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

# M.Sc. Microbiology programme

**CBCS pattern (with effect from 2024-2025)**

## 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 of Paper | Number, Code or ID and Nomenclature of Paper: Code / ID of Paper | | Nomenclature of Paper | Duration of Exam. (in Hrs.) | Teaching Hrs / Week: Teaching Th. | Teaching Pr. | Credit Point | Distribution of Assessment Marks: Continuous or Internal Assessment (30%) Max. Marks | Continuous or Internal Assessment (30%) Min. Pass Marks | Semester or External Assessment (70%) Max. Marks | Semester or External Assessment (70%) Min. Pass Marks | Total Max. Marks | Total Min. Pass Marks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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<br>1. Biofuel and Bioenergy<br>2. Pharmaceutical microbiology | 3 | 4 | - | 4 | 30 | 12 | 70 | 28 | 100 | 40 |
| | Paper-3.4 | MIC -6304 | DSE | ELECTIVE II<br>1. Antimicrobial Resistance<br>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<br>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 voce | 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 ofMicrobiology.
- Students will think critically and creatively about the use of Microbiology to address local and globalproblems.
- Students will be able to implement the scientific skills for development of industrial applications andentrepreneurship

**Hyperlinks of suggested e resources on University website and on web**

NPTL and UGC epathshala, 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 variousindustries, regulators, researchers, educators andmanagers
- 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 paper'sexaminations along with next odd/even semester examinations.

**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.* Firstinternal 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% weightageof 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 ofMicrobiology. 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 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 Anyother 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 alongwith 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 alongwith 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 includerevisions, 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 ofMicrobiology.

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** **15-18**L

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

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.Antibiotics their classification and Mechanism.

**UNIT IV** **15-18**L

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.

**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 Biologyof 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. MousuniDabnath, 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.AKlein, 2007. Microbiology VII Ed.Mc GrowHill,
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. NewDelhi
9. Ronald M. Atlas 1997. Principles of Microbiology. II Ed. Mc Graw HillPub.
10. Salle A.J., Fundamental Principles ofBacteriology.
11. Microbiology Vol.I & II. Power and Daginawala
12. Microbiology. P.D.Sharma.
13. Microbiology: An Introduction. Tortora GJ, Funke BR, and Case CL.

**M.Sc. Microbiology**
**First Semester Examination**

**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 cellsurface 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-functionalenzymes. 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** **15-18**L

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: LubertStryer
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: GeraldKarp.
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 CBucks.
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: MIC5103- 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. Superhelicity 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 andCummings

3. Genetics: From Genes to Genomes: Leland Hartwell, Leroy E. Hood, MichaelL. 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, biosynthesisof 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, PyridoxalPhosphate,$B_{12}$ 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 PooleElsevier Publisher
2. Wilson K. and Walker J. (2008). Principles and Techniques of Biochemistryand Molecular Biology. Cambridge UniversityPress.
3. Nelson D and Cox MM. (2009). Principles of Biochemistry. W.H. Freemanand Company, NewYork.
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 andLange.
9. Biochemistry U,SatyaNarayan.
10. Biochemistry:Lehninger
11. Fundamental of biochemistry byA.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 turbiditymeasurement.
15. Standard qualitative analysis of water(microorganisms).
16. Antibiotics sensitivitytest.
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 IronTest.
2. IMVICTest
3. Oxidase test
4. Casein hydrolysis.
5. Urease test
6. $H_2S$Production
7. Catalase Test.
8. Separation of compounds by paper chromatography
9. Thin layer chromatography:Amino acids, lipids, mixture ofdyes.
10. Qualitative estimation of lipid, carbohydrates &proteins.
11. Qualitative analysis of Biomolecules.
12. Colorimetry: To determine the association constant of a. given indicator calorimetrically andto prepare the buffer solutions in pH range of 2.2 to8.0
13. Spectrophotometry: To find out absorption spectrum of given chromophore and /oroxidised 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 ofproteins.
17. Isolation of plasmid & genomic DNA.
18. Separation of DNA by gelelectrophoresis.
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 geneinheritance.
22. Estimating gene frequencies in humanpopulation,
23. Recombination inBacteria: Conjugation and Transformation
24. To check purity and quantity of DNA by Spectrophotometric method.
25. DNA size determination.
26. Restriction Mapping.

