NEP-2020 BASED CURRICULA AND EXAMINATION SCHEME,
UNIVERSITY OF KOTA, KOTA

M.Sc. Microbiology programme

CBCS pattern (with effect from 2023-2024)

DEPARTMENT OF MICROBIOLOGY

UNIVERSITY OF KOTA
MBS Marg, KOTA (Rajasthan)-324 005
INDIA

Course Code: MIC 12400P

Type of the Course: Professional

Title of the Course: M. Sc. Microbiology

Level of the Course: PG level

Credit of the Course: 100

Delivery subtype of the Course: Practical

Pre requisites and co requisites of the Course

- A candidate who has passed any one of the following examinations from any University recognized by the UGC shall be permitted to take admission in M.Sc. First Semester to award M.Sc. degree in Microbiology from this University after completion of a course of study of two academic years divided in the four-semester scheme of examination:
- B.Sc. (Pass / Hons) under biological science stream with subjects: Microbiology, Biotechnology, Biochemistry, Biology, Chemistry, Botany, Zoology, Genetics, Environmental Sciences, Bioinformatics, Pharmaceutical Science, etc. or
- Bachelor of Science and Education (B.Sc.-B.Ed.) with subject biology, chemistry, botany, zoology.

University of Kota, Kota

M.Sc. Microbiology

Semester wise Consolidated Common Scheme of Examinations for the Academic Sessions 2023-2024

Year / Semester	Number, Code or ID and Nomenclature of Paper				Duration of Exam. (in Hrs.)	Teaching Hrs / Week			Distribution of Assessment Marks					
	Number of Paper	Code / ID of Paper		Nomenclature of Paper					Continuous or Internal Assessment (30%)		Semester or External Assessment (70%)		Total	
						Teaching			Max. Marks	Min. Pass Marks	Max. Marks	Min. Pass Marks	Max. Marks	Min. Pass Marks
						Th.	Pr.	Credit Point						
1st Year I Semester	Paper-1.1	MIC-5101	DCC	General Microbiology	3	4	-	4	30	12	70	28	100	40
	Paper-1.2	MIC-5102	DCC	Cell Biology and Enzymology	3	4	-	4	30	12	70	28	100	40
	Paper-1.3	MIC -5103	DCC	Microbial Genetics	3	4	-	4	30	12	70	28	100	40
	Paper-1.4	MIC -5104	DCC	Biochemistry and Microbial Physiology	3	4	-	4	30	12	70	28	100	40
	Paper-1.5	MIC -5105	DCC	Lab Course-I	6	-	8	4	--	--	100	50	100	50
	Paper 1.6	MIC -5106	DCC	Lab Course-II	6		8	4	--	--	100	50	100	50
	Total (I Semester)				**24**	**32**		24	**120**	**48**	**480**	**212**	**600**	**260**
1st Year II Semester	Paper-2.1	MIC -5201	DCC	Microbial Diversity	3	4	-	4	30	12	70	28	100	40
	Paper-2.2	MIC -5202	DCC	Molecular Biology	3	4	-	4	30	12	70	28	100	40
	Paper-2.3	MIC -5203	DCC	Immunology and Immunotechnology	3	4	-	4	30	12	70	28	100	40
	Paper-2.4	MIC -5204	DCC	Tools and Techniques in Microbiology	3	4	-	4	30	12	70	28	100	40
	Paper-2.5	MIC -5205	DCC	Lab Course-III	6		8	4			100	50	100	50
	Paper 2.6	MIC -5206	DCC	Lab Course-IV	6		8	4			100	50	100	50
	Total (II Semester)				**24**	**32**		**24**	**120**	**48**	**480**	**212**	**600**	**260**
2nd Year III Semester	Paper-3.1	MIC -6301	DSE	Microbial Ecology and Environmental Microbiology	3	4	-	4	30	12	70	28	100	40
	Paper-3.2	MIC -6302	SEC	Fermentation Technology & Bioinformatics	3	4	-	4	30	12	70	28	100	40
	Paper-3.3	MIC -6303	DSE	ELECTIVE I 1. Biofuel and Bioenergy 2. Pharmaceutical microbiology	3	4	-	4	30	12	70	28	100	40
	Paper-3.4	MIC -6304	DSE	ELECTIVE II 1. Antimicrobial Resistance 2. Microbial nanotechnology	3	4	-	4	30	12	70	28	100	40
	Paper-3.5	MIC -6305	DCC	Lab Course-V	6	-	8	4	--	--	100	50	100	50
	Paper-3.6	MIC -6306	DCC	Lab Course-VI	6		8	4			100	50	100	50
	Total (III Semester)				**24**	**32**		**24**	**120**	**48**	**480**	**212**	**600**	**260**
2nd Year IV Semester	Paper-4.1	MIC-6401	DSE	1.Industrial Microbiology 2.Medical Microbiology	3	4	-	4	30	12	70	28	100	40
	Paper-4.2	MIC -6402	SEC	Research Methodology, IPR & Bioethics	3	4	-	4	30	12	70	28	100	40
	Paper-4.3	MIC-6403	DCC	Lab Course-VII	6	-	8	4	--	--	100	50	100	50
	Paper-4.4	MIC-6404	SEM	Comprehensive viva voice	3	-		4	--	--	100	50	100	50
	Paper-4.5	MIC -6405	DPR	Dissertation	3	-		8	--	-	200	100	200	100
	Total (IV Semester)				**16**	**16**		**24**	**60**	**24**	**540**	**256**	**600**	**280**
Grand Total (I + II + III + IV Semester)					**88**	**112**		**96**	**420**	**168**	**1980**	**892**	**2400**	**1060**

Salient features are as follows:

- Discipline Core (DSC) or Domain-specific Core Courses in Microbiology as Major.
- Discipline Electives (DSE) or Elective Courses in the Core Subject or Discipline.
- Open Electives (OE) are Elective Courses offered to students from non-core Subjects across disciplines.
- Skill Enhancement Courses (SEC) that are domain-specific or generic.
- Dissertation/Project/ course (DPR) or Elective course in the core subject
- Seminar/Viva course (SEM) or Elective course in the core subject

Objectives of the Course: Microbiology is the broad area of biology involving living systems and organisms to develop or make products, or "any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use".

