SHIVAJI UNIVERSITY, KOLHAPUR

Established: 1962

A^{++} Accredited by NAAC (2021) with CGPA 3.52

Structure and Syllabus in Accordance with

National Education Policy - 2020

with Multiple Entry and Multiple Exit

Master of Science (General Microbiology)

under
Faculty of Science and Technology

(To Be Implemented From Academic Year 2023-24)

1. Preamble:

Total number of semesters	: 02 (Per year)
Total No. of papers	: 06 (Per year)
Total no. of practical courses	: 04 (Per year)
Maximum marks per paper (Theory)	: 100
Distribution of marks (Theory only) –	
Internal evaluation	: 20
External evaluation	: 80
(Semester exam)	

Total marks for M. Sc. Degree Course

Theory papers	: 1200
Practical course	: 550
Research Methodology	: 100
OJT / Field Project	: 100
Research Project	: 250
	2200

2. Duration – For level 6.5 (4 Years B.Sc.) - 1 Year; for level 6.0 (3 Years B.Sc.) - 2 Years

3. Eligibility for admission – B.Sc. Microbiology / Industrial Microbiology

4. Medium of instruction - English

5. Programme Structure

Structure in Accordance with National Education Policy - 2020
With Multiple Entry and Multiple Exit Options
M.Sc. (General Microbiology) Part – I (Level-6.0)

	Course Code	Teaching Scheme			Examination Scheme					
		Theory and Practical			University Assessment (UA)			Internal Assessment (IA)		
		Lectures + Tutorial/ (Hours/ week)	Practical (Hours/ week)	Credit	Maximum Marks	Minimum Marks	Exam. Hours	Maximum Marks	Minimum Marks	Exam. Hours
Semester-I										
Major Mandatory	MMT-101	4	--	4	80	32	3	20	8	1
	MMT -102	4	--	4	80	32	3	20	8	1
Major Elective	MME - 103	4	--	4	80	32	3	20	8	1
Practical Course	MMPR -104	--	8	4	80	32	3	20	8	1
	MEPR-105	--	4	2	40	16	2	10	4	1
Research Methodology	RM-106	4	--	4	80	32	3	20	8	1
Total				22	440			110		
Semester-II										
Major Mandatory	MMT-201	4	--	4	80	32	3	20	8	1
	MMT -202	4	--	4	80	32	3	20	8	1
Major Elective	MME-203	4	-	4	80	32	3	20	8	1
Practical Course	MMPR -204	--	8	4	80	32	3	20	8	1
	MEPR-205	--	4	2	40	16	2	10	4	1
OJT/FP	OJT-206			4	80*	32		20	4	
Total				22	440			110		
Total (Sem I + Sem II)				44						

<table>
<tr><td>• MMT–MajorMandatory Theory
• MMPR–MajorMandatoryPractical
• MET–MajorElective Theory
• MEPR–MajorElective Practical
• RM - Research Methodology
• OJT/FP- On Job Training/ Field Project</td><td>• Total Marks for M.Sc.-I : 1100
• Total Credits for M.Sc.-I (Semester I & II) : 44
• Separate passing is mandatory for University and Internal Examinations</td></tr>
<tr><td colspan="2">*Evaluation scheme for OJT/FP shall be decided by concerned BOS</td></tr>
<tr><td colspan="2">• Requirement for Entry at Level 6.0: 120 Credits with passing remark at UG level.</td></tr>
<tr><td colspan="2">• Requirement for Exit after Level 6.0: 44 Credits
Students can exit after completion of Level 6.0 with Post Graduate Diploma in General Microbiology</td></tr>
<tr><td colspan="2">• Requirement for Entry at Level 6.5: 160</td></tr>
</table>

Structure in Accordance with National Education Policy - 2020
With Multiple Entry and Multiple Exit Options
M.Sc. (General Microbiology) Part – II (Level-6.5)

	Course Code	Teaching Scheme			Examination Scheme					
		Theory and Practical			University Assessment (UA)			Internal Assessment (IA)		
		Lectures + Tutorial (Per week)	Practicals Hours (Per week)	Credit	Maximum Marks	Minimum Marks	Exam. Hours	Maximum Marks	Minimum Marks	Exam. Hours
Semester-III										
Major Mandatory	MMT-301	4	--	4	80	32	3	20	8	1
	MMT -302	4	--	4	80	32	3	20	8	1
Major Elective	MME -303	4	--	4	80	32	3	20	8	1
Practical Course	MMPR -304	--	8	4	80	32	3	20	8	1
	MEPR-305	--	4	2	40	16	2	10	4	0.5
Research Project	RP-306		8	4	80	32		20	8	1
Total of Sem III				22	440			110		
Semester-IV										
Major Mandatory	MMT-401	4	--	4	80	32	3	20	8	1
	MMT -402	4	--	4	80	32	3	20	8	1
Major Elective	MME - 403	4	--	4	80	32	3	20	8	1
Practical Course	MMPR -404	--	4	2	40	14	2	10	4	0.5
	MEPR-405	--	4	2	40	14	2	10	4	0.5
Research Project	RP-406		12	6	100	40	3	50	20	2
Total of Sem IV				22	420			130		
Total (Sem III + Sem IV)				**44**	**860**			**240**		**1100**

<table>
<tr><td>• MMT–MajorMandatory Theory
• MMPR–MajorMandatoryPractical
• MET–MajorElective Theory
• MEPR–MajorElective Practical
• RP- Research Project</td><td>• Total Marks for M.Sc.-II : 1100
• Total Credits for M.Sc.-II (Semester III & IV) : 44
• Separate passing is mandatory for University and Internal Examinations</td></tr>
<tr><td colspan="2"># Evaluation scheme for Research Project shall be decided by concerned BOS</td></tr>
<tr><td colspan="2">## Evaluation scheme for Research Project shall be decided by concerned BOS</td></tr>
<tr><td colspan="2">• Requirement for Exit after Level 6.5:
Students can exit after completion of Level 6.5 with Post Graduate in General Microbiology</td></tr>
</table>

6. Programme Outcomes (POs)

- This is a two year M. Sc. program covering all general aspects of Microbiology.
- It helps in developing competent Microbiologists who can progress to diverse fields of microbiological interests in various fields of industries, research, teaching, medical science and entrepreneurship.
- The course is aimed at adding to the knowledge base of Microbiology graduates through significant inputs of latest information on the subject.
- It also envisages that the students read original research publications and develop the ability of critical evaluation of the study.
- Development of communication skills as well as laboratory work and team work, creativity, planning and execution are also a major objective of this program.
- In the core courses, the students study the basics of Microbiology along with the basics of subjects allied to and useful in Microbiology (Techniques, Biostatistics, Computer handling and Bioinformatics, Biosafety, Scientific writing and Agricultural and Clinical Microbiology).
- The specializations include topics on various fields of Industrial Microbiology, Fermentation Technology, Quality assurance, Recombinant DNA Technology and Pharmaceutical Microbiology.
- During this program students undertake a On job training, Research Project, field projects which the student is expected to study research methodology through experimental work, literature survey and report writing.
- In On job training, the student is to take training in the Industry for a period of at least two weeks which will help student to study Microbiological aspects in theIndustry.
- Educational tour to various institutes and or industries provides actual microbiological applications in various fields of Microbiology.

7. Course Codes

M.Sc. Semester-I		
Course code.	**Major Mandatory**	
MMT 101	Microbial Systematics (4 credit**)**	**MSU0325MML918G1**
MMT 102	Immunology (4credit)	**MSU0325MML918G2**
MMPR	Practical Lab-I (4credit)	**MSU0325MMP918G1**
MEPR	Practical Lab-II (2credit)	**MSU0325MMP918G2**
RM 106	Research Methodology (4credit)	**MSU0325RML918G**
MME 103	**Major Elective**	
	Biochemistry	**MSU0325MEL918G1**
	Microbial Metabolism	**MSU0325MEL918G2**
	Environmental Microbiology	**MSU0325MEL918G3**
M.Sc. Semester-II		
	Major Mandatory	
MMT 201	Genetics and Molecular Biology (4credit**)**	**MSU0325MML918H1**
MMT 202	Fermentation Technology (4credit**)**	**MSU0325MML918H2**
MMPR	Practical Lab-III(4credit)	**MSU0325MMP918H1**
MEPR	Practical Lab-IV(2credit)	**MSU0325MMP918H2**
OJT/FP 206	Field Project(4credit)	**MSU0325FPP918H**
MME 203	**Major Elective**	
	Techniques in Microbiology	**MSU0325MEL918H1**
	Quality Assurance and Validation in Pharma sector	**MSU0325MEL918H2**
	Microbial Ecology	**MSU0325MEL936H3**

SHIVAJI UNIVERSITY KOLHAPUR
M.Sc. GENERAL MICROBIOLOGY
(For Affiliated Colleges)
CURRICULAM FRAMEWORK BASED ON
'NATIONAL EDUCATION POLICY 2020
SEM-I

YEAR I	LEVEL	Code	Title of the paper	Credits	Hrs/ week	Total Lecturs	Maximum Marks		
							Internal Assessment	University Examination	Total
		Major Mandatory Papers							
		MMT 101	Microbial Systematics	04	04	60	20	80	100
		MMT 102	Immunology	04	04	60	20	80	100
		Major Elective Papers (CHOOSE ANY ONE)							
	6	**MET 103-A**	Biochemistry	04	04	60	20	80	100
		MET 103-B	Microbial Metabolism	04	04	60	20	80	100
		MET 103-C	Environmental Microbiology	04	04	60	20	80	100
		Minor RM (Compulsory paper)							
		RM 106	Research Methodology	04	04	60	20	80	100
		PRACTICAL COURSES							
		MMPR-104	Practical course 1	04		60	20	80	100
		MEPR - 105	Practical course 2	02		30	10	40	50

SEM II

YEAR	LEVEL	Code	Title of the paper	Credits	Hrs/ Week	Total Lecturs	Maximum Marks		
							Internal Assessment	University Examination	Total
I	6	**Major Mandatory Papers**							
		MMT 201	Genetics and Molecular Biology	04	04	60	20	80	100
		MMT 202	Fermentation Technology	04	04	60	20	80	100
		Major Elective Papers (CHOOSE ANY ONE)							
		MET 203-A	Techniques in Microbiology	04	04	60	20	80	100
		MET 203-B	Quality Assurance and Validation in Pharma sector	04	04	60	20	80	100
		MET 203-C	Microbial Ecology	04	04	60	20	80	100
		Minor OJT/FP (Compulsory paper)							
		OJT-206	On Job Training/ Field Project	04	04	60	20	80	100
		PRACTICAL COURSES							
		MMPR-204	Practical course 1	04		60	20	80	100
		MEPR-205	Practical course 2	02		30	10	40	50