**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 CarlWoese, 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 Methanotrophs 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 Periplasmic growth cycle.

**Text/Reference books:**

1. Michael T. Madigan, John M. Martinko, Paul V. Dunlap and David P. Clark, Brock Biologyof Microorganisms, 13th Edition,Pearson Education, Limited,2011.
2. Microbial Diversity: Principles of microbial diversity.JamesW.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., ChanE.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

RNA processing: splicing, capping and polyadenylation, rRNA and tRNA, processing, RNA Editing, RNAi: miRNAs and siRNA, post-transcriptional gene regulation. Ribozymes.

Translation: Mechanisms of translation in prokaryotes and eukaryotes- initiation, elongation and termination.Post-translational modifications.

**UNIT V** **15-18**L

Genetic Engineering: Principle and basic tools and application. Gene cloning vectors: DNA sequencingmethods,Gene libraries,Human genome project,Genetic disorders. Genetically modified organisms,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.Tumorimmunology:cancer,oncogenes,tumor antigens,immune

response to tumors, tumor evasion of the immune system, immune-diagnosis. Immuno-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 testand 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 Willeyand Sons,Incl.
7. Fundamental Immunology. Author – W.E. Paul, Raven Press, NewYork.
8. Fundamentals of Immunology. Authors – R.M. Coleman, M.F. Lombord and R.E. Sicard 2nded. C. Brownpublishers.
9. Immunology. Authors -D.M. Weir and J. Steward 7$^{th}$Ed. (1993).
10. Immunology: Shailendra Sharma.
11. Immunology: C.V.Rao.

**M.Sc. Microbiology**
**Second Semester Examination**
**Paper 2.4: MIC5204-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: adsorption, 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.
Polymerase 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.

**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 Biochemistryand Molecular Biology. Cambridge UniversityPress.
3. Molecular Diagnostics: Promises & Possibilities 2010. MousuniDabnath, G.B.K.S. Prasad P.S. Bisen.
4. Nelson D and Cox MM. (2009). Principles of Biochemistry. W.H. Freemanand 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 ShrutiMathur, 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 GoundingK.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– 5205Lab 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 temporarymounts.
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. Physicochemical analysis of sewage water: BOD,COD,DO.
8. To isolate genomic DNA from bacteria.
9. DNA: a) Isolation of DNA (nuclear andMt)
    i. Agarose gelelectrophoresis
    ii. Demonstration of DNAmodifications
    iii. Restriction endonuclease digestions and separation of fragments bygel chromatography
10. Isolation of total cellular RNA from suitable organisms (yeast, plant, animal cells)
11. Isolation of total m RNA from suitable organisms.
12. To isolate total RNA and mRNA from bacteria.
13. Thermal melting ofDNA
14. To perform SDS-PAGE for separation of proteins in given sample.
15. Blotting Techniques.
16. Fragment separation by restriction endonucleaseenzyme.
17. Isolation of plasmid DNA -i)minipreparation ii) large scaleisolation.
18. DNA *ligation*, transformation of*E.coli*.
19. Culture of *E.coli* cells & plasmid isolation
20. Preparation of competent cells.
21. Calcium chloride mediated transformation.

**M.Sc. Microbiology**
**Second Semester Practical Examination**
**Paper 2.6 MIC– 5206Lab 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 haemoglobincontent.
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 DOTELISA.
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.