- Students will gain necessary knowledge and develop specialized skills in the different areas of Microbiology.
- Students will think critically and creatively about the use of Microbiology to address local and global problems.
- Students will be able to implement the scientific skills for development of industrial applications and entrepreneurship

Hyperlinks of suggested e resources on University website and on web

NPTL and UGC epathsala, SWAYAM, MH Education , NPTEL, GeoGebra and MS Excel toolbox
https://link.springer.com/
https://www.tandfonline.com/
https://onlinelibrary.wiley.com/
https://ghr.nlm.nih.gov/resources#inheritance
https://opentextbc.ca/biology/chapter/10-1-cloning-and-geneticengineering/
http://www.hoajonline.com/molbiolgeneteng
https://www.yourgenome.org/facts/what-is-genetic-engineering
https://www.immunology.org/
https://onlinelearning.hms.harvard.edu/hmx/courses/hmximmunology
https://www.rcsb.org/
http://jgi.doe.gov/our-science/
https://www.genengnews.com/
http://biosafety.icgeb.org/in
https://iop.vast.ac.vn/theor/conferences/smp/1st/kaminuma/SWISSPROT/ index.html
http://www.ipindia.nic.in/
http://www.wipo.int
http://www.wto.org
http://www.nbaindia.org
http://www.envfor.nic.in/ divisions/csurv/geac/annex-5.pdf
Springer® Journal author tutorials now with interactive courses
Elsevier® Researcher Academy
https://www.hhs.gov/vaccines/about/resources/smart-vaccinetool/index.html
https://www.cdc.gov/vaccines/pubs/pinkbook/index.html

https://www.embl.org/
https://www.cathdb.info/
Environmental Microbiology latest research and news
Microbiology news, Science Daily, Nature News, Science News
Nature Microbiology, Journal of Applied Biology & Microbiology

Course learning outcome

Upon completion of the M.Sc. Microbiology programme, the candidate should be able to:

- Demonstrate knowledge for in-depth analytical and critical thinking to identify, formulate and solve the issues related to Microbiology Industry, Pharma industry, Medical or hospital related organizations, Regulatory Agencies & Academia.
- Demonstrate skills to use modern analytical tools/ software/ equipment to design & develop experiments and analyze and solve problems in various courses of Microbiology.
- Appreciate and execute their professional roles in society as Microbiology professionals, employers and employees in various industries, regulators, researchers, educators and managers
- Acquire basic and advance skills in in various fields of Microbiology for self- employment and entrepreneurship

Duration of the Course:

The course for the degree of Master of Science in Microbiology shall consist of two academic years / sessions divided in to four equal semesters. The first academic year / session will comprise first and second semesters. The second academic year / session will comprise of the third and fourth semesters. Each semester shall comprise normally 90 working days. The course shall run on the regular basis.

Minimum Marks required in Qualifying Examination:

❖ Qualifying examination passed from any recognised University which is situated in Rajasthan State:

- General Category = 55%.
- SC / ST / OBC / SBC or MBC = Min. Pass Marks

❖ Qualifying examination passed from any recognised University which is situated at outside the Rajasthan State:

- All Categories = 60%.

❖ Eligibility for Admission in M.Sc. Third Semester:

A candidate may be promoted in the next academic session (in odd semester *i.e.* III semester) if he/she has cleared collectively at least 50% of the papers of both semesters (*i.e.* semester I & II) of previous academic session with 50% of the aggregate marks. The candidate who does not fulfill the above condition will remain as an ex-student and will re-appear in the due papers examinations along with next odd/even semester examinations.

A candidate who has passed B.Ed. examination as a regular course of study after completing first and second semester examinations from this University shall also be eligible to take admission in third semester examination as a regular candidate.

Open elective:

This course is open to students of other Department of the University. The student of the M.Sc. Microbiology Programme can also take up an open elective being offered by any of the other Department of the University of Kota or from Government online portal like SWAYAM, MOOC etc.

Attendance:

Every teaching faculty, handling a course, shall be responsible for the maintenance of Attendance Register for candidates who have registered for the course. The teacher of the course must intimate the Head of the Department at least seven calendar days before the last instruction day in the semester about the attendance particulars of all students. Each student should earn 75% attendance in the courses of the particular semester failing which he or she will not be permitted to sit in the end semester examinations. However, it shall be open to the authorities to grant exemption to a candidate who has failed to obtain the prescribed 75% attendance for valid reasons and such exemptions should not under any circumstance be granted for attendance below 65%.

Teaching Methodologies:

The classroom teaching would be through conventional lectures or use of OHP or power point presentations (PPT). The lecture would be such that the student should participate actively in the discussion. Student seminars would be conducted and scientific discussions would be arranged to improve their communicative skill. In the laboratory, instruction would be given for the experiments followed by demonstration and finally the students have to do the experiments individually. For the students of slow learners, special attention would be given.

Assessment Pattern:

The assessment of the students shall be divided into two parts in which first part is continuous assessment or internal assessment or mid-term assessment (30% weightage of the maximum marks) and second part is semester assessment or external assessment or end-term assessment (70% weightage of the maximum marks). Assessment pattern and distribution of maximum marks is summarized as given below:

(i) Continuous or Internal or Mid Term Assessment:

(a) The continuous or internal or mid-term assessment (30% weightage of the maximum marks) for each theory paper shall be taken by the faculty members of the respective Departments during each semester. There will be three internal assessment tests (*i.e.* first internal assessment test or first mid-term test and second internal assessment test or second mid-term test and third internal assessment test) each of 10% weightage of maximum marks of each theory paper. Each internal assessment shall be of one hour duration for theory paper and shall be taken according to academic calendar which will be notified by the Department / University.

(b) For practical papers, there will be no continuous or internal or mid-term assessment. There will be only one external or semester or end-term assessment (100% weightage of maximum marks).

(c) A student who remains absent (defaulter) or fails or wants to improve the marks in the internal assessment may be permitted to appear in the desired paper(s) (only one time) in the same semester with the permission of the concern Head of the Department. A defaulter / improvement fee of Rupees 250/- per paper shall be taken from such candidates. Duly forwarded application of such candidates by the teacher concerned shall be submitted to Head of the Department who may permit the candidate to appear in the internal assessment after production of satisfactory evidence about the reason of his/her absence in the test(s) and deposition of the defaulter / improvement fee. A record of such candidates shall be kept in the Department.

(d) Regular attendance of the student shall be considered in the internal assessment. Some marks for regularity shall be given to the student(s) who is/are taken classes regularly from the 5% weightage

of the maximum marks. The 5% weightage of the maximum marks of regularity shall be taken from the weightage given for second internal assessment (10% weightage of maximum marks). After excluding the 5% weightage of regularity, the second internal assessment shall be of 10% weightage of maximum marks. If the attendance / regularity factor is similar for all the students, then it may be merged with the weightage of second internal assessment test (class test, home assignment, quiz, seminar, *etc.*) and then second internal assessment test shall be of 15% weightage of maximum marks.

(e) 'Student should qualify both internal & external assessment separately to pass the paper i.e., if candidate passes in external & fails in internal, the candidate has to reappear in internal & external exam of that paper. But if candidate passes in the internal & fails in the external, the candidate has to reappear in external exam of the paper and in internal examination he has option either to forward the obtained internal marks of that paper in the previous attempt (on the basis of the application submitted by the candidate and approval of Head of Department for the same) or can reappear in the internal examination if he wants to improve his marks in that paper.'

(ii) Semester or External or End Term Assessment:

(a) The semester or external or end-term assessment (70% weightage of the maximum marks) shall be three hours duration to each theory paper and twelve hours duration (spread over two days with 6 hours per day) for each practical paper and shall be taken by the University at the end of each semester.

(b) The syllabus for each theory paper is divided into five independent units and question paper for each theory will be divided into three sections as mentioned below:

Section-A *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*

Section-B *will carry 50 marks with equally divided into five long answer type question . Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

(c) The syllabus of practical paper is divided according to main streams of Biotechnology. Marks shall be awarded on the basis of major & minor experiments, spotting, viva-voce, practical record, regularity factor, lab skills, maintain cleanness of workplace, *etc*.

Question Paper Pattern:

(A) Continuous or Internal or Mid Term Assessment:

30% weightage of Maximum Marks (30 Marks out of 100 Maximum Marks).