SEM III

YEAR	LEVEL	Code	Title of the paper	Credits	Hrs/ week	Total Lecturs	Maximum Marks		
							Internal Assessment	University Examination	Total
II	6.5	**Major Mandatory Papers**							
		MMT 301	Quantitative Biology	04	04	60	20	80	100
		MMT 302	Medical Microbiology and Virology	04	04	60	20	80	100
		Major Elective Papers (CHOOSE ANY ONE)							
		MET 303-A	Bioethics, Biosafety, Quality control in Microbiology	04	04	60	20	80	100
		MET 303-B	Bioinformatics, Biostatistics and Bionanotechnology	04	04	60	20	80	100
		MET 303-C	Agricultural Microbiology	04	04	60	20	80	100
		Minor RP (Compulsory paper)							
		RP-306	Research Project	04	04	60	20	80	100
		PRACTICAL COURSES							
		MMPR-304	Practical course 1	04		60	20	80	100
		MEPR-305	Practical course 2	02		30	10	40	50

SEM IV

YEAR	LEVEL	Code	Title of the paper	Credits	Hrs/ week	Total Lecturs	Maximum Marks		
							Internal Assessment	University Examination	Total
II	6.5	**Major Mandatory Papers**							
		MMT 401	Food and Dairy Microbiology	04	04	60	20	80	100
		MMT 402	Molecular Biology Tools and Applications	04	04	60	20	80	100
		Major Elective Papers (CHOOSE ANY ONE)							
		MET 403-A	Industrial Waste Management	04	04	60	20	80	100
		MET 403-B	Enzymology and Enzyme Technology	04	04	60	20	80	100
		MET 403-C	Clinical Microbiology	04	04	60	20	80	100
		Minor RP (Compulsory paper)							
		RP-406	Research Project	06	06	90	50	100	150
		MEPR - 404	Practical course 1	02	02	30	10	40	50
		MEPR-405	Practical course 2	02	02	30	10	40	50
			Total of Sem. IV				130	420	550
			Total of M.Sc. Course						2200

After completing 44 credits in post graduation there is an exit option and respective candidate will be awarded as 'Post Graduate Diploma In Microbiology (PGDM)'. Exit option will commence from academic year 2024-25 and will be applicable to the candidates who opted for NEP syllabus.

Guidelines for conducting OJT/FP- 206 Field Project in Sem II of the curriculum

(Reference: Government of Maharashtra GR:NEP 2022/ PRA-KRA-09/VISHI-3 SHIKANA, Mantralaya, Mumbai dt. 16 May 2023)

1. The candidate should complete the work of RM-MIC 206 after completion of second semester in the summer vacation.
2. On job training (OJT)/ Internship/ Apprenticeship of 60 hours must be completed by the candidate in industry/ health sectors / research labs / public testing laboratories / diagnostic laboratories.
3. During OJT period the candidate should submit weekly progress report and attendance report to the Head of the department of concerned education institute.
4. The administration of the department should keep the record of attendance and progress and that will be submitted to external examiner for verification.
5. The evaluation of OJT should be done on following aspects and that should be reflected through training report and presentation of the candidate.
    - The new skills achieved by the candidate during OJT /Internship/ Apprenticeship
    - Whether the period spent by the candidate has enriched his practical skills and subject knowledge.
    - Whether the candidate has inspired for entrepreneurship

6. The candidate may opt for field projects as an alternative for On job training (OJT)/ Internship/ Apprenticeship.In case of field projects, the evaluation should be done on the basis of
    - Selection of the field project considering its use for community.
    - Sample size and statistical methods followed for reaching the conclusion.
    - Skills achieved.

Guidelines for conducting RP- 406 Research Project in Sem IV of the curriculum

1. RP – 406 research project should be completed minimum of 90 hours.
2. The research project may be completed in research laboratories, industries, National Incubation Centers, research institutes, public testing laboratories, diagnostic laboratories, etc. The candidates who are not getting an opportunity in cited categories may complete their research in the department of their parent institute.

Assessment for Research Project :

The project shall carry 150 marks. The assessment for the said courses should be carried out as follows;

a. Assessment by Research Guide: The entire project will be assessed by research guide for 50 marks. Criteria used for the assessment are as follow:

(Confidential and to be sent through with signed sealed envelope by research guide)

Sr. No.	Criteria	Maximum Marks	Obtained Marks
1.	Understanding the basic concept of dissertation	**05**	
2.	Fulfillment of Aims and objectives	**05**	
3.	Results, discussion and conclusion	**10**	
4.	Regularity and punctuality	**10**	
5.	Literature Review	**05**	
6.	Fulfillment of Plagiarism norms as per attached certificate	**05**	
7.	Publication of work	**05**	
8.	Potential Applications of the work /Social relevance	**05**	
Total out of 50			

Note: respective research guide should submit weekly progress report to the head of the department through official mail. Signed print copies of the progress report are also accepted.

Evaluation by external examiner:

External examiner as appointed above will evaluate the dissertation of the candidate for 100 marks. Following criteria should be used for evaluation purpose by external examiner.

Sr. No.	Criteria	Maximum Marks	Obtained Marks
1.	Understanding the basic concept of dissertation	**10**	
2.	Fulfillment of Aims and objectives	**10**	
3.	Results, discussion and conclusion	**10**	
4.	Regularity and punctuality	**10**	
5.	Literature Review	**10**	
6.	Fulfillment of Plagiarism norms as per attached certificate	**10**	
7.	Publication of work (Conference presentation / Research Paper in Journal)	**20**	
8.	Potential Applications of the work /Social relevance	**20**	
Total out of 100			

b. Internal (institutional) assessment of the project RP-306:

Internal assessment of the project will be carried out in the Department where the candidate is registered for post graduate degree. This will be carried out as follow:

Item	Marks	Note
Presentation of the plan of work	10	Should be carried out as open defense. Any suggestions if are should be communicated to the guide.
Submission of completed work in the form of CD ROM of dissertation copy along with 2 certified bound copies	10	CD ROM should be submitted to the University where the University may take appropriate decision for forwarding it to Shodhganga. Note: Any work having conflicts of interest with respect to intellectual properties should not be published without permission of respective guide.
Total marks:		**20**

University Evaluation:

University evaluation will be carried out for 80 marks. This will be conducted as open defense presentation. For the purpose candidate is allowed to present the work through LCD Projector or any other alternative as available in the institute. In case of national emergencies, online presentation is allowed. For the purpose the candidate is allowed to use online meeting apps as allowed by the central government. For the purpose of the evaluation, external examiners appointed by university at the time of practical exam. One examiner will be external having adequate research experience and minimum qualification as Ph.D. For the purpose any senior academician / senior scientist working in institutes of national and international reputes / senior person working in industry / Entrepreneur with minimum qualification of Ph.D. in Microbiology may be appointed. Another examiner will be appointed from the institute where, the candidate has registered for his/her post graduate degree. Minimum qualification of the internal examiner should be Ph.D. in Microbiology.

Evaluation by External examiner:

Internal examiner as appointed above will evaluate the dissertation of the candidate for 80 marks. Following criteria should be used for evaluation purpose by internal examiner.

Sr. No.	Criteria	Maximum Marks	Obtained Marks
1.	Understanding the basic concept of dissertation	**10**	
2.	Fulfillment of Aims and objectives	**10**	
3.	Results, discussion and conclusion	**10**	
4.	Regularity and punctuality	**10**	
5.	Literature Review	**10**	
6.	Fulfillment of Plagiarism norms as per attached certificate	**10**	
7.	Publication of work	**10**	
8.	Potential Applications of the work /Social relevance	**10**	
Total out of 80			

Thus, projectwill be assessed for 100 marks.

Alternative to Internship / Research Project in case of national emergencies like Covid pandemics:

In case of national emergencies like Covid pandemics, following alternative should be followed vide cited references:

References:

1. Letter no. UNI/2020/Baithak/vishi 1/4131A dt. 8th May 2020, Pg. no. 6, clause no. 5
2. UGC Guidelines on Examinations and AcademicCalendar for the Universities in View of COVID-19Pandemic and Subsequent Lockdown dt. April 2020, pg. no. 6 and 7, clause no 10.

Alternative No. 1:

Review article

Alternative No. 2:

Field work/Online Surveys related to needs of society having subject relevance/Book review

Note: Here, in case of national emergencies or lockdown period students are allowed to work from home and the work done under above titles will be considered for evaluation and grading purposes.

Explanation:

1. Review Article:

The criteria for awarding the marks are as follow:

Sr. No.	Criteria
1.	Selection of the topic considering social relevance
2.	Well organized abstract/ introduction
3.	Survey of the topic selected as evidenced through references
4.	Discussion of current developments in a selected field/ topic
5.	Summarizing significant findings of the present study
6.	Literature Review and the use of software like Mendeley to keep flexibility for publication and referencing style.
7.	Fulfillment of Plagiarism norms as per attached certificate
8.	Publication of work

2. Field work (Data Collection)/ Online surveys: having subject relevance

Sr. No.	Criteria
1.	Selection of the topic considering social relevance
2.	Method followed for data collection
3.	Statistical analysis of the data
4.	Well organized abstract/ introduction
5.	Reference work
6.	Discussion of current developments in a selected field/ topic
7.	Summarizing significant findings of the present study
8.	Fulfillment of Plagiarism norms as per attached certificate
9.	Publication of work

OR

3. Book review: having subject relevance

Sr. No.	Criteria
1.	Name of the author and book with relevant details of publisher and publication
2.	Relevant information about the author like who the author is and where he/she stands in the genre or the field of enquiry.
3.	Context of the book
4.	Brief discussion about the theme of book
5.	Strengths and weaknesses of the book
6.	Highlighting parts of the book by selecting particular chapter/ theme for the justification of review
7.	Concluding remarks about books overall perspective, argument and purpose
8.	Plagiarism check report

Evaluation:

Internal evaluation for the alternative that is, submitting review article and field work /survey / book review will be carried out as follow:

Online presentations through central government approved apps
Presentation based on review article (1)
Presentation based on field work/ survey / book reviews (2 presentations each of 20 marks)
Total marks

IMP Note: The candidate has to submit the project report before the deadlines notified by the department. The candidate who fails to submit the project report may re-submit the same in a subsequent semester examination for evaluation purpose. The project work activities must be duly supported by documentary evidences and those should be endorsed by the HOD or the guide. All forthcoming UGC notifications regarding promotion of academic integrity and prevention of plagiarism in higher education institutions will be binding to the students. Submitted thesis by the students will be evaluated by, 'Departmental Academic Integrity Panel (DAIP)' and will be certified to be eligible for further evaluation as mentioned above.

