders from the environmental samples. 3. To appraise the microbial degradation of polycyclic aromatic compounds.
Learning Outcomes: After the successful completion of the practical the learner will be able to: 1. Perform techniques to isolate host range mutants. 2. Apply the concept of viral genetics to solve practical problems. 3. Analyse sludge for different parameters.. 4. Interpret one step growth curves, providing insights into viral life cycle. 5. Isolate and characterize cellulose, lignin and xylan degraders from the environmental sample.

Experiment No	Title of the experiment	Number of hours (Total : 180 hours) 45 hours/course
Practical I (Core Course I and II)		
1.	Transduction	8
2.	Isolation of host range mutants.	8
3.	Problems on gene transfer mechanisms.	7
4.	Problems on viral genetics.	7
5.	Study of One Step Growth Curve of Lambda phage / T4 Phage.	7
6.	Assignment on plant and animal viruses.	3

7.	Egg inoculation and cultivating animal virus in embryonated egg. Demonstration	5
8.	Enrichment and isolation of cellulose from mangrove soil.	5
9.	Enrichment and isolation of lignin degraders from mangrove soil.	5
10.	Enrichment and isolation of xylanase producers from mangrove soil.	5
11.	Microbial degradation of polycyclic aromatic hydrocarbons (PAHs) enrichment, isolation and screening of bacteria.	10
12.	PAH degradation studies.	5
13.	Analysis of sludge: sewage and industrial for the following parameters: sludge volume index (SVI), Mixed liquor suspended solids (MLSS), Mixed liquor volatile suspended solids (MLVSS), F/M ratio.	5
14.	Study tour/ academic visit to any large scale industry (environmental health and safety aspects) Food/ Pharma/chemical, environmental consultancy, research centres OR Study tour/ academic visit to Sewage treatment plant/ ETP of any industry /water purification unit/ Pollution Control Board Lab, CETP, landfill, etc.	10

References:

- L. L. Daane, I. Harjono, G. J. Zylstra, Isolation and Characterization of Polycyclic Aromatic Hydrocarbon-Degrading Bacteria,2001 doi:10.1128/AEM.67.6.2683-2691.2001
- L. L. Daane, I. Harjono, G. J. Zylstra, Isolation and Characterization of Polycyclic Aromatic Hydrocarbon-Degrading Bacteria,2001 doi:10.1128/AEM.67.6.2683-2691.2001
- https://www.eurofins.in/food-testing/blog/mlss-and-mlvss-testing-mixed-liquor-suspended-solids-and-mixed-liquor-volatile-suspended-solids-waste-water/
- https://www.sas.upenn.edu/LabManuals/biol275/Table_of_Contents_files/13-PhageGrowth.pdf

MSc Microbiology SEMESTER II

Practical II - Core Course III and IV

Course Code -23PS2MBMJP2

Experiment No	Title of the experiment	Number of hours (Total : 180 hours) 45 hours/course
Course Learning Outcomes		
After the successful completion of the course the learner will be able to: 1. **Assess the kinetics of enzyme-catalyzed reactions.** 2. **Describe genetic inherited disorders.** 3. **Evaluate response of a microbial cell to a signal.**		
Learning Objectives: 1. To evaluate the effect of enzyme and substrate concentration, pH, temperature and inhibitors on enzyme activity. 2. To assess the response of a microbial cell to different signals. 3. To summarize different genetically-inherited disorders.		
Learning Outcomes: After the successful completion of the practical the learner will be able to: 1. Purify enzymes. 2. Assess activity of enzymes under different conditions. 3. Evaluate the effect of different parameters on enzyme activity. 4. Determine the response of a microbial cell to different signals. 5. Solve problems on recombination.		
Practical II (Core Course III and IV)		
Experiment No	**Title of the experiment**	**Number of hours (Total : 180 hours) 45 hours/course**
1.	Purification of an extracellular enzyme (ß- amylase) by salting out and dialysis.	10
2.	Enzyme kinetics-effect of enzyme concentration, substrate concentration, pH temperature and inhibitors on enzyme activity.	10
3.	Demonstration of proteolytic activity.	5