(i) First Continuous or Internal or Mid Term Assessment:

Format

Department of .....
College / University .....
Address.....

First Internal Assessment Test 20… - 20….

Class	**:**	**Max. Marks**	**: 10 Marks**
Semester	**:**	**Duration of Exam.**	**:**

Subject	**:**	**Date of Examination**	**:**
Paper	**:**	**Name of Teacher**	**:**

Note: All questions are compulsory and marks are given at the end of the each question. Two or three sub-divisions may be given in the question.

Q. No. 1. ……..
or
…….
4 Marks
Q. No. 2. ……..
or
…….
3 Marks
Q. No. 3. ……..
or
…….
3 Marks

(ii) Second Continuous or Internal or Mid Term Assessment:

(a) Attendance:
Marks shall be given by the faculty member in each paper according to its weightage.
5% weightage of Maximum Marks
Note:
If the attendance / regularity factor is similar for all the students, then it may be merged with the weightage of second internal assessment test (class test, assignment, quiz, etc.).

(b) Seminar / Presentation/ Minor Projects
5% or 10% weightage of Maximum Marks

Format

Department of .....
College / University .....
Address.....
Second Internal Assessment Test 20… - 20….

Class	**:**	**Max. Marks**	**: 10 Marks**
Semester	**:**	**Duration of Exam.**	**:**
Subject	**:**	**Date of Examination**	**:**
Topic/Paper	**:**	**Name of Teacher**	**:**

Seminar /Presentation
(Based on Curriculum)

Format

Department of .....
College / University .....

Address.....

Third Internal Assessment Test 20… - 20….

Class	**:**	**Max. Marks**	**: 10 Marks**
Semester	**:**	**Duration of Exam.**	**:**
Subject	**:**	**Date of Examination**	**:**
Topic/Paper	**:**	**Name of Teacher**	**:**

(a) Assignment:

(May be divided in parts or questions or may not be. It will be depending on the nature of assignment).

10% weightage of Maximum Marks

or

(b) Quiz:

(May be divided in parts or questions or may not be. It will be depending on the nature of quiz).

10% weightage of Maximum Marks

Or

(c) Excursion or Industrial visit or Any other tool may be adopted for internal Assessment

10% weightage of Maximum Marks

(B) Semester or External or End Term Assessment:

70% weightage of Max Marks (*i.e.*70 Marks out of 100 Max Marks).

Duration of Examination: 3 Hours **Max. Marks: 70**

Note: *The syllabus is divided into five independent units and question paper will be divided into three sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of one mark.*
- ***Section-B*** *will carry 50 marks with equally divided into five long answer type questions . Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

SECTION-A

Q. 1.

Unit-I

(i) …… **2 Mark**

(ii) …… **2 Mark**

Unit-II

(iii) …… **2 Mark**

(iv) …… **2 Mark**

Unit-II

(v) …… **2 Mark**

(vi) …… **2 Mark**

Unit-IV

(vii) …… **2 Mark**

(viii) ..…… **2 Mark**

Unit-V

(ix) …… **2 Mark**
(x) …… **2 Mark**

SECTION-B

Unit-I

Q. 2. ……..…… **10 Marks**
or
……....…… **10Marks**

Unit-II

Q. 3. ……...…… **10 Marks**
or
……..…...…… **10 Marks**

Unit-III

Q. 4. ……..…… **10 Marks**
or
…….…...…… **10 Marks**

Unit-IV

Q. 5. . ……..…...…… **10 Marks**
or
……..……..... **10Marks**

Unit-V

Q. 6. ……...…… **10Marks**
or
……..……..… **10 Marks**

Practical Examinations: For All Lab Courses

Continuous or Internal or Mid Term Assessment: *Not applicable in practical.*
External or Semester or End Term Assessment:
Duration of Exam : 6 Hours
Maximum Marks : 100 Marks*

Distribution of Maximum Marks:

S. No.	Name of Exercise	Marks
1.	Exercise No. 1 : Major Experiment	20
2.	Exercise No. 2 : Major Experiment	20
3.	Exercise No. 3 : Minor Experiment	10
4.	Exercise No. 4 : Minor Experiment	10
5.	Exercise No. 5 : Spotting Experiment(5 spots)	15
6.	Laboratory Skills, Regularity, *etc.*	10
7.	Practical Record	5
8.	Viva-voce	10
Total Marks		**100**

Seminar:

The students shall compulsorily have to deliver an oral presentation on for continuous or internal or mid-term assessment in each semester. There will not be semester or external or end-term assessment for seminar.

Dissertation :

A dissertation shall be initiated at the end of the Semester III and continued during Semester IV.A dissertation may be undertaken in any research laboratories/industries/university department. The students shall compulsorily submit the certificate of completion and report to the Department during the practical examination. The marks will be awarded by the external examiner on the day of the practical examination on the basis of the experimental, presentation and viva-voce.

Minimum Pass Marks and Rules regarding Determination of Results:

Each semester shall be regarded as a unit for working out the result of the candidates. The result of each semester examination shall be worked out separately (even if the candidate has appeared at the paper(s) of the lower semester examination along with the papers of higher semester examination) in accordance with the following conditions:

(i) The candidate shall be declared as pass in a semester examination, if he/she secures at least 40% marks in each theory paper separately in external & internal examinations and 50% marks in each practical paper and at least 50% marks in project/ dissertation with 50% aggregate marks in that semester.

(ii) A candidate declared as fail/absent in one or more papers at any odd semester examination shall be permitted to take admission in the next higher semester (even semester) of the same academic session.

(iii) A candidate may be promoted in the next academic session (odd semester) if he/she cleared collectively at least 50% of the papers of both semester of previous academic session with 50% of the aggregate marks. The candidate who does not fulfil the above condition will remain as an ex-student and will appear S in the due papers with next odd/even semester exams.

(iv) If any student who is provisionally admitted in higher odd semester but not secure prescribed minimum marks in previous semesters will be treated as ex-student and his/her admission fee will be carry forward to the next odd semester of forthcoming academic session.

(v) A candidate may be promoted in the next semester (odd semester) if he/she has cleared collectively at least 50% of the papers of both semesters of previous academic session with 50% of the aggregate marks. The candidate who does not fulfill this condition will remain in the same semester as an ex-student and will re-appear in the due papers examination along with next odd/even semester examinations.

(vi) If any student who is provisionally admitted in higher odd semester but could not secure prescribed minimum marks in previous semesters will be treated as ex-student and his/her admission fee will be carry forwarded to the next odd semester of forthcoming academic session.

(vii) A candidate declared as failed in that particular paper he/she can re-appear for that paper in the next year examination as a due paper. However, the internal marks shall be carried forward for the total marks of the due examination. A candidate will not be allowed to re-appear in the practical examination.

(viii) A candidate may be given only two additional chances for passing the semester thus maximum tenure for completing the two years' postgraduate course will be limited to four years, for three years postgraduate programme up to five years and so on.

(ix) If the number of papers prescribed at the first and second or third and fourth semester examination is an odd number, it shall be increased by one for the purpose of reckoning 50% of the papers.