Award of the Grade will be based on the following criteria.

SHIVAJI UNIVERSITY, KOLHAPUR
M. Sc. GENERAL MICROBIOLOGY SYLLABUS
AS PER NEP 2020 PATTERN
(To be implemented from June, 2023)
(Applicable to affiliated colleges only)

PROGRAM OUTCOMES

- This is a two year M. Sc. program covering all general aspects of Microbiology.
- It helps in developing competent Microbiologists who can progress to diverse fields of microbiological interests in various fields of industries, research, teaching, medicalscience and entrepreneurship.
- The course is aimed at adding to the knowledge base of Microbiology graduates throughsignificant inputs of latest information on the subject.
- It also envisages that the students read original research publications and develop the ability of critical evaluation of the study.
- Development of communication skills as well as laboratory work and team work, creativity, planning and execution are also a major objective of this program.
- In the core courses, the students study the basics of Microbiology along with the basics of subjects allied to and useful in Microbiology (Techniques, Biostatistics, Computer handling and Bioinformatics, Biosafety, Scientific writing and Agricultural and Clinical Microbiology).
- The specializations include topics on various fields of Industrial Microbiology, Fermentation Technology, Quality assurance, Recombinant DNA Technology and Pharmaceutical Microbiology.
- During this program students undertake a On job training, Research Project, field projects which the student is expected to study research methodology through experimental work, literature survey and report writing.
- In On job training, the student is to take training in the Industry for a period of at least two weeks which will help student to study Microbiological aspects in the Industry.
- Educational tour to various institutes and or industries provides actual microbiologicalapplications in various fields of Microbiology.

REVISED SYLLABUS FOR MASTER OF SCIENCE (M. Sc. Part-I):

1. Title: Subject: - GENERAL MICROBIOLOGY

Compulsory under the Faculty of Science

2. Year of implementation: New syllabus will be implemented from June 2023 onwards

3. Preamble: (Applicable to University affiliated college centers)

Total number of semesters	: 02 (Per year)
Total No. of papers	: 06 (Per year)
Total no. of practical courses	: 04 (Per year)
Maximum marks per paper (Theory)	: 100
Distribution of marks (Theory only) –	
Internal evaluation	: 20
External evaluation	: 80
(Semester exam)	

Total marks for M. Sc. Degree Course

Theory papers	: 1200
Practical course	: 550
Research Methodology	: 100
OJT / Field Project	: 100
Research Project	: 250
	2200

	Semester I	
Credits	**MMT-101:Microbial Systematics** Core Compulsory Theory Paper Total: 4 Credits; Workload: -15 hrs /credit (Total Workload: - 4 credits x 15 hrs = 60 hrs in semester) **Course outcome:** **1.** To gain knowledge of systematics of bacteria **2.** To understand new trends in systematics of bacteria **3.** To learn different approaches bacterial systematics	**Lectures**
I	1. Species concept in prokaryotes and eukaryotes 2. Speciation concept 3. 5-Kingdom classification system 4. 3-Domain classification system 5. History and Approach of development of the Bergey's Manual, and its current status 6. Polyphasic Approach 7. Molecular clocks, phylogeny and molecular distances	15
II	8. Identification of microbes using conventional biochemical methods and genome based tools. 9. Nomenclature of microbes as per International Code of Nomenclature of Prokaryotes (ICNP). 10. Nomenclature of microbes as per the SeqCode. Details about Rule 30 and the reasons for developing the SeqCode. 11. Discussion and debate from a purely taxonomic perspective on ICNP and SeqCode. 12. Concept of 'List of Prokaryotic names with Standing in Nomenclature' (LPSN) and citing of LPSN. 13. Use of 'EzTaxon' for naming convention.	15
III	14. Advances in Chemotaxonomy: the in-silico approach 15. Molecular chronometers in phylogeny: single gene & multi-gene sequence based microbial typing 16. Advances in Genome relatedness Indices: • Various databases and their use in Whole genome comparisons. • Tree-building algorithms: distance-matrix methods, minimum evolution, LS, maximum parsimony, maximum likelihood and Bayesian inference	15
IV	17. Omics in microbial systematics • Metagenomics • Metaproteomics • Metatranscriptomics • Metabolomics 18. Microbial culture collections, Nagoya protocol, NBA and the National Biological Diversity Act for patenting of microbes. 19. Culture independent molecular methods for identifying unculturable bacteria • PCR	15

	• RFLP • ARDRA • DGGE • TGGE • RAPD • Microarray • FISH • RISA 20. Strategies for exploring 'unculturable' bacteria	

Suggested References:

References:

1. Black J. G. (2013). Microbiology: Principles and Explorations. 6th Edition. John Wiley & Sons, Inc
2. Bromham L. and Penny D. (2003). The Modern Molecular Clock. Nat Rev Genet. 4(3): 216-224. Nature Publishing Group.
3. Brown J. (2014). Principles of Microbial Diversity. ASM Press.
4. Buchanan, R. E. and Gibbons, N. E. (editors). 1974. Bergey's Manual of Determinative Bacteriology. 8th ed. Williams & Wilkins Co., Baltimore
5. Garrity G., Boone D. R. and Castenholz R. W. (2001). Bergey's Manual of Systematic Bacteriology. Volume One: The Archaea and the Deeply Branching and Phototrophic Bacteria. 2nd Edition. Springer-Verlag NewYork
6. Garrity G., Brenner D. J., Krieg N. R. and Staley J. R. (2005). Bergey's Manual of Systematic Bacteriology. Volume Two: The Proteobacteria, Part A: The Gamma proteobacteria. 2nd Edition. Springer-Verlag US
7. Garrity G., Brenner D. J., Krieg N. R. and Staley J. R. (2005). Bergey's Manual of Systematic Bacteriology. Volume Two: The Proteobacteria. Part B: Alpha proteobacteria. 2nd Edition. Springer-Verlag US
8. Garrity G., Brenner D. J., Krieg N. R. and Staley J. R. (2005). Bergey's Manual of Systematic Bacteriology. Volume Two: Part C. the combination of the Beta-, Delta- and Epsilon proteobacteria. 2nd Edition. Springer-Verlag US
9. Krieg N. R., Ludwig W., Whitman W., Hedlund B. P., Paster B. J., Staley J. T., Ward N., Brown, D. and Parte A. (Editors). (2010). Bergey's Manual of Systematic Bacteriology. Volume 4. 2nd Edition. Springer-Verlag NewYork
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MMT 102: IMMUNOLOGY

Total Credits: 04 **Total Lectures: 60**

Course Outcomes:

At the end of this course the students will be able to:

1. Understand classes of immunoglobulin, organization and expression of immunoglobulin genes.
2. Know details of major histocompatibility complex and disease susceptibility.
3. Understand cytokines and their medical significance.
4. Understand hypersensitivity reactions.
5. Know immunodeficiencies and auto immunity.
6. Understand details of transplantation immunology and immunity to cancer.

Credit	Semester	Lectures
	MMT 102: IMMUNOLOGY Core Compulsory Theory Paper Total: 4 Credits; Workload: -15 hrs /credit (Total Workload: - 4 credits x 15 hrs = 60 hrs in semester) **Course Outcomes:** **At the end of this course the students will be able to:** **1.** Understand classes of immunoglobulin, organization and expression of immunoglobulin genes. 2. Know details of major histocompatibility complex and disease susceptibility. 3. Understand cytokines and their medical significance. 4. Understand hypersensitivity reactions. 5. Know immunodeficiencies and auto immunity.	

I	**IMMUNOGLOBULINS:** 1. Structure, classes & biological activities of immunoglobulins 2. Organization & expression of immunoglobulin genes • Genetic model compatible with Ig structure • Multigene organization of Ig Genes. • Variable region gene rearrangements • Mechanism of Variable region DNA rearrangements • Generation of Antibody diversity • Expression of Ig Genes • Regulation of Ig - Gene transcription.	**15**
II	**MAJOR HISTOCOMPATIBILITY COMPLEX:** 1. General Organization and Inheritance of the MHC 2. MHC molecules and Genes 3. Detailed Genomic Map of MHC genes 4. Cellular Distribution of MHC molecules 5. Regulation of MHC Expression. 6. MHC and Immune Responsiveness 7. MHC and Disease susceptibility	**15**
III	**IMMUNE EFFECTOR MECHANISMS:** 1. Cytokines – properties, receptors, antagonists, Cytokine secretion, related diseases, Therapeutic uses. 2. Complement system - Functions, Components, activation, Regulation, Biological consequences, Deficiencies. 3. Leukoyte Migration & Inflammation- Lymphocyte re-circulation, Cell Adhesion molecules, Neutrophils Extravasation, Lymphocyte Extravasation, Mediators of Inflammation, The inflammatory process, Anti inflammatory agents.	**15**
IV	**TRANSPLANTATION IMMUNOLOGY:** 1. Immunologic Basics of Graft Rejection. 2. Clinical manifestation of Graft rejection 3. General Immunosuppressive Therapy 4. Specific Immunosuppressive Therapy 5. Clinical Transplantation **VACCINES AND VACCINATIONS:** 1. New approaches to vaccine production 2. International Standards for Evaluation of Antibody Response to Vaccines	**15**