## M.Sc. Microbiology

## Third Semester Examination

## Paper3.1 MIC-6301–Microbial Ecology and Environment 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

Soil: Soil Profile, Microorganism, Fertility, Rhizosphere & Phyllosphere. Biogeochemical cycles, Biological nitrogen fixation.
Microbial ecology: Concept of habitat and niche. Concept of population and community.
Development of microbial communities & diversity analysis. Microbial growth curve representing r and k reproductive strategies. Planktonic growth and Biofilm formation.Concept of plant probiotics.

### UNIT II 15-18L

Microbial interactions.Microbiology of extremophiles (Stress microbiology): Stress sequestration in halophiles, osmophiles, thermophiles, xerophiles, barophiles. Heavy metal detoxificants.
Quantitative microbial ecology: Modern and conventional methods used to study microorganism, (sampling procedure, microbial enumeration, biomass determination).

### UNIT III 15-18L

Biofertilizers: Definition, types- Nitrogen fixing, Phosphate solubilizing and cellulolytic microbes, mass production of bacterial inoculants (*Rhizobium, Azotobacter, Azospirillum,cyanobacteria*) mode of action, advantages and limitations.
Biopesticides: Bacterial, viral, fungal and protozoan, mode of action, factors influencing, genes involvedin production technology. Mycorrhiza: Types and their application.Lichen.

**UNIT IV** **15-18L**

Introduction of environmental microbiology. Applications of microbes in solving environmental pollution problems.
Bioaccumulation of metals and detoxification, biosorption, scavenging.
Bioaugmentation: Pollution, wastes, their types and characterization. Methods of treatment-Physical, chemical, biological (Oxidation ponds, HRABP, ASP, Trickling Filter, Fluidized Bed Reactor, Biogas, Rotating contactor).
Nanotechnology: Concept, scope and their role in pollution abatement.Biosensors for environment monitoring

**UNIT V** **15-18L**

Bioremediation techniques:*In situ* and *ex-situ.* Use ofGEMs in bioremediation.
Biodeterioration: Role of microbes in wood, pulp and paper.
Biodegradation: Xenobiotics, hydrocarbons, pesticides and plastics.
Biomonitoring: Microorganisms as bioindicators and applications of bioindicators. Role of *Dianococcusradiodurans* in disposal of radioactive waste material and its future in environmental biotechnology.

**Recommended Books:**

1. Soil Microbiology by Prof. N.S. Subba Rao, Fourth edition, Oxford and IBHPublishing CO. PVT., LTD., New Delhi
2. P.D.Sharma.2006. Plant pathology. Alpha Science International.19.
3. Modern Soil Microbiology, Dirk J, Elas V, Trevors JT, Wellington, EMH (1997)Marcel Dekker INC, New York.
4. Robert, S. Burlage Ronald Maltus, 1998. Techniques in Microbial Ecology. ASM Press.
5. Larry Barton, Diana E. Northup, 2011. Microbial Ecology. John Publisher, Academic Press.
6. Environmental microbiology: principles and applications by Patrick K. Jemba.Science publisher,2004.
7. Environmental microbiology by P. D. Sharma, Alpha Sciences international, 2005.
8. Environmental microbiology, second edition, by Ralph, Ji Doug Gu, Wiley.
9. Atlas R M and Bartha, 1993. Microbial Ecology, Bejaminn Cummings Publishing Co.Redwood City CA
10. Environmental microbiology by Ian Papper and Charles Gerba, Elsevier Press.
11. Environmental microbiology by Rose Vol III-IV, 1999
12. Practical microbiology, third edition, by Dubey, D K. Maheswari, S. Chand publishers, 2012
13. Advances in applied Bioremediation, Springer.
14. Alexander M 1971. Microbial Ecology. John Wiley & Sons Inc., New York.
15. EldowneyEc S., Hardman DJ. and Waite S 1993. Pollution: Ecology and biotreatment. Longman Scientific Technical.
16. Baker KH and Herson DS 1994. Bioremediation. Mc Graw Hill Inc., New York.