(x) A candidate who passes in 50% or more papers of the first and second semester examination, and thereby becomes eligible for admission to the third semester examination, but chooses not to do so and desires to appear in the remaining papers of first and second semester examination only or to re-appear in all the prescribed papers and practical/dissertation/seminar of the M.Sc. first and second semester examination

will be permitted to do so on the condition that in the latter case his previous performance will be treated as cancelled.

(xi) If a candidate, who has been promoted to the next semester and wishes to improve his / her performance in the theory paper(s) of previous semester,can be permitted to do so in case of the theory papers only, not in practical / project / dissertation / seminar, belonging to the immediately preceding semesteronly for one time in these papers in next odd/even semester examinations. In such a case, he/she shall have to appear in these papers along with the papers of his/her own semester.

(xii) A candidate shall be declared as passed after the result of the fourth semester examination, if he/she cleared all papers of the all the four semesters and secure minimum 40% of the aggregate marks of the maximum marks in theory papers and 50% of the aggregate marks of the maximum marks for practical / dissertation / presentation / seminar prescribed for four semesters Master's programme.

(xiii) In the case of an ex-student, the marks secured by him/her at his/her last examination as a regular candidate shall be taken into account except in cases where a candidate is re-appearing at the examination as a regular student and in that event he/she shall have to repeat the internal assessment test which will be finally accounted for working out his result.

(xiv) A candidate who has failed at the M.Sc. third and fourth semester examination but has passed in at least 50% of the papers prescribed for the examination shall be exempted from re-appearing in a subsequent year in the papers in which he/she has passed.

(xv) If a candidate clears any paper(s) prescribed at the first and second semester (previous) and/or third and fourth semester (final) examination after a continuous period of three years, then for the purpose of working out his/her division, only the minimum pass marks shall be taken into account in respect of such paper(s) as are cleared after the aforesaid period provided that in case where a candidate requires more than 40% marks in order to reach the requisite minimum aggregate, as many marks out of those secured by him/her will be taken in to account as would enable him/her to make up the deficiency in the requisite minimum aggregate.

(xvi) In case the candidate is not able to clear his/her due paper(s) in the stipulated period as mentioned above (continuous period of three years), he/she may be given last one mercy attempt to clear due paper(s) subjected to approval of the Vice Chancellor or Board of Management.

(xvii) The grace marks scheme shall be applicable as per University norms.

Syllabus

M.Sc. Microbiology
First Semester Examination

Paper 1.1: MIC-5101-General Microbiology

Contact Hours / Week	: 4 Hours	Maximum Marks	: 100 Marks
Duration of Examination	: 3 Hours	Continuous/Internal/Assessment	: 30 Marks
		Semester Assessment	: 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into two sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*
- ***Section-B*** *will carry 50 marks with equally divided into five long answer type questions (answer about in 400 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

UNIT I **15-18L**

Overview of history of Microbiology: Contribution of Antonie Von Leeuwenhoek, Needham, Redi, Spallanzani, Tyndal, Joseph Lister, Paul Ehrlich, Edward Jenner, Louis Pasteur, Robert Koch, Alexander Fleming, Scope of Microbiology.

Microbial World: Classification system and distinctive characters of major groups: Fungi, Algae, Protozoa, Viruses, Viroids, and Prions.

Nomenclature and Modern methods of Taxonomy. Classification of microbes on the basis of phenotypic and genotypic characters.

UNIT II **15-18L**

Stains and Staining Techniques: Definition of Auxochrome, Chromophores, dyes, Classification of Stains, Mechanism of Gram's, Capsule, Endospore, Flagella, Acid fast staining. Hanging drop, Wet mounting Method.

Culture Media, Isolation Techniques, Maintenance and Preservation of pure cultures.

Principles and Theory of biochemical activities of microorganisms: TSI agar Test, IMViC test, Urease Test, Nitrate Reduction Test, Catalase Test, Oxidase Test, and Sugar Fermentation Test.

UNIT III **15-18L**

Concept of asepsis: Definition of Sterilization, disinfection, Sanitization, Antisepsis, Sterilant and Fumigation.

Physical methods: Moist and Dry heat, Pasteurization, Tyndallization, Radiation, Filtration. Chemical Methods: Phenol and its Derivatives, Aldehyde, Heavy metal, Halogens and Sterilizing gases. Testing and Efficacy evaluation of Antimicrobial Agents.

UNIT IV **15-18L**

Bacterial Morphology: size, shape and arrangement of bacteria. Cell: glycocalyx, capsule, flagella, fimbriae and pili. Composition and detailed structure of gram positive and gram-negative cell walls, spheroplasts, protoplasts, and L-forms. Ribosomes, mesosomes, inclusion bodies, nucleoid, Extrachromosomal genetic material. Endospore: structure, formation, stages of sporulation. Methods of reproduction in bacteria and new cell formation. Microbial Growth curve and its kinetics and growth yield. Determination of cell mass and cell number. Environmental factors affecting growth. Antibiotics their classification and Mechanism.

UNIT V **15-18**L

Innovations in microbiology for human welfare: Impact of microbes on the genome project, microbial biosensors, Nanomedicines, molecular diagnostics. Probiotics microbes. Application of Artificial intelligence and machine learning in microbiology. Microbes as a biowarfare agent, Microbes in the space. Aptamers.

Text/Reference books:

1. Microbes: Concepts & Applications- P.S. Bisen, Mousumi Debnath, Godavarthi B.K.S. Prasad, John Wiley & Sons Publication 2012.
2. Brock Biology of Microorganisms, 14thEdition. Michael T. Madigan, John M. Martinko, Paul V. Dunlap and David P. Clark.
3. Bergey`s manual of systematic bacteriology. George M. Garrity, David R. Boone, Richard W. Castenholz.
4. Molecular Diagnostics: Promises & Possibilities 2010. Mousuni Dabnath, G.B.K.S. Prasad P.S. Bisen.
5. General Microbiology by S. B. Sullia, 2017, Oxford Publisher's.
6. Prescott, L.M., J.P Harley and D.A Klein, 2007. Microbiology VII Ed. Mc Grow Hill,
7. Davis R.Y. E.A. Adeberg and J.L. Ingram,1991 General Microbiology
8. Stainer. General Microbiology, V Ed., Printice Hall of India Pvt, Ltd. New Delhi
9. Ronald M. Atlas 1997. Principles of Microbiology. II Ed. Mc Graw Hill Pub.
10. Salle A.J., Fundamental Principles of Bacteriology.
11. Microbiology Vol. I & II. Power and Daginawala
12. Microbiology. P.D. Sharma.
13. Microbiology: An Introduction. Tortora GJ, Funke BR, and Case CL.

Paper 1.2: MIC -5102-Cell Biology and Enzymology

Contact Hours / Week	: 4 Hours	Maximum Marks	: 100 Marks
Duration of Examination	: 3 Hours	Continuous/Internal/Assessment	: 30 Marks
		Semester Assessment	: 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into two sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*
- ***Section-B*** *will carry 50 marks with equally divided into five long answer type questions (answer about in 400 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

UNIT I 15-18L

Cell as a unit of living organism and structure of prokaryotic cell, Structural and functional features of eukaryotic cell. Cell organelles; endoplasmic reticulum, golgi complex, lysosomes, vacuoles, peroxisomes, mitochondria, chloroplast, cytoskeleton. Structure of nucleus and chromosomes of eukaryotes. Cancer biology: characteristics of cancer cell, types of cancer, oncogene and tumor markers.