4.	Determination of glucose isomerase present intracellularly in *Bacillus sp.*	5
5.	Chemotaxis of *Pseudomonas.*	5
6.	Effect of temperature and water activity on swarming of *Proteus.*	5
7.	Different bacteriolytic response associated with addition of lysozyme and salt.	5
8.	Beta galactosidase assay.	10
9.	Problems on recombination.	10
10.	Effect of light and dark repair.	10
11.	Assignment on inherited genetic disorders.	15

References:

- Tino Krell, Jane Emily Hill Pseudomonas Chemotaxis FEMS Microbiology Reviews August 2014 DOI:10.1111/1574-6976.12081
- Emiliano D., Lisandro H. Otero, Francisco. R, Sebastián. K, Walter.G The disruptive effect of lysozyme on the bacterial cell wall.13 November 2017 DOI: https://doi.org/10.1002/bmb.21092

M. Sc. (MICROBIOLOGY) SEMESTER II

DSE I

COURSE TITLE: Industrial Microbiology

COURSE CODE: 23PS2MBDSEIMY

[CREDITS - 02]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Explain the role of QC, QA as GMP parameters in Industrial productions. 2. Comprehend various methods for the isolation, detection and identification of microorganisms in foods. 3. To substantiate the importance of functional foods in human health.

MODULE I	Good Manufacturing Practices	NO OF LECTURES - 15

Learning Objectives:
1. To discuss the importance of GMP in the manufacturing and pharmaceutical industries.
2. To comprehend the concept of HACCP in the manufacturing industry.

Learning Outcomes
After the successful completion of the module the learner will be able to:
1. Describe the importance of QA and QC in GMP.
2. Explain the regulatory factors involved in the pharma industry.
3. To elaborate the principles of HACCP.

Subtopic	Title	15L
1.1	Quality Control: Definition, Principle and its application.	2L
1.2	Quality Assurance: Definition, Principle and its application, GMP, Quality assurance beyond GMP Inter-relationship between QA, QC & GMP.	3L
1.3	Concept of Quality and regulatory factors in Pharma.	1L
1.4	QC using microbiological control: Control at source, Codes of GMP.	3L

1.5	HACCP: Principles and application.	4L
1.6	Laboratory accreditation: NABL guidelines	2L
MODULE II	**Advances in Food Microbiology**	**NO OF LECTURES - 15**

Learning Objectives:
1. To discuss the sampling processes for detection of microbes in food.
2. To distinguish between Functional food and supplements.
3. To elaborate on the characteristics and significance of food additives.

Learning Outcomes
After the successful completion of the module the learner will be able to:
1. Elaborate on spoilage causing microorganisms and food preservation methods.
2. Evaluate the food products as per BIS/ISO/APHA standards
3. Describe the functional foods and nutraceuticals.

Subtopic	Title	15L
2.1	Control and detection of Microorganisms: Conventional methods of detection of Microbes Fiber optic and surface plasmon resonance biosensors Novel emerging techniques of food preservation Control by combination of methods (Hurdle concept)	4L
2.2	Sample processing approaches for detection of: Mycotoxic fungi, pathogenic bacteria (Enteropathogenic E.coli, Vibrio, Salmonellae) and Viruses (Hepatitis A, Norwalk) in meat/fish products as per BIS/ISO/APHA standards.	2L
2.3	Food additives and ingredients: Definitions, classification and functions of antioxidant, colors, emulsifiers, sequestrants, natural and microbial flavors.	2L
2.4	Applications of fibers : Food sources, microbial Fructo-oligosaccharides.	1L
2.5	Nutraceuticals and health foods: Introduction to nutraceuticals - Definitions, basis of claims for a compound as a nutraceutical, regulatory issues for nutraceuticals.	2L
2.6	Microbes and production of nutraceuticals: Lycopene, isoflavonoids, prebiotics and probiotics.	3L

2.7	Formulation of functional foods containing nutraceuticals – stability and analytical issues, labelling issues.	1L

References:

- Pharmaceutical Microbiological Quality Assurance and Control: Practical Guide for Non-Sterile Manufacturing. 2020. United Kingdom: Wiley
- Sao, R. B. 2016. Perfect: Quality Assurance and Quality Control. CreateSpace Independent Publishing Platform.
- Bhunia, A., Ray, B. 2008. Fundamental food microbiology. United Kingdom: Taylor & Francis.
- Srilakshmi, B. 2006. Nutrition Science. India: New Age International.
- Jay, J. M. 2000. Modern food microbiology. Netherlands: Springer US.
- James Jay, M Loessner and D Golden. 2005. Modern Food Microbiology. 7th Edition.
- Adams, M. R., Moss, M. O. 1995. Food Microbiology. United Kingdom: Royal Society of Chemistry.

Question paper Template
M. Sc. (Microbiology) SEMESTER II
DSE - I

COURSE TITLE: Industrial Microbiology
COURSE CODE: 23PS2MBDSEIMY
[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

PRACTICAL

COURSE - DSE I

COURSE CODE - 23PS2MBDSEIMY

CREDITS - 02

Course Learning Outcomes
After the successful completion of the course the learner will be able to: 1. Analyze the microbiological quality of different types of foods. 2. Apply the advanced methods for detecting food borne pathogens. 3. Employ spectrometric techniques to measure the concentrations of antioxidants and anti-nutritional factors in food samples.
Learning Objectives: 1. To assess the microbiological load of fermented food. 2. To comprehend the role of fermentation in food preservation. 3. To evaluate the microbial load of commonly consumed foods items. 4. To perform quality assessment and analysis of different dairy products and fish samples.
Learning Outcomes: After the successful completion of the practical the learner will be able to: 1. Apply microbiological techniques to assess and monitor the microbial load and diversity in different types of foods.. 2. Evaluate the levels of antioxidants and anti-nutritional factors present in food samples providing insights into their potential benefits and risks associated.

Experiment No	Title and Number of Credits	Number of hours Total - 60 hours
1.	Microbiological study of fermented foods (Idli batter and sauerkraut).	10
2.	Microbiological load in carrot and apple juice, salad, mayonnaise.	10
3.	Quality Assessment and Analysis of food: i) Milk (Raw, Packed) ii) Ice- Cream iii)Yogurt.	10
4.	Report to be written in journal on Novel detection methods for food borne pathogens/toxins.	10
5.	Estimation of anti-oxidants and anti-nutritional factors (tannin/phytic acid) by spectrometric method.	10
6.	Microbiological analysis of fish samples w.r.t sample processing for recovery and detection of Enteropathogenic	10

	E.coli, Vibrio, Salmonellae as per BIS/ISO/APHA standards and computation of measure of uncertainty.	

References:

- https://downloads.hindawi.com/journals/ijfs/2016/8605689.pdf?_gl=1*1p04bic*_ga*MTEOMzcyMDM3OS4xNzEONjM3MDY5*_ga_NF5QFMJT5V*MTcxNDYzNzA2OC4xLjAuMTcxNDYzNzA2OC42MC4wLjA.&_ga=2.158746872.3584872O6.1714637069-1143720379.1714637069
- https://www.fssai.gov.in/upload/uploadfiles/files/MILK_AND_MILK_PRODUCTS.pdf
- https://www.sciencedirect.com/science/article/pii/S2666154323003848z

M. Sc. (MICROBIOLOGY) SEMESTER II

DSE II

COURSE TITLE: Cancer Biology

COURSE CODE: 23PS2MBDSECAN

[CREDITS - 02]

Course Learning Outcomes		
After the successful completion of the Course, the learner will be able to: 1. Describe the molecular mechanisms of cell division and fertilization. 2. Evaluate the genetic basis of cancer.		
MODULE I	Cell Cycle	NO OF LECTURES - 15
Learning Objectives: 1. To analyze the molecular mechanism of cell division. 2. To describe the events involved in fertilization in mammals. 3. To assess the various checkpoints in the cell cycle control.		
Learning Outcomes After the successful completion of the module the learner will be able to: 1. Describe the significant events during cell division and fertilization. 2. Compare and Contrast between the intrinsic and extrinsic pathway of apoptosis.		
Subtopic	**Title**	**15L**
1.1	Cell division: Mitosis- M-phase, Cytokines Meiosis	5L
1.2	Germ cells (egg and sperm), fertilization and Sex determination in mammals.	3L
1.3	Cell cycle and Programmed cell death: Control system, intracellular control of cell cycle events, Apoptosis (intrinsic and extrinsic), extracellular control of cell growth and	7L

	apoptosis.	
MODULE II	**Transposable gene elements and genetic basis of cancer**	**NO OF LECTURES - 15**