**M.Sc. Microbiology**

**Third Semester Examination**

Paper 3.2 **MIC -6302–Fermentation Technology & Bioinformatics**

| | | | |
|---|---|---|---|
| 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 fermentation technology: History, Scope and Development of Fermentation technology. Microbial culture selection for fermentation processes. Strain improvement: Mutant Selection, Recombination and Recombinant DNA technology.

Preservation and maintenance of industrially important microbes.

**UNIT –II**

**15-18L**

Inoculum development for industrial fermentation & Microbial Kinetics: Introduction, Criteria for transfer of inoculum, development of inoculum for microbial processes. Inoculum development for plant fermenter, aseptic method of inoculation, achievement, and maintenance of aseptic conditions. Fermentation Material and Energy balance, Microbial growth kinetics: Microbial growth cycle, measurement of growth, Batch culture, continuous culture, fed-batch culture, applications, and examples. Design of fermenter/ bioreactors- Design aspects of flask, stirred tank reactor, Air-lift fermenter, Tower fermenter, Kinetics of operation of bioreactors, Batch, Fed-batch, Continuous processes, Design and operation of immobilized cell reactors.

**UNIT III** **15-18L**

Fermentation media Natural and Synthetic media; Basic components of a media (Carbon sources; Nitrogen sources; Vitamins; Minerals; Anti-foaming agents); Role of buffers in media. Media formulation and process optimization.Process of aeration, and agitation. Aeration-Theory of oxygen transfer in bubble aeration, Oxygen transfer kinetics, determination of KLa, Agitation-Design of impellers and their hydrodynamics, Fermentation

broth rheology and power requirements for agitation-Concept of Newtonian and non-Newtonian fluids, effect of broth rheology on heat, nutrient and oxygen transfer, Reynolds number, power number, aeration number.

**UNIT-IV** **15-18L**

Bioinformatics: An overview, introduction and scope of bioinformatics. Databases: Characteristics, categories and types (Genome database, Literature database, Disease database, Sequence database, Structure database,PDB). Information retrieval system (Entrez, SRS). Data mining tools: Modelling tools (Rasmol, SPDV, HyperChem), Data submission tools (Bankit, Sequin, Webin, Sukura, Spin, AutoDep).

**UNIT-V** **15-18L**

Algorithms: Classification of algorithms. Sequence Comparison algorithms. Submission metrics algorithms, Tools for sequence alignment. Gene Prediction: Methods, Gene mapping: DNA sequencing, Sequence alignment optimal algorithms. Tools for Genome analysis. Phylogenetic analysis: Phylogenetic trees. Methods of phylogenetic evaluation. Prediction tools Proteomics: Proteome analysis, Tools for Protein sequence analysis and proteomics, structure analysis. Molecular descriptors in QSAR studies, small molecule force field parameters (charges), potentials, Active site identification, ligand docking, Drug stability, synthesizability and drug delivery. Steps and software of drug designing.

**Books/ References**

1. Whitaker; Stanbury, Peter F; Hall, S.; Whitaker, A. Principles of Fermentation Technology, Second Edition (9780750645010) by Robert W. Hutkins. Microbiology and Technology of Fermented Foods.
2. D. W. Mount; Bioinformatics-Sequence and genome analysis; Cold Spring Harbour Lab press. 2001.
3. B.N. Mishra; Bioinformatics: Concept and application, Pearson Education (in press) 2020.
4. O' Reilly; Developing Bioinformatics computer skills-1stIndian edition, SPD publication. 2001.
5. Anthony J.F. Griffiths et al; An introduction to genetic analysis, 1stEd 1976.
6. Michael Starkey and Ramnath Elaswarapu; Genomics protocols, Humana press.
7. Peter F Stanbury, Allan Whitaker, Stephen J Hall. Principles of Fermentation Technology. (2016) Butterworth-Heinemann Press. UK.
8. H. J. Peppler, D. Perlman. Microbial Technology: Fermentation Technology. (2014). Academic Press.
9. T. El-Mansi, C. Bryce, Arnold L. Demain, A.R. Allman. Fermentation Microbiology and Biotechnology. Second Edition. (2006). CRC Press, USA.
10. Hongzhang Chen. Modern Solid-State Fermentation: Theory and Practice. (2013). Springer Press, Germany.
11. John E. Smith. Biotechnology. (2009). Cambridge University Press.UK.
12. Celeste M. Todaro, Henry C. Vogel. Fermentation and Biochemical Engineering Handbook. (2014). William Andrew Press. Norwich, NY.
13. G. Lancini, R. Lorenzetti. Biotechnology of Antibiotics and other Bio.