UNIT II 15-18L

Biological membranes: Membrane structure and transport mechanisms- diffusion, active and co-transport, secondary active transport, membrane selectivity, electrolyte selectivity, non- electrolyte selectivity, stimuli, receptors, second messengers and cellular response, membrane channels and pumps. Cell cycle: mitosis and meiosis and their regulation. Programmed Cell Death: intrinsic and extrinsic pathways. Stem cells Types: Embryonic stem cell, induced pluripotent stem cells

UNIT III 15-18L

Cell signaling and signal transduction pathways-Signalling molecules and their receptors. Function of cell surface receptor**s** MAPK/ERK pathway, cAMP dependent pathway, IP_3/DAG Pathway.

General properties, structure, classification and nomenclature of enzymes. Enzyme activators, co-enzymes, co-factors and prosthetic groups in enzyme catalysis, Enzyme and substrate specificity. Enzyme activation, zymogens, multi-enzymes complexes and multi-functional enzymes. Mechanism of Enzyme Action.

UNIT IV 15-18L

Factors affecting enzyme activity. Steady state kinetics: Methods of estimation of rate of enzyme catalyzed reaction with special reference to Michaelis-menton kinetics.

Enzyme inhibition and its kinetics: Reversible and irreversible inhibition, competitive, non-competitive and uncompetitive, mixed, partial, substrate and allosteric inhibition.

UNIT V 15-18L

Isoenzymes and its physiological significance, Ribozymes and Abzymes.

Enzyme engineering: Chemical modification of enzymes: methods of modification of primary structure, catalytic and allosteric properties, use of group specific reagents. Enzyme Immobilization Enzymes in non-conventional media, Enzymes sensors, Enzymes as analytical reagents.

Text/Reference books:

1. Biochemistry: Lubert Stryer
2. Biochemistry: Lehninger
3. Microbial Physiology: Moat, Foster and Spector
4. Molecular biology of the cell: Bruce Alberts et. al.
5. Cell and molecular biology: Gerald Karp.
6. Cell and molecular biology: P.K. Gupta.
7. Molecular cell biology: By Lodish
8. The Cell: Cooper.
9. Enzyme: Copeland.
10. Enzyme Technology: M F Chaplin and D C Bucks.
11. Enzymology and Enzyme Technology: S M Bhatt.
12. Essentials of Biochemistry: Dr Pankaja Naik, Jaypee Brothers Medical Publishers

M.Sc. Microbiology
First Semester Examination

Paper1.3: MIC 5103- Microbial Genetics

Contact Hours / Week	: 4 Hours	Maximum Marks	: 100 Marks
Duration of Examination	: 3 Hours	Continuous/Internal/Assessment	: 30 Marks
		Semester Assessment	: 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into two sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*
- ***Section-B*** *will carry 50 marks with equally divided into five long answer type questions (answer about in 400 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

UNIT-I **15-18L**

Introduction to Microbial Genetics. DNA and RNA: structure and types. Super helicity in DNA. Law of DNA constancy, Cot curve and C value paradox, DNA renaturation kinetics and Tm value determination and interpretation, Repetitive DNA, Satellite DNA, Selfish DNA, DNA Compaction.

UNIT-II **15-18**L

Recombination: Types of recombination, Models for Homologous recombination, Molecular mechanism of homologous recombination, Homologous recombination in eukaryotes, Molecular mechanism and biological role of site-specific recombination. Transposable elements in prokaryotes.

UNIT-III **15-18**L

Plasmid: types and their significance. Conjugation and chromosomal mobilization. E. coli as model prokaryote**s**: Conjugation by *E. coli* F factor. (Structure of F factor and regulation of F-factor fertility), F- prime conjugation, Hfr and chromosomal mobilization.

UNIT-IV **15-18**L

Transformation: Mechanism of natural competence and transformation in *Bacillus subtilis*, *Streptococcus pneumoneae and Haemophilus influenzae.* Transformation by artificial competence. Gene linkage and mapping by transformation. Transduction- specialized and generalized transduction and its applications.

UNIT-V **15-18**L

Regulation of gene expression: Operon concept, catabolite repression, positive and negative regulation: inducers and co-repressors. Negative regulation in *E. coli* lac operon. Positive regulation in *E. coli* ara operon; regulation by attenuation of his and trp operons.

Text/Reference books:

1. Genetics of Bacterial by Sheela Shrivastava, 2013 Springer Publisher.
2. Concepts of genetics: Klug and Cummings

3. Genetics: From Genes to Genomes: Leland Hartwell, Leroy E. Hood, Michael L. Goldberg
4. Genetics: Analysis and Principles (3rd Edition): Brooker
5. Gene cloning: T.A. Brown
6. Cell and molecular Biology: P.K. Gupta.

M.Sc. Microbiology
First Semester Examination
Paper 1.4 MIC – 5104- Biochemistry and Microbial Physiology

Contact Hours / Week	: 4 Hours	Maximum Marks	: 100 Marks
Duration of Examination	: 3 Hours	Continuous/Internal/Assessment	: 30 Marks
		Semester Assessment	: 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into two sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*
- ***Section-B*** *will carry 50 marks with equally divided into five long answer type questions (answer about in 400 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

UNIT I **15-18L**

Water, acid, base and buffers, pH and pH indicators, Solutions, Redox potential, Hydrogen bonding; Hydrophobic, Electrostatic and Vander Waal forces. Scope and importance of biochemistry. Bioenergetics and metabolism: Basic concepts. First and second law of thermodynamics. High energy phosphate compounds. Biological redox reactions, Biological reducing power and its role in biological system.

UNIT II **15-18**L

Carbohydrate and glycobiology: Structure, properties and functions of carbohydrates. Gluconeogenesis, Glycogenolysis, Glycolysis. Citric acid cycle, Electron transport system, Oxidative phosphorylation, inhibitors of oxidative phosphorylation. Chemiosmotic theory of ATP, Glyoxalate Cycle, Pentose phosphate pathway, E-D pathway, Amphibolic and Anapleurotic reaction, Photosynthesis: Oxygenic and an-oxygenic.

UNIT III **15-18**L

Amino acids: structure, classification, properties and functions. Amino Acid Metabolism- Overview of amino acid metabolism, Biodegradation of amino acids – deamination, transamination, decarboxylation, glutamine and glutamic acid pathway, urea cycle, uric acid biosynthesis. Protein structure (primary, secondary, tertiary and quaternary). Ramachandran plot. Protein degradation and targeting.

UNIT IV **15-18**L

Lipids: classification, structure, properties and functions. Steroids: Structure of steroid nucleus, biological role of cholesterol.

Lipid Metabolism- Biodegradation of fatty acids, beta – oxidations of fatty acids. Ketone bodies production during starving and diabetes.

Biosynthesis of fatty acids – Acetyl-CoA carboxylase reaction, Fatty acid synthase complex, biosynthesis of palmitate. Biosynthesis of triacylglycerols, Biosynthesis of cholesterol, Prostaglandins**.**

UNIT V **15-18**L

Nucleic acids: structure and properties. Nucleic Acid: Biosynthesis and degradation of Purines and Pyrimidines. Coenzymes and cofactors: Role and mechanisms of action of NAD^+/$NADP^+$, FAD, lipoic acid, thiamine,

Pyrophosphate, Biotin, Pyridoxal Phosphate, B_{12} co-enzymes and Metal ions with specific examples. Water- and Fat-soluble vitamins; Structure, distribution, interaction and functions.