Learning Objectives:
1. To analyze the genetic and evolutionary significance of transposable elements.
2. To evaluate the role of oncogenes in cancer.

Learning Outcomes
After the successful completion of the module the learner will be able to:
1. Evaluate the relationship between the cell cycle and cancer.
2. Analyze the role of different genes in cancer progression.

Subtopic	Title	15L
2.1	Transposable genetic elements Elements in Maize, P Elements and Hybrid Dysgenesis in Drosophila, Mariner. Retrotransposons, Retrovirus like Elements. Genetic and Evolutionary Significance of Transposable Elements, Transposons, and Genome Organization, Transposons and Mutation, Rearrangement of Immunoglobulin Genes. Evolutionary Issues Concerning Transposable Elements.	7L
2.2	Genetic basis of cancer Introduction: Development of cancer, Cancer: A Genetic Disease, Types of cancer. Oncogenes: Oncogenes in Human Cancer (ras, c-myc and abl gene). Tumour-Inducing Retroviruses and Viral Oncogenes Cellular Homologs of Viral Oncogenes: The Proto-oncogenes Mutant Cellular Oncogenes and Cancer Chromosome Rearrangement. Tumor Suppressor Genes (Rb gene) and Cell cycle (p21 and p53). Inherited Cancers and Knudson's Two-Hit Hypothesis. Cellular Roles of Tumor Suppressor Proteins. Genetic Pathways to Cancer. Malignant Transformation, Oncogenes & Cancer.	8L

References:

- Russell, P.J. 2016. iGenetics- A Molecular Approach. 3rd Edition. Pearson Education

India

- Snustad & Simmons, 2006. Principles of Genetics, 6th Edition, John Wiley & Sons Inc.
- Albert, Johnson, Lewis, Raff, Roberts & Walter. 2008. Molecular Biology of The Cell. 5th Edition.
- Lodish, Birk, and Zipursky. Freeman. Molecular Cell Biology 8th Edition.
- Alberts, Bray, Hopkin, Johnson, Lewis, Walter. Essential Cell Biology 3rd Edition.
- Geoffrey M. Cooper and Robert E. Hausman. The Cell: A Molecular Approach. 4th Edition.

Question paper Template
M. Sc. (Microbiology) SEMESTER II
DSE - II

COURSE TITLE: Cancer Biology
COURSE CODE: 23PS2MBDSECAN
[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 II

COURSE CODE - 23PS2MBDSECAN

CREDITS - 02

Course Learning Outcomes
After the successful completion of the course the learner will be able to: 1. Demonstrate the different stages of mitosis and meiosis and also the corresponding cellular transformations occurring throughout each stage. 2. Articulate cancer research and treatment methods. 3. Distinguish between different types of inherited cancer.
Learning Objectives: 1. To identify the different stages of mitosis and meiosis. 2. To gain practical insights into cancer research. 3. To study different types of inherited cancer.
Learning Outcomes: After the successful completion of the practical the learner will be able to: 1. Compare and contrast mitosis and meiosis with respect to the changes in the cell. 2. Discuss the various methods used to detect the cancer and also its treatment.

Experiment No	Title and Number of Credits	Number of hours Total - 60 hours
1.	Study of Mitosis.	10
2.	Study of Meiosis.	15
3.	Visit to ACTREC.	20
4.	Case studies on inherited cancers.	15

References:

- Alberts, Bray, Hopkin, Johnson, Lewis, Walter. Essential Cell Biology 3rd Edition.
- https://www.edvotek.com/site/pdf/APO7.pdf

M. Sc. (MICROBIOLOGY) SEMESTER II

DSE III

COURSE TITLE: Microbial Ecology

COURSE CODE: 23PS2MBDSEECO

[CREDITS - 02]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Elaborate on the concept of ecosystem. 2. Discuss the different classes of extremophiles.