## M.Sc. Microbiology

### Third Semester Examination
### Paper3.3 MIC -6303(1)–Biofuel and Bioenergy

| | | | |
|---|---|---|---|
| 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**

Current energy consumption, overview of biofuel/bioenergy and biorefinery concepts. Fundamental concepts in understanding biofuel/bioenergy production. Biomass preprocessing: drying, size reduction, and densification. Microbes as a source of bioenergy.

Biomass for energy. Calorific value and its estimation. Co-generation of energy. Various biofuels/bioenergy from biomass. Biomass conversion to heat and power: thermal gasification of biomass, anaerobic digestion.

**UNIT II** **15-18L**

Biomass conversion to biofuel: thermochemical conversion, syngas fermentation. Environmental impacts of biofuel production. Alternatives as biofuels: Alkanes, Biobutanol, bioethanol, biomethanol, biodiesel, biogas, hydrogen, syngas/synfuels and other energy dense molecules and their comparisons.

Biochemical conversion to ethanol: biomass pretreatment,Starch to sucrose conversion and Sucrose to ethanol fermentation. Different enzymes, enzyme hydrolysis, and their applications in ethanol production. Distillation and Quantification of ethanol.

**UNIT III** **15-18L**

Lignocellulosic hydrolysis, Fermentation of pentoses and other issues in bioethanol production from lignocelluloses. Biobutanol production, Estimation of biobutanol.

Microbes and biogas production: Biogas and methane estimation. Bio gas Bottling Plant Technology, Application of Bio gas slurry in agriculture.Design of Biogas for cold climates.

**UNIT IV** **15-18L**

Global biodiesel scenario. Oil crops. Microbes and Biodiesel:Production and feed stock. Techniques of lipid extraction and conversion to biodiesel (lipid transesterification), Biodiesel quality and its assessment.
Strategies of genetic engineering of organisms for biofuel production.

Wastewater remediation and biomass generation for biofuel purposes. Microbial Fuel Cells.

**UNIT V** **15-18L**

Food vs Fuel debate. Carbon sequestration and its necessity. Carbon credits. Biorefinery, Thermochemical Conversion Processes (Gasification: Biofuels from Synthesis Gas and Pyrolysis) Biochemical Conversion Processes, Photobiological conversion: Biohydrogen production. Commercialized microalgae (*Spirulina, Dunaliella, Hematococcus, Chlorella* and others) and their production. Economics of microalgae production. Cultivation of seaweeds.

**Reference Books:**

1. Balachandran P. (2010); Engineering Fluid Mechanics, Prentice Hall India
2. Dessler A. (2011); Introduction to Modern Climate Change, Cambridge University Press.
3. Bioenergy (Biomass to Biofuel) 1st Edition 2014 Academic Press Editor: Anju Dahiya.
4. Biorenewable Resources: Engineering New Products from Agriculture. Robert C. Brown. Wiley-Blackwell Publishing (2003).
5. Anaerobic Biotechnology for Bioenergy Production: Principles and Applications. Samir K. Khanal. Wiley-Blackwell Publishing (2008).
6. Kothari D. P. and Nagrath I. (2009); Basic Electrical Engineering, Third Edition, McGraw Hill, India
7. Zemansky M. and Dittman R. (2011); Heat and Thermodynamics, McGraw Hill, India
8. Wadhwa C. L. (2012); Generation,Distribution and Utilization of Electrical Energy,Third Edition, New Age International.