Text/Reference books:

1. Advances in Microbial Physiology, 2020 editor: Robert Poole Elsevier Publisher
2. Wilson K. and Walker J. (2008). Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press.
3. Nelson D and Cox MM. (2009). Principles of Biochemistry. W.H. Freeman and Company, New York.
4. Voet D and Voet JG. (2003). Biochemistry. John Wiley and sons NewYork.
5. Zubay G (2000). Biochemistry. W. C. Brown, NewYork.
6. Berg J, Tymoczko J, Stryer L (2001). Biochemistry. W. H. Freeman, NewYork.
7. Moat AG and Foster J W (2003). Microbial Physiology. John Wiley and Sons,New York.
8. Robert K., Murray M.D., Granner D.K., Mayes P.A. and Rodwell V.I. Harper's Biochemistry. McGraw-Hill/Appleton and Lange.
9. Biochemistry U, SatyaNarayan.
10. Biochemistry: Lehninger
11. Fundamental of biochemistry by A.C. Dev.
12. J.L. Jain, Biochemistry.
13. Elements of biochemistry by H.R. Shrivastava.

M.Sc. Microbiology
First Semester Practical Examination
Paper 1.5 MIC - 5105 Lab Course-I

1. Good Microbiology laboratory practices: Laboratory safety (Dos and Don'ts), hazard from chemicals, handling of cultures and chemicals, disposal of chemicals and cultures.
2. Introduction to different Glass wares used in Microbiology Laboratory.
3. To learn handling of different instruments and Equipment's used for culture and Sterilization.
4. Techniques of pure culture isolation-pour plate, spread plate, streaking.
5. Preparation of Basic Liquid and Solid media for cultivation of bacteria and fungi.
6. Isolation and Enumeration of microorganisms from Air (plate exposure method), Soil and Water (serial dilution method)
7. To perform different staining methods to study morphological and structural characteristics of bacteria and fungi a. Gram Staining b. Acid fast staining c. Fungal staining (Lacto-phenol cotton blue) d. Spore staining e. Flagella staining f. Capsule staining (Negative staining)
8. To check motility of bacteria by hanging drop and semi solid agar methods
9. To learn culture preservation techniques (Agar slants, stabs and glycerol stocks)
10. Calibration of an ocular micrometre for different objectives of microscope.
11. Measurement of microorganisms by the use of an ocular micrometre.
12. To study microorganisms under dark and phase contrast microscope.
13. To study activity of disinfectants.
14. Bacterial growth curve-serial dilution, plating and turbidity measurement.
15. Standard qualitative analysis of water(microorganisms).
16. Antibiotics sensitivity test.
17. Study the effect of colchicine on the mitotic division of the Onion root tip .
18. Identification and study of cancer cells by photomicrographs.
19. Study of different stages of mitosis and meiosis.
20. Urease estimation by titrimetric method.
21. Urease estimation by colorimetric method.
22. Acid Phosphatase estimation.
23. Alkaline Phosphatase estimation.
24. Estimation of amylase.
25. Study of enzyme kinetics – calculation of *V*max, Km, Kcat values

M.Sc. Microbiology
First Semester Practical Examination
Paper 1.6 MIC - 5106 Lab Course-II

1. Triple Sugar Iron Test.
2. IMVIC Test
3. Oxidase test
4. Casein hydrolysis.
5. Urease test
6. H_2SProduction
7. Catalase Test.
8. Separation of compounds by paper chromatography
9. Thin layer chromatography: Amino acids, lipids, mixture of dyes.
10. Qualitative estimation of lipid, carbohydrates &proteins.
11. Qualitative analysis of Biomolecules.
12. Colorimetry: To determine the association constant of a. given indicator calorimetrically and to prepare the buffer solutions in pH range of 2.2 to8.0
13. Spectrophotometry: To find out absorption spectrum of given chromophore and /or oxidised and reduced forms (NAD, NADH).
14. Chlorophyll-a concentration measurement with acetone method using spectrophotometer
15. Separation of sub cellular organelles by differential centrifugation.
16. Polyacrylamide gel electrophoresis of proteins.
17. Isolation of plasmid & genomic DNA.
18. Separation of DNA by gel electrophoresis.
19. To induce mutation by UV radiations and to exhibit DNA repair by photo reactivation.
20. To isolate and produce UV induced auxotrophic mutants by replica plating method.
21. Study of sex-linked gene inheritance.
22. Estimating gene frequencies in human population,
23. Recombination in Bacteria.
24. To check purity and quantity of DNA by Spectrophotometric method.

M.Sc. Microbiology
Second Semester Examination
Paper 2.1: MIC -5201 Microbial Diversity

Contact Hours / Week	: 4 Hours	Maximum Marks	: 100 Marks
Duration of Examination	: 3 Hours	Continuous/Internal/Assessment	: 30 Marks
		Semester Assessment	: 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into two sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*
- ***Section-B*** *will carry 50 marks with equally divided into five long answer type questions (answer about in 400 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

UNIT- I **15-18L**

Evolutionary (Phylogenetic) tree of microorganisms. Classification of microorganisms– Haeckel's three kingdom concept, Whittaker's five kingdom concept, Three domain concept of Carl Woese, Classification systems-artificial, natural and phylogenetic, Classification and salient features of bacteria according to the Bergey's manual of bacteriology.

UNIT II **15-18**L

Fungi: Recent Trends in fungal systematics (Alexopolus & Mims), Fungi (habitat, nutritional requirements, fungal cell ultrastructure, thallus organization and aggregation, fungal wall structure and synthesis, asexual reproduction, sexual reproduction, Life cycle), heterokaryosis Parasexuality and Heterothallism. Economic Importance (Agriculture, Environment, Industry, Medicine, Food, Biodeterioration, Mycotoxins).

UNIT III **15-18**L

Algae: Definition, occurrence, Classification upto class level, Ultra-structure, Reproduction and Life cycle. Economic importance (Agriculture, Industry, Environment and Food)
Protozoa (Occurrence, classification, Ultrastructure, Reproduction, Economic importance).
Virus (Definition, Structure, multiplication and replication). Virus cultivation. Bacteriophages: Structure, Life cycle –Lytic & Lysogenic

UNIT IV **15-18**L

Characteristics of important genera and physiology of: Chemoautotrophic and Methanogenic eubacteria, Gram negative aerobic eubacteria, Gilding bacteria (Myxobacteria), Enteric group and related eubacteria, Gram negative anaerobic eubacteria, Gram negative eubacteria- Rickettsia, Chlamydia and Spirochaetes. Gram positive eubacteria- Unicellular endospore forming eubacteria, Actinomycetes.

UNIT V **15-18**L

General Characters, Classification, Adaptations and Physiology of Archaebacteria: methanogens, Acidophiles, Halophiles, Thermoacidophiles.