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MET 103 A: BIOCHEMISTRY

Total Credits: 4 **Total Lectures: 60**

Credit	Semester	Lectures
	Core Compulsory Theory Paper Total: 4 Credits; Workload: -15 hrs /credit (Total Workload: - 4 credits x 15 hrs = 60 hrs in semester) **Course Outcomes:** **At the end of this course the students will be able to:** 1. Understand basic concepts in biochemistry. 2. Understand structural features and chemistry of macromolecules. 3. Know membrane transport mechanism in bacteria.	
I	**THE SCOPE OF BIOCHEMISTRY:** i. What is Biochemistry? ii. Goals of Biochemistry. iii. The roots of Biochemistry. iv. Biochemistry as a discipline and an interdisciplinary science. v. Biochemistry as a chemical science. vi. Biochemistry as a biological science. vii. New tools in Biological revolution viii. The uses of Biochemistry. **BASIC CONCEPTS IN BIOCHEMISTRY:** • Common functional groups in biochemistry. OH, CHO, C = 0, NH2, C – NH2, SH, ester, ethers, methyl, ethyl, phospho, guanidio, imidazole etc). • Common ring structures in biochemistry.	**15**

	• Isomerism. • Isotopes. • Energetics. • Redox systems. • High energy compounds. **WATER:** Structure and properties. • Water as a solvent. • Ionization. • Ionic equilibrium. **STRUCTURAL FEATURES AND CHEMISTRY OF MACROMOLECULES:** **Nucleic acids:** i. Tautomeric forms of bases and their implication in pairing of bases. ii. Structure of polynucleotides, DNA structure, DNA and RNA (t -RNA, r- RNA, m- RNA etc). iii. Structure of DNA double helix. iv. R and L handed forms. v. A, B, C and Z forms of DNA. vi. Denaturation and Renaturation of DNA and Tm value.	
II	**Proteins:** i. Structural features of amino acids, classification of amino acids,Amino acids as buffers, ii. Henderson Hasselbalch equation and its role in bufferformulation Peptide linkage, partial double bond nature of peptide bond iii. Determination of primary structure of polypeptide (N-terminal,C-terminal determination, method of sequencing of peptides), iv. Structural classification of proteins: primary, secondary, tertiary,quaternary structures of proteins. v. Non-covalent interactions, Conformational properties ofproteins, Polypeptide chain geometry, Resonance forms of thepeptide group, cis/trans isomers of peptide group Ramachandranplot (Molecular visualization tools, Uniprot). vi. Secondary, Super-secondary Motif &Domain. vii. Tertiary and Quaternary structures of proteins, (Myoglobin &hemoglobin). **Membrane transport :** • Overview of membrane transport. • ATP powered pumps and intracellular ionic environment. • Non gated Ion channels and the resting membrane potential.	**15**

	• Co-transport – symport, antiport. • Neurotransmitters. • ATP driven active transport system for Sodium and Potassium ions. • Proton gradient in *Halobacteria.* • Transport of antibiotics that increase the ionic permeability of membranes.	
III	**Carbohydrates:** • L forms and D forms of sugar. • Reducing and non reducing sugars. • Aldoses / ketoses. • Alpha and Beta, ring forms of sugars. • Glycosidic linkages. • Sugar derivatives – sugar alcohol, amino sugars, dextro sugars, sugaracids • Polysaccharides (starch, glycogen, cellulose)	**15**
IV	**Lipids:** • Fatty acids – Types and nomenclature. • Saturated and unsaturated fatty acids, • Structure and function of Triglycerides, Phospholipids, Sphingolipids. • Structure and function of steroids, terpenes, prostaglandins.	**15**

References:

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MET-103 B MICROBIAL METABOLISM

TOTAL CREDITS:04 **TOTAL LECTURES:60**

Credits	Semester	Lectures
	Core Compulsory Theory Paper Total: 4 Credits; Workload: -15 hrs /credit (Total Workload: - 4 credits x 15 hrs = 60 hrs in semester) **Course Outcomes:** **At the end of this course the students will be able to:** **1.** Understand basic concepts of metabolism. **2.** Understand bioenergetics, aerobic respiration and anaerobic respiration. **3.** Know metabolism of carbohydrates, lipids and nucleic acids.	
Unit I	**BASICS OF MICROBIAL METABOLISM:** 1. Catabolism 2. Anabolism 3. Types of metabolic reactions 4. Methods employed to study metabolism. 5. Metabolic control mechanisms. Control of enzyme levels. • Control of enzyme activity. • Compartmentation. • Hormonal regulation. **BIOENERGETICS:** 1. Membrane Potential • Generation & maintenance. • Energetics of proton motive force. 2. Oxidation as a Metabolic enzyme source – • Biological oxidations. • Reductions. • Oxidation - a. Reduction potentials and standard electrode potential. b. Redox couple. c. Nernst equation. • High energy compounds – ATP, GTP, CTP, PEP, NAD, NADP, FAD, FMN. • Hormonal regulation.	**15**
Unit II	**AEROBIC RESPIRATION:** 1. Bacterial Electron transport chain 2. Mitochondrial ETC – • Structure of mitochondria • Mitochondrial ETC • Shuttle systems across mitochondrial membrane. • Citric acid cycle and oxidative phosphorylation.	**15**

	ANAEROBIC RESPIRATION: 1. Concept. 2. Sulfur Compounds, Nitrate & CO_2 as electron acceptors. 3. ETC in SO_4 reducers and NO_3 reducers.	
Unit III	**CARBOHYDRATE METABOLISM:** 1. Concept of fermentation with respect to - • Homo &heterolactic, bacteria. • Saccharolytic *Clostridia* & proteolytic *Clostridia*. • Enzymes, intermediates, cofactors & regulation of glycolysis. • Gluconeogenesis. • HMP pathway. • ED pathway. • TCA cycle & glyoxylate bypass. 2. Metabolism of – • Starch. • Glycogen.	**15**
Unit IV	**METABOLISM OF LIPIDS:** 1. Fatty acid oxidation – stages and tissues. 2. Oxidation of odd carbon chain fatty acid. 3. Oxidation of unsaturated fatty acids – • Alpha (α) • Beta (β) • Omega (ω). 4. Biosynthesis of fatty acids. 5. Synthesis of Triacylglycerols. 6. Metabolism of phospholipids. **NUCLEIC ACID METABOLISM:** 1. Synthesis and Catabolism of purines and pyrimidines – *De novo* biosynthesis. 2. Regulation of steps. 3. Purine degradation and clinical disorders of purine metabolism. 4. Pyrimidine metabolism. 5. Deoxyribonucleotide biosynthesis and metabolism. 6. Inhibitors of nucleotide biosynthesis.	**15**

References:

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MET 103-C : ENVIRONMENTAL MICROBIOLOGY

Total Credits: 04 **Total Lectures: 60**

Credits	Semester	Lectures
	Course Outcomes: **At the end of this course the students will be able to:** **1.** Understand concept of aeromicrobiology, biosafety and waste water management. **2.** Understand bioremediation and biodegradation processes. **3.** Know environmental laws.	**15**
Unit I	**ENVIRONMENTAL LAWS:** 1. Introduction 2. Environmental legislation in India 3. Legal aspects of waste treatment and disposal. 4. Notification relating to hazardous microorganisms and genetically modified organisms. **5.** Rules for management of Bio medical wastes **AEROMICROBIOLOGY:** 1. Droplets, Droplet Nuclei and Bioaerosols 2. Sampling of bioaerosols • Integral • Size selective • Passive 3. Bioaerosol control • Extramural Aeromicrobiology • Intramural Aeromicrobiology • General Pathological effects of air pollution. • Biosafety in laboratory	**15**
Unit II	**WASTE WATER MICROBIOLOGY:** **1. Waste water types.** • Characteristics. • Nature of pollutants and their effects • Microbial pollution and its effects. **2. Treatment.** • Principles of waste water treatment. • Disposal of waste water • Aerobic processes a. Activated sludge process. b. Fixed film systems. c. High rate filters. d. Trickling filters	**15**

	e. Rotating biological contactors. f. Fluidized bed reactors. g. Oxidation ditch. h. Aerated lagoons. • Anaerobic digestion a. Anaerobic lagoons and covered anaerobic lagoons. • Biosorption – N and P removal. • Biofilms and kinetics a. Root zone process. b. Reverse osmosis. c. Waste water disposal by dilution. • Difficulties encountered in operation of different methods of waste treatment. • Economics of waste treatment and feasibility.	
Unit III	**BIOREMEDIATION:** 1. Bioremediation of Metals • Metal toxicity effect on microbes • Mechanisms of microbial resistance to metals, metal -microbe interactions • Methods to detect metal – microbe interactions • Microbial remediation of metal contaminated soils • Microbial remediation of metal contaminated aquatic systems 2. Bioremediation of petroleum 3. Bioremediation of waste gases	**15**
Unit IV	**BIODEGRADATION OF XENOBIOTIC AND INORGANIC POLLUTANTS:** 1. Recalcitrant organic compounds and their presence in natural ecosystem 2. Concept and Consequence of biomagnifications. 3. Biomagnification of hydrocarbons and pesticides. 4. Process of Biodegradation 5. Relationship between Contaminant Structure, Toxicity and biodegradability 6. Environmental factors affecting biodegradability 7. Biodegradation of recalcitrant xenobiotic and toxic compounds 8. Recalcitrant Halocarbons 9. Recalcitrant Nitro aromatic compounds 10. Polychlorinated Biphenyl's 11. Radionuclide 12. Pesticides	**15**

References:

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RM-106 Research Methodology

Total: 4 Credits **Workload: -15 hrs /credit**

(Total Workload: - 4 credits x 15 hrs = 60 hrs in semester)

Credits	Semester	Lectures
	Course Outcomes: **At the end of this course the students will be able to:** **4.** Understand concept of aeromicrobiology, biosafety and waste water management. **5.** Understand bioremediation and biodegradation processes. **6.** Know environmental laws.	**15**
Credit I	**Research and Research Methodology: Strategies and Planning** **Introduction to research** • Objectives of research • Motivation in research • Basic types of research (Descriptive vs. analytical, applied vs.fundamental, qualitative vs. quantitative and conceptual vs.empirical) • Research approaches • Significance of research **Research Process:** **Formulating the research problem** • Selecting the research problem. • Necessity of defining problem • Technique involved in defining a problem **Extensive literature survey** • Search strategies **(**Methodology filters and PubMed filters) • Quality of bibliographies/reference lists. • Impact factor to assess research quality. • Principal Bibliographic databases (PubMed, OldMedline, Cochrane Library, EMBASE, BIOSIS Previews, PsycINFO and ISI Web of Science). **Preparing the research design** • Need for research design • Features of good design • Important concept relating to research design • Different research designs. • Basic principles of experimental designs. • Classification of experimental designs (Informal and Formal experimental design). **Determining the sample design** • Steps in sample design • Criteria of selecting a sampling methods/procedure. • Different types of sample designs (non-probability and probability sampling).	**15**