**M.Sc. Microbiology**

**Third Semester Examination**

Paper3.3MIC -6303(2)– **Pharmaceutical Microbiology**

***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**

Antibiotics and synthetic antimicrobial agents: Antibiotics and synthetic antimicrobial agents:(Aminoglycosides, β lactams, tetracyclines, Ansamycins, macrolid antibiotics),Antifungal antibiotics, antitumor substances. Peptide antibiotics, Chloramphenicol, Sulphonamides and Quinolones antimicrobial agents.Chemical disinfectants, antiseptics and preservatives.Antimicrobial Testing Systems: Introduction, Antimicrobial agents, broad types, therapeutic ratio, MIC and MBC. Antimicrobial Susceptibility Testing.

**UNIT II** **15-18L**

Mechanism of action of antibiotics:Mechanism of action of antibiotics (inhibitors of cell wall synthesis, nucleic acid and protein synthesis).Molecular principles of drug targeting.Drug delivery system in gene therapy.Bacterial resistance to antibiotics.Mode of action of bacterial killing by quinolones.Bacterial resistance to quinolone.Mode of action of non – antibiotic antimicrobial agents.Penetrating defenses- How the antimicrobial agents reach the targets (cellular permeability barrier, cellular transport system and drug diffusion).

**UNIT III** **15-18L**

Microbial production and Spoilage of pharmaceutical Products: Microbial contamination and spoilage of pharmaceutical products (sterile injectables,non-injectables, ophthalmic preparations and implants) and their sterilization.Manufacturing procedures and in process control of pharmaceuticals.Other pharmaceuticals produced by microbial fermentations (streptokinase,streptodornase).

**UNIT IV** **15-18L**

Regulatory practices, biosensors and applications in Pharmaceuticals:Financing R&D capital and market outlook. IP, BP, USP.Government regulatory practices and policies, FDA perspective.Reimbursement of drugs and biologicals, legislative perspective.Rational drug design.Immobilization procedures for pharmaceutical

applications (liposomes).Macromolecular, cellular and synthetic drug carriers. Biosensors in pharmaceuticals.Application of microbial enzymes in pharmaceuticals.

**UNIT V** **15-18L**

Quality Assurance and Validation:Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry.Regulatory aspects of quality control.Quality assurance and quality management in pharmaceuticals ISO, WHO and US certification.Sterilization control and sterility testing (heat sterilization, D value, z value, survival curve, Radiation, gaseous and filter sterilization)Chemical and biological indicators.Design and layout of sterile product manufacturing unit, Designing of Microbiology laboratory.

**References**

1. K. Park (2009), 20th Edition Park's Textbook of Preventive and Social Medicine
2. Konrad J. Karczewski, Roxana Daneshjou, Russ B. Altman, 2012 Chapter 7.Pharmacogenomics PLOS
3. Franklin T.J. and Snow G.A., 1975, Biochemistry of Antimicrobial Action,Chapman and Hall, London
4. Gale E.F., Cundliffe E., Reynolds P.E., Richmond M.H. and Waring M.J., 1972,The molecular basis of antibiotic action, John Wiley and Sons, London
5. Goldstein A., Aronow L. and Kalman S.M. 1969, Principles of Drug Action, TheBasis of Pharmacology, Harper International Edition, New York
6. Mannfred A. Holliger, 2008, Introduction to Pharmacology, 3rd Edition, CRCPress
7. Kokate C. K., Purohit A.P., Gokhale A.B.2000, Pharmacology, 4th Edition, NiraliPrakashan

## M.Sc. Microbiology

## Third Semester Examination

## Paper3.4 MIC -6304(1)–Antimicrobial Resistance

***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**

Definition, phenomenon of antibiotics, concept of secondary metabolites. Discovery and History of antibiotics, importance of antibiotics, Different classes of antimicrobials (bacterial, Viral & fungal) and their mode of action. Role of antibiotics in the producer organism. Importance of optimizing antimicrobial usage for maintaining cost-effective therapies.