Cyanobacteria: General characters, Ultra structure, Reproduction and Economic importance. Photosynthetic eubacteria: Anoxygenic and oxygenic photosynthesis, Sulfur or Non-Sulfur Bacteria (purple and green), Mollicutes. Gram positive fermentative eubacteria. Bdellovibrio and its interperiplasmic growth cycle.

Text/Reference books:

1. Michael T. Madigan, John M. Martinko, Paul V. Dunlap and David P. Clark, Brock Biology of Microorganisms, 13th Edition, Pearson Education, Limited,2011.
2. Microbial Diversity: Principles of microbial diversity. James W. Brown. Wiley Blackwell Publishers.2014.
3. Microbes: Concepts & Applications- P.S. Bisen, Mousuns Debnath, Godavarthi B.K.S. Prasad, Wiley Blackwell. John wiley & Sons Publication 2012.
4. Pelczar, M.J., Chan E.C.S. and Krieg, N.R., Microbiology –Application based approach, 5th edition, Mc Graw Hill,2009.
5. Tortora, G. Microbiology: An Introduction-Benjamin Cummings, 10thEdition,2009.
6. Willey J, Sherwood and Woolwerton C, Prescott, Harley and Klein's, Microbiology,8thEdition, McGraw Hill International, 2010.
7. Singh, Pandey, Jain. A text Book of Botany, 2016

M.Sc. Microbiology
Second Semester Examination
Paper 2.2 MIC -5202- Molecular Biology

Contact Hours / Week	: 4 Hours	Maximum Marks	: 100 Marks
Duration of Examination	: 3 Hours	Continuous/Internal Assessment	: 30 Marks
		Semester Assessment	: 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into two sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*
- ***Section-B*** *will carry 50 marks with equally divided into five long answer type questions (answer about in 400 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

UNIT I **15-18L**

The nature of Genetic material: The structure of DNA and RNA. Organization of Microbial Genomes, Organization of Eukaryotic Genomes, Chromatin arrangement, nucleosome and solenoid structure of DNA. Genetic code. introduction of Central dogma.

UNIT II **15-18**L

DNA Replication: DNA replication in prokaryotes and eukaryotes- Initiation, elongation and termination. Enzymology of replication. Regulation of replication. code. Proofreading of DNA with reference to specific enzymes and co-factors. Mutations: Types of Mutations and mutagens. Molecular mechanisms of induced mutation, DNA damages and it repair pathways.

UNIT III **15-18**L

Transcription: Transcription machinery of prokaryotes and eukaryotes -initiation, elongation and termination, various transcription enzymes and cofactors. Operon Models. Transcription eukaryotes -initiation, elongation and termination. Types of RNA polymerase. Regulation of transcription. Promoters, enhancers, silencers, activators

UNIT IV **15-18**L

Translation: Mechanisms of translation in prokaryotes and eukaryotes- initiation, elongation and termination. RNA processing: splicing, capping and polyadenylation, rRNA and tRNA, processing, RNA Editing, RNAi: miRNAs and siRNA, Post-transcriptional gene regulation. Ribozymes.

UNIT V **15-18**L

Genetic Engineering: Principle and basic tools and application. Gene cloning vectors: DNA sequencing methods, Gene libraries, Human genome project, Genetic disorders. Genetically modified organisms, IPR, Transgenic Technology. Antisense technology.
Nanotechnology, DNA nanotechnology. Stem cell technology.

Text/Reference books:

1. Molecular Biology: D. Freifelder
2. Molecular biotechnology: Glick.
3. Gene VII: Lewin Benjamin (Oxford)
4. Molecular Cell Biology: J. Darnell, H. Lodhis & D. Baltimore (W.H. Freeman &Co.)
5. Genetics: From Genes to Genomes by Leland Hartwell, Leroy E. Hood, Michael L. Goldberg
6. Genetics: Analysis and Principles (3rd Edition): Brooker
7. Gene cloning: T.A. Brown
8. Genetic Engineering: Nicoll
9. Molecular Biology and Genetic Engineering: P.K. Gupta

M.Sc. Microbiology
Second Semester Examination
Paper 2.3- MIC -5203 Immunology and Immunotechnology

Contact Hours / Week	: 4 Hours	Maximum Marks	: 100 Marks
Duration of Examination	: 3 Hours	Continuous/Internal/Assessment	: 30 Marks
		Semester Assessment	: 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into two sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*
- ***Section-B*** *will carry 50 marks with equally divided into five long answer type questions (answer about in 400 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

UNIT-I **15-18L**

Historical account and introduction to immune system. Innate and acquired immunity. Humoral and cell mediated immune responses. Cells and tissues of immune system – Structure, Functions and Properties of Immune Cells - Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT. Immuno-prophylaxis: Active and passive immunization, Vaccines: whole organism vaccine, subunit vaccine, vaccine, DNA vaccine, recombinant vaccine, subunit vaccines and anti-idiotype vaccine.

UNIT-II **15-18**L

Antigens: Structure and properties, Types, haptens, adjuvants, antigen specificity, Epitopes (T & B cell epitopes); T-dependent and T-independent antigens; Immunoglobulins- structure, heterogeneity, types and properties. Molecular mechanism of antibody diversity and class switching. Antigen processing and presentation. Cytokines: profile and functions.

Complement system: components, activation pathways, regulation of activation pathways.

UNIT-III **15-18**L

Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co- stimulatory signals); Killing Mechanisms by CTL and NK cells, Introduction to tolerance. Antibody: Mediated-type I. Anaphylaxis; Type II. Antibody dependent cell cytotoxicity; Type III immune complex mediated reactions; Type IV Cell mediated hypersensitivity reactions.

UNIT-IV **15-18**L

Major histocompatibility complex: organization of MHC genes, types and function of MHC molecules, antigen presentation. Transplantation immunology: immunologic basis of graft rejection, HLA typing methods. Autoimmunity–mechanism and diseases. Tumor immunology: cancer, oncogenes, tumor antigens, immune

response to tumors, tumor evasion of the immune system, immune-diagnosis. Imuno-deficiencies: congenital and acquired. Immune response to SARS-Cov-2.

UNIT-V **15-18**L

Antigen- Antibody interaction - Agglutination, Precipitation, Immunofluorescence, ELISA, Radio-immunoassays; Immuno-blotting, Immunofluorescence, Flow cytometry, Protein microarrays, *In vivo* methods: skin test and their applications. Epitope mapping, Detection of immune complex. Hybridoma Technology: Monoclonal antibodies production. Antibody engineering: Chimeric and Humanized monoclonal antibodies.

Text/Reference books:

1. Essentials of Immunology, Author- Roitt, I.M., ELBS. Blackwell Scientific Publishers, London.
2. Immunology II Edition, Author- Kuby, J. WH., Freeman and Company, NewYork.
3. Immune Response Activation and Immunomodulation. Edit by R.K. Tyagi & P.S. Bisen, 2019. Intechopen .com
4. Immunology. Author- Klaus D. Elgert, Wiley-Liss. NY.
5. Text Book on Principles of Bacteriology, Virology and Immunology, IX Edition (5 volumes). Topley and Wilson's, Edward Arnold, London.
6. The Experimental Foundations of Modern Immunology. Authors- Clark, V.R., John Willey and Sons, Incl.
7. Fundamental Immunology. Author – W.E. Paul, Raven Press, New York.
8. Fundamentals of Immunology. Authors – R.M. Coleman, M.F. Lombord and R.E. Sicard 2nded. C. Brown publishers.
9. Immunology. Authors -D.M. Weir and J. Steward 7th Ed. (1993).
10. Immunology: Shailendra Sharma.
11. Immunology: C.V. Rao.