	• Complex random sampling designs (Systematic sampling, stratified sampling, area sampling, quota sampling, cluster sampling, multi-stage sampling and sequential sampling).	
Credit 2	**Research Data Collection and Analysis** **Collecting the data** • Data types, Repeatability, Reproducibility and Reliability, Validity (concept validity, internal validity and external validity) • Methods of collecting primary data: Observation method, Interview method, through questionnaires, through schedules and other methods. • Methods of collecting secondary data: Case study method. • Measurement scales (nominal, ordinal, interval and ratio) **Analysis of data** • Data presentation by Tables and Graphs (Histogram, bar, pie and line) • Measures of central tendency – Mean, Mode, median • Measures of dispersion – Mean deviation, Standard deviation and Variance **Hypothesis testing** • The concepts of null hypothesis and alternative hypothesis • P-value significance level • Type I and type II errors • One tailed and two tailed tests • Degrees of freedom • Tests of hypothesis (Parametric tests : z-test, t-test, and F test)	**15**
Credit 3	**Ethics in Biological Research** **Introduction to Research ethics** • Ethical theories and frameworks i) Consequentialismii) Deontological ethics iii) Virtue ethics. • Basic principles of human research ethics. • The ethics of animal research • International regulations • Basic principles for all medical research • Rules for basic medical research projects • The role of research ethics committees **Scientific conducts and Misconducts** • Characterization of scientific work by three norms 1) Internalnorms 2) Linkage norms 3) External norms. • Fabrication of data Plagiarism • Authorship issues (Exclusion from authorship, Giftauthorship, Authorship achieved by coercion and Unsolicited authorship) • Duplicate publication • Publication bias • Other form of misconducts • The investigation and punishment of scientific misconduct.	**15**

Credit 4	**Essentials of Scientific Writing** **Research Communications:** • Purpose of science communication • Requirement of producing publications. • Choosing a journal for publications. **Writing of Scientific Papers:** • **Characteristics of a good scientific paper** • **Structure of Research paper:** Title, Authors, Abstract, Introduction, Materials and methods, Results, Discussion, Conclusions, Acknowledgements and References, Citation ofreferences (textual citations and order of references), Listingreferences, foot notes and End notes, Figures, tables, captions andequations , Units of measurements. • **Planning of Research paper writing:** The first draft of researchpaper, Revising the first draft, the second draft, the third draft,checking of references, figures and tables, proofreading andreporting statistics in the final manuscript. Style and language of research papers • **Style and language of research papers** **Review Articles** • Kinds of reviews • Literature search • Writing a review article: Introduction, Description of theliterature review, Headings in the middle review, Conclusions,Recommendations, Acknowledgement and References. **Handling of negative results** **Purpose of Peer reviewing** **Most common reasons of research papers rejections** **Research papers Publishing ethics :** • Using other's words or data (Plagiarism) • Not reporting other's work • Putting your name on work you did not carry out • Double publishing • Multiple submissions • Publishing the same results many times • Failing to obtain approval from authors • Authorship • Copyright • Data fabrication • Fraud or error • Conference and Journal publishing **Fraudulent research :**Fabrication, falsification, plagiarism, failure toGAdisclose conflict of interest, inefficiency, anonymity **Poster preparation**	**15**

REFERENCES:

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MMPR- 104 PRACTICAL COURSE-1

UNITS	Semester	CREDITS
	Course Outcomes: At the end of the practical course, students will learn, 1. Operating of high end laboratory instruments 2. Basic practical skills in Biochemistry 3. Basic practical skills in Immunology 4.	
I	**INSTRUMENTATION & BIOCHEMISTRY** 1. Study of different instruments in the laboratory. • Laminar airflow, Microfuge, UV. Spectrophotometer, Incubator shaker, Cooling incubator, Deepfreeze, colorimeter, pH meter, lyophilizer (visit). • Laboratory Safety. 2. Preparation of buffers and molar solutio 3. Estimation of protein by Lowry's / Biuret method. 4. Separation & identification of amino acids, carbohydrates by TLC.	**1**
II	5. Estimation of reducing sugars by DNSA. 6. Estimation of lipids / fats 7. Study and justification of Beer Lambert's law.	**1**
III	**Blood transfusion related techniques.** • Blood grouping. • Cross matching. • Visit to blood bank. **Applications of Immunology** • Demonstration / visit. a) RIA b) ELISA • Study of vaccination schedule.	**1**
IV	**Study of Immunological reactions. (to be conducted in the laboratory of the institution)** • Immunoelectrophoresis- • Purification of Immunoglobulin-Ammonium Sulphate precipitation • Haemagglutionation Inhibition Test • Immunodiffusion • Rapid NS1 Antigen Test	**1**

References:

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MEPR- 105 PRACTICAL COURSE-II

UNITS	Semester	CREDITS
	Course Outcomes: **At the end of this course the students will be able to:** **1.** Use basic softwares for bacterial systematics **2.** Cultivate extremophiles. **3.** Conduct experiment for detection of pollution strength.	
I	**Basic skills in Microbial Systematics:** 1. 16s RNA Fragment Analysis using 'Sequence Scanner Software' 2. Contig generation using ChromasPro 3. Fragment analysis and assembly using SeqMan Software 4. Study of closest match of bacterial genome using Ez. Taxon Database 5. Study of closest match of bacterial genome using NCBI Database 6. Study of closest match of bacterial genome using RDP Database 7. Demonstration of MEGA Software	**1**

Guidelines

Practicals of the Microbial Systematics have been designed with the objective of providing students with comprehensive experience in comparative genomics, taxonomic analysis, and phylogenetic reconstruction using bioinformatics tools, including BLAST, the List of Prokaryotic Names with Standing in Nomenclature (LPSN), and phylogeny tools. Students will learn how to analyze DNA sequences, perform sequence alignments, assign taxonomic names, and reconstruct phylogenetic trees.

Materials and Equipment:

Access to a computer or laptop with internet connectivity

BLAST (Basic Local Alignment Search Tool) software or access to the NCBI BLAST website (blast.ncbi.nlm.nih.gov)

LPSN website (www.bacterio.net)

Phylogeny tools such as Chromas, MEGA or PhyML (software or online tools)

Procedure:

Introduction to Comparative Genomics, Taxonomic Analysis, and Phylogeny (1 session):

Provide an overview of comparative genomics, its significance in microbial taxonomy, and the construction of phylogenetic trees.

Explain the use of BLAST, LPSN, and phylogeny tools as bioinformatics resources for taxonomic analysis and phylogenetic reconstruction.

Discuss the importance of DNA sequence alignment and evolutionary relationships in understanding microbial taxonomy.

Sequence Retrieval and Preparation (1 session):

Instruct students on how to search for and retrieve DNA sequences from public databases, such as GenBank or NCBI.

Explain the importance of selecting appropriate sequences for taxonomic analysis and phylogenetic reconstruction.

Guide students in downloading and organizing the sequences for further analysis.

BLAST Analysis (2-3 sessions):

Provide a demonstration of the BLAST tool and its functionalities.

Guide students in performing sequence alignments using BLAST against relevant databases.

Instruct students on how to interpret BLAST results, including sequence similarity, E-values, and alignment scores.

Help students in identifying the most closely related taxa based on the BLAST results.

Taxonomic Assignment using LPSN (1-2 sessions):

Familiarize students with the LPSN website and its resources.

Instruct students on how to search for taxonomic information

	using LPSN. Guide students in assigning taxonomic names to their sequences based on the BLAST results and LPSN information. Discuss the limitations and challenges of taxonomic assignment using genomic data. **Phylogenetic Reconstruction (2-3 sessions):** Introduce students to phylogeny tools such as MEGA or PhyML. Guide students in aligning the DNA sequences and constructing phylogenetic trees using appropriate methods (e.g., maximum likelihood or neighbor-joining). Instruct students on how to interpret and visualize the phylogenetic trees. Discuss the significance of evolutionary relationships revealed by the phylogenetic trees. **Data Analysis and Reporting (2 sessions):** Assist students in organizing and analyzing their BLAST, LPSN, and phylogenetic results. Instruct students on summarizing their findings and drawing conclusions about the taxonomic affiliations and phylogenetic relationships of their sequences. Help students in preparing a comprehensive report detailing their methodology, results, and conclusions. **Assessment:** Active participation and engagement during practical sessions. Accuracy and completeness of BLAST analysis, LPSN taxonomic assignments, and phylogenetic reconstruction. Competence in using phylogeny tools for sequence alignment and tree construction. Quality of the final report, including data analysis, interpretation, and conclusions. **Note:** It is important to provide clear instructions on data retrieval, sequence preparation, the use of BLAST and LPSN, and phylogenetic reconstruction. Familiarize students with the limitations of bioinformatics tools and the challenges associated with taxonomic assignments and phylogenetic analysis based on genomic data. Encourage critical thinking, independent exploration, and effective communication of scientific findings throughout the practical.	
II	**1.** Cultivation of Extremophiles.(any two) • Acidophiles. • Alkalophiles. • Halophiles. 2. Systematic study of the extremophile isolates using 'Bergey's Manual of Systematic Bacteriology'. 3. Sewage decomposition by aerobic and anaerobic microorganisms. 4. Determination of BOD and COD of a given sample.	**1**

References:

1. Bathra Atlas (2007) Microbial Ecology Fundamentals and Application4th edition, Pearson Education Publication
2. Kormondy H.J(2007) Concepts of Ecology .fourth Edn .Pearson, Prentice
3. Maier R M , I L Pepler, C P Gerba (2000) Environmental Microbiology,
4. Krieg, M. R. and J. G. Holt (Editors) (1984) Bergey's Manual of Systematic Bacteriology. Vol I Williams and Wilkins, Baltimore, London, Tokyo
5. Sharma B.K. and H. Kaur (1994). Water pollution Goel Publishing House Meerut.
6. Sneath, P. H. A. Mair: N. S. Sharpe: M. E. and J. G. Holt (Eds) (1986). Bergey'sMannual of Systematic Bacteriology Vol. II Williams and Wilkins, Baltimore, London, Tokyo.
7. Staley, J. T. Bryant: M. P. Penning: N and J. G. Holt (Eds) (1989) Bergey'sMannual of Systematic Bacteriology Vol. III Williams and Wilkins, Baltimore, London, Tokyo.
8. Skinner,(1987)Bacterial Systematics Academic Press.
9. Cappucino& Sherman (2004) Microbiology a laboratory mannual 6^{th}Edn. Pearson Education, New Delhi.
10. Tripathi A.K. (1993) Understanding Environmental Disruption. Volume-I & II. Ashish Publishing House, New Delhi.
11. Trivedi R K (1998) Advances in Wastewater Treatment Technologie vol.1, Global Science, Aljgarh
12. Williams, S. T. Sharpe: M. E. and J. G. Holt (Eds) (1989) Bergey'sMannual of Systematic Bacteriology. Vol. IV Williams and Wilkins, Baltimore, London, Tokyo.
13. MEGA SOFTWARE through https//wwwmegasoftware.net

Semester II

MMT 201	GENETICS AND MOLECULAR BIOLOGY (4Cr)	60 Hrs
CREDIT I	1. Origin of life- aspects of prebiotic environment, evolution of the pre-cell. 2. Organic evolution: concepts and theories, mechanisms of speciation, genetic basis of evolution - Hardy-Weinberg genetic equilibrium, evolutionary clock. 3. Molecular basis- genetic polymorphism and selection, coincidental and concerted molecular basis, gene duplication, sequence divergence, recombination and crossover fixation, pseudo-genes as dead ends of evolution 4. Origin and evolution of economically important microbes, plants and animals. 5. Evidences for nucleic acids as genetic material. 6. Organization of eukaryotic genetic material: Operon, Unique and repetitive DNA, Interrupted genes, gene families, structure of chromatin and chromosomes, heterochromatin and euchromatin. Polytene and Lampbrush chromosomes.	15 Hrs
CREDIT II	1. Principles of Mendelian inheritance: linkage and gene mapping - Tetrad analysis, split and overlapping genes. 2. Law of DNA constancy and redundancy, C-value paradox, Cot curves and DNA re-association constant, dosage compensation, genetic load. 3. Molecular basis of mitosis and meiosis 4. Replication of DNA and duplication of chromosomes – modes and molecular mechanisms of DNA replication in prokaryotes (bacteria) and eukaryotes (nuclear and mitochondrial). 5. Co-transcriptional and post-transcriptional processing of RNA, structure and stability of Mrna	15 Hrs
CREDIT III	1. Translation in eukaryotes – machinery, initiation, elongation, termination and release, posttranslational processing. 2. Localization of proteins in cell - mechanisms of transport to nucleus, mitochondria, chloroplasts and outside the cell 3. Molecular mechanism of homologous recombination in bacteria and other organisms – RecBCD and Ruv systems, Holliday junction, interallelic, specialized and site specific recombination; Gene targeting. 4. Restriction and modification of DNA – enzymes, molecular mechanisms and significance.	15 Hrs
CREDIT IV	1. Teratogenesis- chromosome aberrations, genetic disorders; Genetic counseling. 2. Cancer and oncogenesis: 2.1 Transforming viruses, environmental factors causing cancer - carcinogens 2.2 Molecular mechanism and sequence of changes leading to oncogenesis - mutations, activation of proto-oncogenes, loss of function of tumour suppressor (anti-cancer) genes, role of apoptosis and telomere shortening in cancer.	15 Hrs

	3. Techniques in molecular genetics:	
	3.1 Basic techniques - PCR, LCR, Nick translation, Blotting techniques – Southern, Northern and Southwestern blotting, colony hybridization	
	3.2 Applications - Chromosome walking, DNA foot printing and 16s rRNA sequence analysis 3.3 Transfection – Protoplast fusion, electroporation	

REFERENCE BOOKS

1. Molecular Biology of the Cell by Alberts and others, Garland Publishing, NY.
2. Concept of Evolution by P. S. Verma and V. K. Agarwal, S. Chand and Co., New Delhi
3. Organic Evolution by N. Arumugam
4. Organic Evolution by R. S. Lulla, Seema Publications
5. Genetics by Strickberger
6. Microbial Genetics by D. Freifelder, J. Wiley and Sons
7. Genes – VI, VII, VIII and IX by B. Lewin, Jones and Bartlett Publishers
8. Molecular Biology of the Gene by J. D. Watson and others, Benjamin CummingsPublishing Co.
9. Genetics by S. Mitra, Macmillan India
10. Genetic Engineering by S. Mitra, Macmillan India
11. Molecular Biology and Biotechnology by J. M. Walker and R. Rapley, Panima Publishing Corp. New Delhi
12. Molecular Biology by P. C. Turner and others, Bioscientific Publishers
13. Principles of Genetics and Genetic Engineering by E. John Jothi Prakash, JPR Publications
14. Principles and Techniques of Practical Biochemistry by K. Wilson and J. Walker, Cambridge University Press
15. Molecular Cloning – A Laboratory Manual, Vol. 1, 2, 3 by J. Sambrook, E. F. Fritsch and T. Maniatis
16. An Introduction to Genetic Analysis Freeman 1993
17. Molecular Gebetics of Bacteria by L. Snyder and W. Champness, ASM Press, Washington

MMT 202	FERMENTATION TECHNOLOGY (4Cr)	60 Hrs
CREDIT I	Fermentation equipment and its use: 1. Basic functions of a fermenter, body construction, aeration, Agitation, baffles, etc. 2. Design of other fermentation vessels: Airlift fermenter, tower fermenter Continuous fermenter, fed batch fermenter, Waldhof type fermenter 3. Sterilization of fermentation equipment, air and media 4. Fermentation broth rheology and power requirements, concepts of Newtonian and non-Newtonian fluids, plastic fluids, effect of rheology on heat and oxygen transfer, Reynold's number, power number, aeration number and apparent viscosity	15 Hrs
CREDIT II	1. Fermentation media- Types of fermentation media, sources of carbon, nitrogen trace elements, growth factors, precursors, buffers, antifoam agents, sterilization of media, screening for fermentation media. 2. Fermentation economics – A case study, market potential for product and fermentation, product recovery cost, Entrepreneurship, plan for industry, product selection process, site selection, finance, feasibility, excise and legal aspects 3. Patents – Introduction, composition of patent, background, patent practice and problems	15 Hrs
CREDIT III	1. Environmental control of metabolic pathways 2. Genetic Control of Metabolic pathways 3. Growth and product formation: Concept of primary and secondary metabolites and their control,kinetics of growth and product formation (growth rate, yield coefficient, efficiency), economics 4. Contamination problems in fermentation industry 5. Computer applications in fermentation technology- General applications and specificapplications	15 Hrs
CREDIT IV	Industrial production of: 1. Lactic starter culture for food fermentations 2. Vitamin- B12 3. Gluconic acid 4. Distilled alcoholic beverages – Whisky and Brandy 5. Bacterial vaccines	15 Hrs

REFERENCE BOOKS

1. Industrial Microbiology by L. E. Casida, John Wiley and Sons INC
2. Annual Reports on Fermentation processes Vol. I and II by D. Perlman, Academic pressINC
3. Prescott and Dunn's Industrial Microbiology, 4th edition (1982) by Gerald Reed
4. Food processing: Biotechnological applications by S. S. Marwaha and J. K. Arora (2000), Asiatech publishers INC
5. Microbial technology Vol. I and II by H. J. Peppler and D. Perlman Academic Press INC
6. Principals of Fermentation Technology by P. Stanbury and A. Whitaker, Pergamon Press
7. Essays in Applied Microbiology by J. R. Norris and M. H. Richmond, John Wiley and Sons, Chicester, New York
8. Biology of Industrial Microorganisms by A. Demain and N. Solomon Butterworths Biotechnology Series
9. Overproduction of Microbial Metabolites: Strain Improvement and Process Control strategies by Z. Vanek and Z. Hostalek Butterworths Biotechnology Series
10. Fermentation Microbiology and Biotechnology by E. M. T. El-Mansi and C. F. A. Bryce Taylor and Francis Ltd. London
11. Legal protection for Microbiological and Genetic Engineering Inventions by R. Saliwanchik Butterworths Biotechnology Series
12. Methods in Industrial Microbiology by B. Sikyta, Ellis Horwood Ltd. Chichester (1983) Industrial Microbiology by A. H. Patel, MacMillan India Ltd.
13. Principals of fermentation technology by P. Stanbury and A. Whitaker, Pergamon Press
14. Advances in Applied Microbiology Vols. 9 and 13, by W. W. Umbreit, Academic Press, New York
15. Essays in Applied Microbiology by J. R. Norris and M. H. Richmond, John Wiley and Sons, Chicester, New York.