**UNIT II** **15-18L**

Biochemical modes of action of antibiotics acting as inhibitors of ribosomal function (as for example aminoglycosides, tetracyclines, puromycin, chloramphenicol, macrolides etc.), inhibitors of nucleic acid metabolism (actinomycin D, mitomycin C etc.), inhibitors of cell wall biosynthesis (penicillin, bacitracin etc.) and inhibitors of membrane function (polyenes, tunicamycin, ionophores etc.) and other mode of actions.

**UNIT III** **15-18L**

Phenomenon of antibiotic resistance. Emergence and spread of resistance; Microbial resistance – a global issue. Reservoirs of antibiotic resistance, Molecular mechanisms of Resistance; Different biochemical mechanisms of resistance development, multiple-drug resistance and XDR, their genetics and chemical significance. Bacterial Biofilms.

**UNIT IV** **15-18L**

Assay of antibiotics: chemical versus microbiological assay system, different methods of antibiotic assays (serial dilution, photometric and agar-diffusion methods) - theory and practice; Chemical and biochemical modification of antibiotic structures: development of antibiotics (Different generations of antibiotics) taking penicillin and chloramphenicol's as parent compounds.

**UNIT V** **15-18L**

Antimicrobial susceptibility tests; methods for detecting antimicrobial resistance; Obtaining good results; interpretation of antimicrobial susceptibility results; genomic analysis tools to detect resistance genes. Alternative therapies to antibiotics – phage therapy, probiotics, vaccines, etc. Roles and responsibilities of different stakeholders in antimicrobial stewardship (including physician, pharmacist, microbiologist, hospital administrators); Case studies - Antimicrobial stewardship strategies by WHO, ICMR etc.

**Books/References:**

1. Kateryna Kon and Mahendra Rai "Antibiotic Resistance: Mechanisms and NewAntimicrobial Approaches" Academic press 2016
2. CARD - Comprehensive Antibiotic Resistance Database (https://card.mcmaster.ca/) sitefor information on publicly available resistance genes and related information.
3. Research papers and Reports provided as per the course content.

## M.Sc. Microbiology

## Third Semester Examination

Paper3.4MIC -6304(2)– **Microbial Nanotechnology**

***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 Nanotechnology: Characteristic scale for quantum phenomena, nanoparticles,nano-clusters, nanocomposite, nanotubes, nanowires and emergence of bio-nanotechnology.
Characterization of nanoparticles – UV-Vis. spectroscopy, FTIR, Electron Microscopy – HRTEM,SEM, AFM, EDS, XRD.

**UNIT II** **15-18L**

Microbial nanotechnology-Microbial synthesis of Nanoparticles. Synthesis of nanodrugs-metal nanoparticles and drug delivery vehicles- Nanoshells- Tectodentrimers. Nanoparticledrug systems – Diagnostic applications of nanotechnology.Drug delivery- protein mediated and nanoparticle mediated.

**UNIT III** **15-18L**

Preparation of nano-biomaterials – Polymeric scaffolds collagen, Elastins:Mucopolysaccharides, proteoglycans, cellulose and derivates; Dextrans, Alginates, Pectins, Chitin. Nanoparticles-types, functions- Silver, Gold and Titanium. Physical and chemicalproperties of nanoparticles.