M.Sc. Microbiology
Second Semester Examination
Paper 2.4: MIC 5204-Tools and Techniques in Microbiology

Contact Hours / Week	: 4 Hours	Maximum Marks	: 100 Marks
Duration of Examination	: 3 Hours	Continuous/Internal/Assessment	: 30 Marks
		Semester Assessment	: 70 Marks

Note*: The syllabus is divided into five independent units and question paper will be divided into two sections.*

- ***Section-A*** *will carry 20 marks with one compulsory question comprising ten short answer type questions taking two questions from each unit. Each question shall be of two marks.*
- ***Section-B*** *will carry 50 marks with equally divided into five long answer type questions (answer about in 400 words). Paper setter shall be advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*

Note: *Contents of each unit may be completed into 15-18 lectures or contact hours which also include revisions, seminars, internal assessments, etc.*

UNIT- I **15-18**L

Microscopy: Microscopes types, use of techniques of preparing specimens, resolving power, optical microscope-Basic idea of light microscopy, Types- bright field, dark field, ultra-violet, fluorescence and phase-contrast microscopes, confocal microscopy Electron microscope. TEM, SEM.

UNIT – II **15-18**L

Centrifugation techniques: - Differential, gradient, zonal or band and isopycnic density gradient centrifugation. Chromatography: Basic principles and applications: absorption, exclusion, ion-exchange, partition and affinity chromatography; GLC, HPLC, fast protein liquid chromatography and gas-liquid ion-exchange chromatography.

UNIT – III **15-18**L

Electrophoresis: principle, types and applications. Pulse field GE, Denaturing gradient GE, Temperature gradient GE, SDS-PAGE electrophoresis, Iso- electric focusing and 2D gel electrophoresis.
Nucleic acid hybridizations Technique: colony, plaque, dot blot, southern, northern and western blotting, *In situ* hybridization, Microarray technology.

UNIT- IV **15-18**L

DNA sequencing techniques: Sanger-Coulson method, Maxam Gilbert method and next generation sequencing. Polymerized Chain Reaction: PCR -steps, Types of PCR and its applications.

UNIT-V **15-18**L

Spectroscopy: Principles, instrumentation and applications: Colorimetry, UV-visible spectroscopy, Infrared Spectroscopy, fluorescence Spectroscopy.
Characterization and Methods: FTIR, NMR, ESR, Mass Spectroscopy (types of ion source, analyzers and detectors), GC-MS, MALDI-TOF. X Ray Microanalysis, Techniques with radioisotopes: GM counter, Scintillation counter, Autoradiography, RIA.

Text/Reference books:

1. Introduction to Instrumentation in Life Sciences. P.S. Bisen & Anjana Sharma. 2013. CRC Press.

Taylor & Francis group
2. Wilson K. and Walker J. (2008). Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press.
3. Molecular Diagnostics: Promises & Possibilities 2010. Mousuni Dabnath, G.B.K.S. Prasad P.S. Bisen.
4. Nelson D and Cox MM. (2009). Principles of Biochemistry. W.H. Freeman and Company, NewYork.
5. Voet D and Voet JG. (2003). Biochemistry. John Wiley and sons NewYork.
6. Zubay G (2000). Biochemistry. W. C. Brown, NewYork.
7. Life Science in tools and Techniques: P.S. Bisen and Shruti Mathur, S. Chand Publication
8. Berg J, Tymoczko J, Stryer L (2001). Biochemistry. W. H. Freeman, NewYork.
9. Nuclear Magnetic Resonance: Williams
10. A Biologist Guide to Principle and Techniques: Willson K. and Gounding K.H.
11. Biochemical Techniques theory and practice: WhiteR.
12. Molecular biotechnology-Glick
13. An Introduction to Practical Biochemistry: Plummer D.T.

M.Sc. Microbiology
Second Semester Practical Examination
Paper 2.5 MIC – 5205 Lab Course III

1. Isolation cultivation and morphological studies of Actinomycetes.
2. Isolation cultivation and morphological studies of fungi.
3. Study of *Rhizopus*, *Penicillium*, *Aspergillus, Saccharomyces* using temporary mounts.
4. Study of *Spirogyra* and *Chlamydomonas, Volvox* using temporary mounts.
5. Study of the following protozoans using permanent mounts/photographs: *Amoeba*, *Entamoeba*, *Paramecium* and *Plasmodium*.
6. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample.
7. To isolate genomic DNA from bacteria.
8. DNA: a) Isolation of DNA (nuclear and Mt)
   i. Agarose gel electrophoresis
   ii. Demonstration of DNA modifications
   iii. Restriction endonuclease digestions and separation of fragments by gel chromatography
9. Isolation of total cellular RNA from suitable organisms (yeast, plant, animal cells)
10. Isolation of total m RNA from suitable organisms.
11. To isolate total RNA and mRNA from bacteria.
12. Thermal melting of DNA
13. To perform SDS-PAGE for separation of proteins in given sample.
14. Blotting Techniques.
15. Fragment separation by restriction endonuclease enzyme.
16. Isolation of plasmid DNA -i) minipreparation ii) large scale isolation.
17. DNA *ligation*, transformation of *E. coli*.
18. Culture of *E. coli* cells & plasmid isolation
19. Preparation of competent cells.
20. Calcium chloride mediated transformation.

M.Sc. Microbiology
Second Semester Practical Examination
Paper 2.6 MIC – 5206 Lab Course IV

1. To prepare soluble antigen by different methods.
2. To demonstrate various routes of immunization in mice.
3. To prepare serum and plasma from blood.
4. To precipitate immunoglobulins by ammonium sulphate and to determine total protein contents.
5. To determine Blood group and Rh factor by slide agglutination test
6. Estimation of haemoglobin content.
7. To determine Total Leukocyte Count (TLC) for given blood sample
8. To determine Differential Leukocyte Count (DLC) for given blood sample using Leishman's stain.
9. To perform Widal agglutination test (slide and tube) for diagnosis of typhoid.
10. To perform Ouchterlony double diffusion test for detection of antigen and antibody reaction and to demonstrate relationship between antigens.
11. To perform Radial immuno-diffusion test for detection of antigen and antibody reaction and for quantification of antigens.
12. To perform immuno-electrophoresis for separation of antigens and for detection of antigen and antibody reaction
13. To perform Rocket immuno-electrophoresis for detection of antigen and antibody reaction
14. To perform ELISA for assay of antibodies in serum sample against given antigen.
15. To perform DOT ELISA.
16. Study of Laboratory Instruments
17. Ion exchange and gel filtration chromatography.
18. Separation of subcellular organelles by differential centrifugation.
19. Separation of blood cells by density gradient centrifugation.
20. Polyacrylamide gel electrophoresis of proteins.
21. To perform PCR for amplification of target DNA segment (or gene).
22. Electrophoretic separation of DNA in agarose gel.
23. Demonstration of DNA fingerprinting,
24. Gel documentation of DNA, RNA and proteins.