MODULE I	Ecology	NO OF LECTURES - 15

Learning Objectives:
1. To analyze the factors that influence the species interactions and succession.
2. To analyze the flow of energy and matter through the ecosystem.

Learning Outcomes
After the successful completion of the module the learner will be able to:
1. Examine the role of biodiversity in the ecosystem.
2. Define key concepts in population ecology.
3. Solve problems based on species solving skills in ecological research.

Subtopic	Title	15L
1.1	Introduction and concept of ecology	1L
1.2	Ecosystem concept and function	1L
1.3	Energy flow /food chains, food web	2L
1.4	Concept of biomes	1L
1.5	Population ecology	2L
1.6	Species diversity	2L
1.7	Competition between different species.	2L

1.8	Succession & its types	2L
1.9	Behavioral ecology.	2L
MODULE II	**Extremophiles**	**NO OF LECTURES - 15**

Learning Objectives:
1. To summarize the development of exobiology.
2. To describe the adaptations of extremophiles.

Learning Outcomes
After the successful completion of the module the learner will be able to:
1. Analyze the challenges and methods involved in studying extremophiles.
2. Apply laboratory techniques for characterization of extremophiles.

Subtopic	Title	15L
2.1	Exobiology: Extra-terrestrial life detection studies. The Martian environment: Antarctica as a model of Mars.	7L
2.2	Introduction and types of extremophiles: Habitat, cellular organization, biodiversity, survival strategy limitations and culturing protocols: Thermophiles Psychrophiles Acidophiles Alkaliphiles Halophiles Barophiles Radiation resistant microorganisms.	8L

References:

- Odum, E. P., Barrett, G. W. 2005. Fundamentals of ecology. India: Thomson Brooks/Cole.
- Stiling, P. 2011. Ecology: Global Insights and Investigations. United Kingdom: McGraw-Hill Education.
- Narlikar, J. V. 2003. The Scientific Edge: The Indian Scientist from Vedic to Modern Times. India: Penguin Books Limited.
- The New Science of Metagenomics: Revealing the Secrets of Our Microbial Planet. 2007. United States: National Academies Press.
- Extremophiles: Sustainable Resources and Biotechnological Implications. 2012.

Germany: Wiley.

- Rainey, Aharon Oren. 2006. Methods in Microbiology Vol 35- Extremophiles Edited by Academic press.
- https://www.ncbi.nlm.nih.gov/books/NBK223869/#!po=2.63158

Question paper Template
M. Sc. (Microbiology) SEMESTER II
DSE - III

COURSE TITLE: Microbial Ecology
COURSE CODE: 23PS2MBDSEECO
[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

PRACTICAL

COURSE - DSE III

COURSE CODE - 23PS2MBDSEECO

CREDITS - 02

Course Learning Outcomes
After the successful completion of the course the learner will be able to: 1. **Isolate extremophiles and characterize them.** 2. **Appraise the significance of microorganisms in exobiology**
Learning Objectives: 1. To isolate extremophiles from different environments 2. To analyze reviews on exobiology.
Learning Outcomes: After the successful completion of the practical the learner will be able to: 1. Apply the microbiological techniques to isolate and characterize extremophiles. 2. Present the recent advances in the field of exobiology.

Experiment No	Title and Number of Credits	Number of hours Total - 60 hours
1.	Review writing on exobiology.	10
2.	Presentation on Prof. Jayant Narlikar's research.	5
3.	Isolation of Psychrophiles from milk samples.	15
4.	Enrichment & isolation of thermophiles from hot springs/compost heaps/Milk.	15
5.	Isolation of halophiles from mangrove soil.	15

References:

- Rainey, Aharon Oren. 2006. Methods in Microbiology Vol 35- Extremophiles Edited by Academic press.
- https://www.ncbi.nlm.nih.gov/books/NBK223869/#!po=2.63158

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 End Semester 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	25	75
Practical II (Core Course III and IV)	50	25	75
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.