MET 203-A	TECHNIQUES IN MICROBIOLOGY (4Cr)	60 Hrs
CREDIT I	1. Enrichment culture techniques – principles and selective factors employed, enrichmentsystems – closed and open, single cell isolation methods 2. Principles and methods of preservation of bacteria, viruses, yeasts and molds 3. Isolation and cultivation of anaerobes – principles, reducing agents, indicators, anaerobic jarmethods and anaerobic glove box, Hungate's roll tube technique and its serum bottle modification. 4. Isolation of human and animal pathogenic fungi 5. Microscopic techniques – 5.1 Electron microscopy – principles and working of transmission and scanning microscopes. 5.1 Dark field, phase contrast, polarisation, differential interference contrast (DIC),fluorescence, confocal scanning, scanning tunnelling, atomic force microscopy.	15 Hrs
CREDIT II	1. Good laboratory practices: 1.1 Accuracy in preparation of solutions, media, etc. 1.2 Qualifications of equipment – design (DQ), installation (IQ), operational (OQ) andperformance (PQ) 1.3 Validation and calibration 1.4 Documentation- Concepts, necessity and types 2. Safety in the laboratory: 2.1 Common hazards in the laboratory – 2.1.1 Electrical equipment 2.1.2 Chemicals – corrosive, irritant, toxic, flammable, explosive 2.1.3 Ionising radiations 2.1.4 Infectious materials 2.1.5 Gas and fire 2.2 Safety measures – 2.2.1 In the use of equipments and gas facility 2.2.2 Personal protection 2.2.3 Waste disposal 2.2.4 First aid 3. Cell disruption methods – principles and methods of disruption of microbial, plant andanimal cells and separation of cellular components	15 Hrs
CREDIT III	1. Chromatography – general principles and working of 1.1 Column chromatography – gel, ion exchange. 1.2 Gas chromatography 1.3 HPLC 2. Electrophoresis- 2.1 Polyacrylamide gel electrophoresis (PAGE) - native and gradient gels, DNA Sequencinggels, SDS-PAGE, isoelectric focusing, 2-D PAGE 2.2 Agarose gel electrophoresis- DNA gel, Pulsed field gel, RNA electrophoresis. 2.3 Capillary electrophoresis 3. Centrifugation – principles of differential and density gradient centrifugation,sedimentation coefficient determination	15 Hrs

CREDIT IV	1. Spectroscopy – Principles of IR and Raman spectrophotometry, turbidimetry andnephelometry, fluorimetry, luminometry, circular dichroism and optical rotational dichroismspectrophotometry, ESR,NMR 2. Mass spectrometry 3. X – ray crystallography 4. Radioisotopic techniques – 4.1 Nature of radioactivity and general principles of radioisotopic techniques 4.2 Methods of detection of radioactivity – gas ionization (GM counter), excitation(scintillation) and exposure of photographic emulsions (autoradiography). 4.3 Methods of using radioisotopes – radioisotope tracer technique, isotope dilution assay(RIA) and other methods 5. Electrochemical techniques – general principles of electrochemical cells and potentiometry,principles and applications of the pH, ion selective and oxygen electrodes	15 Hrs

REFERENCE BOOKS

1. Methods in Microbiology (series) by Norris and Ribbons, Academic Press, NY.
2. Principles and techniques in Practical Biochemistry by K. Wilson and J. M. Walker
3. Research Methodology for Biological Sciences by N. Gurumani, MJP Publishers, Chennai
4. Bioinstrumentation by L. Veerakumari, MJP Publishers, Chennai
5. A manual of Laboratory Techniques by N. Raghuramulu and others, NIN, Hyderabad
6. Microbiological aspects of Anaerobic Digestion – Laboratory Manual by D. R. Ranade and R. V. Gadre, MACS, Agharkar Research Institute, Pune
7. Isolation Methods for Anaerobes by Shapton, Academic Press.
8. Tools in Biochemistry by D. Cooper
9. Protein Purification by R. Scopes, Springer Verlag Publications
10. Analytical Biochemistry (Biochemical Techniques) by P. Asokan, Chinnaa Publications

MET 203-B	QUALITY ASSURANCE AND VALIDATION IN PHARMACEUTICAL SECTOR (4Cr)	60 Hrs
CREDIT I	**Drug designing and development** Introduction to drug design, computer aided drug design, molecular modeling in drug design – structure-based drug design. General approach in novel drug discovery- new Lead molecule discovery–Lead molecule optimization, Lead molecule modifications–ADME properties of new drug molecule. Mechanism of drug action and its physiochemical principles- drug stereo chemistry, structure activity relationship. Comparative modeling of proteins–comparison of 3D structure – Homology – steps in homology modeling – tools (Modeler) –side chain modeling – loop modeling. 3D structure databases–molecular docking – (Auto Dock). Introduction to energy minimization, MD simulation, Setting up MD (System preparation- parameter files), equilibration, Analysis of MD-RMSD, RMSF, Radius of gyration.	15 Hrs
CREDIT II	**Microbial synthesisof pharmaceutical productsand spoilage** Manufacturing procedures and in process control of pharmaceuticals products. Production of pharmaceutical products- by using microbial fermentations (Streptokinase, Streptodornase). Development of new vaccines- DNA vaccines, synthetic peptide vaccines, multivalent subunit vaccines, recombinant vaccine. Vaccine efficacy testing and its clinical trials. Microbial contamination and spoilage of pharmaceutical products (sterile injectables, non-injectables, ophthalmic preparations and implants) and their sterilization.	15 Hrs
CREDIT III	**Quality assurance and product validation** Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry. Quality assurance and quality management in pharmaceuticals ISO 9000, series, practices of GMP WHO, and US certification. Drug stability: parameters for physical stability testing, solution stability, solid stability. Sterilization control and sterility testing (For heat sterilization, TDP, TDT, D value, F value, z value, survival curve, Radiation, gaseous and filter sterilization (Mention Tests). Chemical and biological indicators. Design and layout of sterile product manufacturing unit Designing of Microbiology laboratory, Industrial Safety: Assessment of risk, Industrial hazards and their prevention, fire, accidents, mechanical and electrical equipment's, industrial effluent testing, laboratory standards-(BL-6). Records and documentations: Records related to products release, Quality review, and Quality audits. Complains and recalls.	15 Hrs
CREDIT IV	**Intellectual property rights and regulatory practices in pharma industries**: Intellectual property rights, Introduction to patents. Regulatory aspects of quality control of pharmaceutical products. IP, BP, USP. Government regulatory practices and policies, FDA perspective. Reimbursement of drugs and biologicals, legislative perspective. Biosensors in Pharmaceuticals (Cholesterol oxidase). Application of microbial enzymes in pharmaceuticals.	15 Hrs

References

1.Quality control in the Pharmaceutical Industry - Edt. by Murray S.Cooper Vol.2. Academic Press New York.
2. Sidney H Willing, Murray M, Tuckerman. Williams Hitchings IV, Good manufacturing of pharmaceuticals (A Plan for total quality control) 3rd Edition. Bhalani publishing house Mumbai.
3. Quality Assurance of Pharmaceuticals- A compedium of Guide lines and Related materials Vol I & II, 2nd edition, WHO Publications, 1999.
4. Good laboratory Practice Regulations – Allen F. Hirsch, Volume 38, Marcel Dekker Series, 1989.
5. The International Pharmacopoeia – vol I, II, III, IV & V - General Methods of Analysis and Quality specification for Pharmaceutical Substances, Expedients and Dosage forms, 3rd edition, WHO, Geneva, 2005

MET 203-C	**MICROBIAL ECOLOGY (4Cr)**	**60 Hrs**
CREDIT I	1. Concept and importance of microbial ecology. 2. Microbial communities and ecosystems - Development of microbial communities,Experimental Ecosystem models – Batch system, Flow-Through System, Microcosm, Germfree animal. 3. Physiological ecology of Microorganisms: abiotic limitations to microbial growth,starvation strategies, environmental determinants - temperature, radiation, pressure, salinity,water activity, pH, redox potential, magnetic force, organic and inorganic compounds	15 Hrs
CREDIT II	1. Culture dependant and culture independent analyses of microbial communities. 2. Quantitative ecology: Sample collection, processing and detection of microbialpopulations 3. Determination of microbial numbers, biomass, measurement of microbial metabolism.	15 Hrs
CREDIT III	1. Biological interactions – 1.1 Microbe – Microbe interactions – Interaction within single microbial populationpositive and negative interactions, Interactions between diverse microbial populationsmutualism,commensalism, synergism, ammensalism, parasitism and predation. 1.2 Microbe – Plant interactions – Interactions with aerial plant structures. 1.3 Microbe – Animal interactions- Microbial contributions to animal nutrition,Commensal and mutualistic intestinal symbionts, Symbiotic light production.	15 Hrs
CREDIT IV	1. The animal as an environment – The indigenous microbial population of alimentary tractand skin, factors affecting composition of flora, sources of nutrients for organisms in the alimentary tract and on skin, energy metabolism in rumen 2. Ecological control of pests and disease causing populations- Modification of - populations, reservoirs of pathogens and vector populations Microbial control of pests,genetic engineering in biological control.	15 Hrs

References
1. Microbial Ecology by M. Lynch and others
2. Experimental Microbial Ecology by R. C. Burns and others
3. Environmental Microbiology by K. Vijaya Ramesh, MJP Publishers
4. Microbial Ecology by Larry L. Barton and Diana E. Northup Copyright © 2011 Wiley-Blackwell.
5. Soil Microbiology by N. S. Subba Rao Oxford and IBH Publishing Co. Pvt. Ltd
6. Introduction to Soil Microbiology by M. Alexander, John Wiley and Sons Inc. New York, London
7. Microbial Ecology by R. M. Atlas and R. Bartha
8. The Prokaryotes: A handbook on the Biology of Bacteria; M. Dworkin (Editor inChief)and others.

MMPR- 204 PRACTICAL COURSE I (4Cr)

UNIT	SEMESTER II	Credits
UNIT I	1. Isolation of RNA from yeasts. 2. Isolation of Plasmid DNA from bacteria 3. Thermal denaturation of DNA 4. Gene transfer in E. coli by – conjugation 5. Demonstration of protoplast fusion in bacteria 6. Estimation of mutation rate in E. coli 7. PCR (demonstration)	1
UNIT II	1. Production of a Lactic starter culture 2. Fermentative production of gluconic acid 3. Fermentative production of ethanol by using Saccharomyces sp. 4. Fermentative production of acetic acid	1
UNIT III	1. Enrichment and isolation of chitin degrading bacteria 2. Enrichment of Clostridium species using potato, Thioglycollate broth and Candle jar 3. Spectroscopy - 3.1 Calibration of colorimeter/ spectrophotometer (Verification of Beer's law) 3.2 Determination of absorption maxima, molar extinction coefficient and difference spectra	1
UNIT IV	1. Qualitative and Quantitative study of water microflora 2. Qualitative and quantitative study of air microflora 3. Isolation and characterization of microflora from human skin. 4. Demonstration of bacterial synergism and antagonism 5. Isolation and characterization of ruminant bacteria from animal gut.	1

References

Genetics and Molecular Biology

1. PracticalMicrobiology by R. C. Dubey and D. K. Maheshwari. S. Chand & Co.
2. Environmental Science and Biotechnology: Theory and Techniques by A. G. Murugesan and C. Rajakumari. MJP Publishers
3. Laboratory Manual in Biochemistry by J. Jayaraman. New Age International Publishers
4. Experimental Microbiology by R. J. Patel. Aditya Publishers, Ahmedabad
5. Methods in Microbiology (Vol. 5B and Vol. 3A) by Norris and Ribbons. Academic Press
6. Molecular Cloning – A Laboratory Manual, Vol. 1,2,3 by J. Sambrook, E. F. Fritsch and T.Maniatis
7. Molecular Biology Laboratory Manual by Denny R. Randall
8. Environmental Science and Biotechnology- Theory and Techniques by A. G. Murugesanand C. Rajkumari, MJP Publisher Chennai.

FERMENTAION

1. Dairy Microbiology by Robinson
2. Outlines of Dairy technology by Sukumar De

TECHNIQUES

1. Identification Methods for Microbiologists by B. M. Gibbs and F. A. Skinner. AcademicPress
2. Methods in Microbiology (Vol. 1, 3A and 5B) by Norris and Ribbons. Academic Press
3. Handbook of Microbiological Media by R. M. Atlas. CRC Publications
4. Laboratory Exercises in Microbiology by Robert A. Pollock and others

MICROBIAL ECOLOGY

1. PracticalMicrobiology by R. C. Dubey and D. K. Maheshwari. S. Chand & Co.
2. Environmental Science and Biotechnology: Theory and Techniques by A. G. Murugesanand C. Rajakumari. MJP Publishers
3. Experimental Microbiology by R. J. Patel. Aditya Publishers, Ahmedabad
4. Laboratory Microbiology by L. Jack Bradshaw. W. B. Saunders & Co.
5. Benson’s Microbiological Applications: Laboratory Manual in GeneralMicrobiology byAlfred E. Brown
6. MicrobiologicalMethods by Michael Collins
7. Handbook of Microbiological Media by R. M. Atlas. CRC Publications
8. Laboratory Excersises in Microbiology 5th edn. Harley Prescott

MEPR- 205 PRACTICAL COURSE II (2Cr)

UNIT	Semester II	Credit
UNIT I	1 Chromatography – 1.1 Separation of dyes and amino acids on silica gel column 1.2 Ion exchange chromatography of amino acids / proteins 2 Agarose gel electrophoresis 3 Density gradient centrifugation of budding yeast cells 4. Preservation of microbial cultures – 4.1 Slant cultures of aerobic and facultative organisms 4.2 Stab cultures of microaerophilc organisms 4.3 Soil culture technique for spore formers	1
UNIT II	1 Environmental monitoring : air sampling. 2 Microbial limit test 3 Sampling of pharmaceutical products (syrups, suspensions, creams and ointments, ophthalmic preparations) for microbial contamination and load. 4 Molecular docking and drug designing	1

References

Techniques

1. Laboratory Manual in Biochemistry by J. Jayaraman. New Age International Publishers
2. Experimental Microbiology by R. J. Patel. Aditya Publishers, Ahmedabad
3. Microbiological Methods by Michael Collins

Quality assurance

1. Practical Microbiology by Plummer
2. Industrial Microbiology: A Laboratory Manual- Mathur.

Nature of question paper and scheme of marking:

a) External Evaluation (Semester exam) Theory paper: Maximum marks – 80

- ✓ Equal weightage shall be given to all units of the theory paper
- ✓ Total number of questions – 07
- ✓ All questions will carry equal marks.
- ✓ Out of the seven questions, five are to be attempted of which Question 1 will be compulsory
- ✓ Question No. 1 will be of an objective type
- ✓ Total No. of bits – 16, Total marks – 16
- ✓ **Nature of questions** - multiple choice, fill in the blanks, definitions, true or false, match the following
- ✓ These questions will be answered along with the other questions in the same answer book
- ✓ Remaining six questions will be divided into two sections, I and II.
- ✓ Four questions are to be attempted from these sections in such a way that not more than two questions are answered from each section.
- ✓ Both sections are to be written in the same answer book

Total Marks: 80

Instructions:
1. A total of **FIVE** questions are to be answered from the entire paper
2. Answers to all the **FIVE** questions are to be written in the **SAME** answer book
3. Question – 1 is **COMPULSORY**
4. Attempt **ANY TWO** questions from Section – I (Q. 2 to Q. 4) and **ANY TWO** questions from Section – II (Q. 5 to Q. 7)
5. **No** supplements will be provided
6. Figures to the **RIGHT** indicate **FULL MARKS**

Q.1 State whether the given statements are TRUE or FALSE/MCQ. (16)

SECTION – I

Q. 2. (16)

OR

Q. 2. (16)

Q. 3 Discussin brief (ANY TWO) (16)

a)
b)
c)

Q. 4 Write short notes on (ANY FOUR) (16)

a)
b)
c)
d)
e)
f)

SECTION – II

Q. 5 (16)

OR

Q. 5 (16)

Q. 6 Describe in brief **(ANY TWO)** (16)

a)
b)
d)

Q. 7 Write short notes on **(ANY FOUR)** (16)

a)
b)
c)
d)
e)
f)

b) Internal Evaluation Theory paper: Maximum marks – 20

Objective- multiple choice/True or false/ fill in the blanks/match the following
Total number of questions will be 10 each carrying 01 mark

PRACTICAL EXAMINATION

- There will be semester wise practical examination to be conducted at the end of each semester.
- Total marks -150 per semester out of which 120 marks will be assessed by external examiner.
- Nature of question paper for practical examination will be provided by BOS before the practical examination.

9. Scheme of Teaching

Offline / online as per the requirement of NEP.

10. Examination Pattern

Theory – Semester wise

Practical – Semester wise

On Job Training / Field Project

Guidelines for conducting OJT/FP- 206 Field Project in Sem II of the curriculum

(Reference: Government of Maharashtra GR:NEP 2022/ PRA-KRA-09/VISHI-3 SHIKANA, Mantralaya, Mumbai dt. 16 May 2023)

1. The candidate should complete the work of RM-MIC 206 after completion of second semester in the summer vacation.
2. On job training (OJT)/ Internship/ Apprenticeship of 60 hours must be completed by the candidate in industry/ health sectors / research labs / public testing laboratories / diagnostic laboratories.
3. During OJT period the candidate should submit weekly progress report and attendance report to the Head of the department of concerned education institute.
4. The administration of the department should keep the record of attendance and progress and that will be submitted to external examiner for verification.
5. The evaluation of OJT should be done on following aspects and that should be reflected through training report and presentation of the candidate.
    - The new skills achieved by the candidate during OJT /Internship/ Apprenticeship
    - Whether the period spent by the candidate has enriched his practical skills and subject knowledge.
    - Whether the candidate has inspired for entrepreneurship

6. The candidate may opt for field projects as an alternative for On job training (OJT)/ Internship/ Apprenticeship.In case of field projects, the evaluation should be done on the basis of
    - Selection of the field project considering its use for community.
    - Sample size and statistical methods followed for reaching the conclusion.
    - Skills achieved.

Research Methodology - As per Theory Paper

11. Nature of question paper and scheme of marking:

a) External Evaluation (Semester exam) Theory paper: Maximum marks – 80

- ✓ Equal weightage shall be given to all units of the theory paper
- ✓ Total number of questions – 07
- ✓ All questions will carry equal marks.
- ✓ Out of the seven questions, five are to be attempted of which Question 1 will be compulsory
- ✓ Question No. 1 will be of an objective type
- ✓ Total No. of bits – 16, Total marks – 16
- ✓ **Nature of questions** - multiple choice, fill in the blanks, definitions, true or false, match the following
- ✓ These questions will be answered along with the other questions in the same answer book
- ✓ Remaining six questions will be divided into two sections, I and II.
- ✓ Four questions are to be attempted from these sections in such a way that not more than two questions are answered from each section.
- ✓ Both sections are to be written in the same answer book

Total Marks: 80

Instructions:
1. A total of **FIVE** questions are to be answered from the entire paper
2. Answers to all the **FIVE** questions are to be written in the **SAME** answer book
3. Question – 1 is **COMPULSORY**
4. Attempt **ANY TWO** questions from Section – I (Q. 2 to Q. 4) and **ANY TWO** questions from Section – II (Q. 5 to Q. 7)
5. **No** supplements will be provided
6. Figures to the **RIGHT** indicate **FULL MARKS**

Q.1 State whether the given statements are TRUE or FALSE/MCQ. (16)

SECTION – I

Q. 2. (16)

OR

Q. 2. (16)

Q. 3 Discussin brief (ANY TWO) (16)

a)

b)

c)

Q. 4 Write short notes on (ANY FOUR) (16)

a)

b)

c)

d)

e)

f)

SECTION – II

Q. 5 (16)

OR

Q. 5 (16)

Q. 6 Describe in brief **(ANY TWO)** (16)

a)

b)

d)

Q. 7 Write short notes on **(ANY FOUR)** (16)

a)

b)

c)

d)

e)

f)

b) Internal Evaluation Theory paper: Maximum marks – 20

Objective- multiple choice/True or false/ fill in the blanks/match the following

Total number of questions will be 10 each carrying 01 mark

PRACTICAL EXAMINATION

- There will be semester wise practical examination to be conducted at the end of each semester.
- Total marks -150 per semester out of which 120 marks will be assessed by external examiner.
- Nature of question paper for practical examination will be provided by BOS before the practical examination.

12. Equivalence of courses

M. Sc. Part I (Semester I and II)

Old Course				Equivalent Course		
Sem. No.	Course Code	Title of Old Course	Credit	Course Code	Title of New Course	Credit
I	MIC - 101	Taxonomy and Microbial Diversity	4	MMT - 101	Microbial Systematics	4
I	MIC - 102	Virology	4	MMT - 102	Immunology	4
I	MIC - 103	Genetics and Molecular Biology	4	MET - 103	A – Biochemistry B – Microbial Metabolism C – Environmental Microbiology	4
I	MIC - 104	Immunology	4	RM -106	Research Methodology	4
I	MIC - 105	Practical Course – I	4	MMPR	Practical Course I	4
I	MIC - 106	Practical Course – II	4	MEPR	Practical Course II	2
II	MIC - 201	Techniques in Microbiology	4	MMT - 201	Genetics and Molecular Biology	4
II	MIC - 202	Microbial physiology, biochemistry and metabolism	4	MMT - 202	Fermentation Technology	4
II	MIC - 203	Medical Microbiology	4	MET - 203	A – Techniques in Microbiology B - Quality Assurance and Validation in Pharma sector C- Microbial Ecology	4
II	MIC - 204	Microbial Ecology	4	OJT/FP	On Job Training / Field Project	4
II	MIC - 205	Practical Course – III	4	MMPR	Practical Course I	4
II	MIC - 206	Practical Course – IV	4	MEPR	Practical Course II	2