**UNIT IV** **15-18L**

Nanoscale applications in biology and medicine: Nanotechnologies for biology and medicine- Micro- and nano-fluidics - Scanning probe microscopy in biology and medicine- Self-assembly of biological molecules. Nano-biotics, Application of Nanoparticles in theragnostic. Hybridconjugates of goldnanoparticles- DNA oligomers -

use of DNA molecules in nano-mechanics andComputing.Nanoparticles as carrier for genetic material. Genetically Modified Organisms(GMO) and applications.

**UNIT V** **15-18L**

Implications of nanotechnology: Health and safety implications from nanoparticles: Healthissues- Environmental issues- Need for regulation- Societal implications: Possible militaryapplications - Potential benefits and risks for developing countries - Intellectual propertyissues - Criticism of Nanotechnology - Studies on the implications of Nanotechnology.

**Recommended Text Books:**

1. Pradeep T. (2012). Textbook of Nanoscience and Nanotechnology. McGraw HillEducation (India) PrivateLimited.
2. Murty B.S., Shankar P., Baldev Raj, Rath B. B., James Murday. (2013). Textbook ofNanoscience and Nanotechnology. Springer, Berlin, Heidelberg.
3. Risal Singh, Shipra Mital Gupta. (2016). Introduction to Nanotechnology:Understanding the Essentials, 1st edition. Oxford University Press.
4. Rakesh K. Tekade. (2019). Biomaterials and Bio-Nanotechnology, 1st edition.Academic Press.
5. David E. Reisner. (2011). Bio-nanotechnology II: Global Prospects. CRC Press.
6. Yubing Xie. (2017). The Nanobiotechnology Handbook, 1st edition. CRC Press.

**M.Sc. Microbiology**

**Third Semester Examination**
**Paper 3.5** MIC **6305 Lab Course V**

**Practical Exercises**

1. To study the micro-flora of air (indoor and outdoor).
2. Analysis of soil: Texture, pH, moisture content, water holding capacity, percolation, and capillary action.
3. Isolation and study of microbes (bacteria and fungi) from Rhizosphere and Phyllosphere.
4. Isolation of *Rhizobium* from root modules of legumes (*Trigonella / Cicer / Soybean*)
5. Isolation of free nitrogen fixers (*Azotobactor, Azospirillum*) from soil.
6. Isolation of Phosphate solubilizing bacteria from soil.
7. To study the bacterial ecology in freshwater environment.
8. To study the microbial ecology of the rhizosphere and determination of Rhizospheric effect.
9. To study the effect of various salt concentrations on bacterial fungal growth.
10. To study the effect of osmotic pressure on bacterial fungal growth.
11. To determine the microbial biomass from different natural habitats.
12. Demonstration of biological treatment.
13. Determination of alkalinity
14. Determination of chlorine in water.
15. Demonstration of VAM.
16. Production of Biofertilizers: *Rhizobium / Azotobacter sp.*
17. Production of Single cell protein
18. Demonstrate the Mushroom cultivation.
19. Bioremediation of polluted soils by plants/ microbes.
20. Laboratory demonstration of vermi-composting.
21. Determination of BOD, COD and DO of water samples.
22. Field visit to recycling industries.
23. To study the Fermenter, Its Design and Working mechanism.
24. Determine the growth patterns and specific growth rate of *E. coli*
25. Determine the effect of peptone concentration on *E. coli* growth
26. Isolation of antibiotic and enzyme producing microorganisms from soil
27. Isolation of organic acid producing microorganisms from soil
28. Retrieving sequence data from Entrez

29. Locating the chromosome of a Gene
30. Retrieve gene expression data from GEO
31. Finding ORF of a Given Sequence
32. Retrieving structural data of a protein using PDB database
33. To access scientific data from Literature data bases (PUBMED, LITDB, Medline)
34. To access nucleic acid databases for retrieval of gene sequence.
35. To access protein databases for retrieval of amino acid sequence of target protein.
36. To perform multiple sequence alignment using BLAST and CLUSTAL-W
37. To prepare Phylogenetic tree and Cladogram using CLUSTAL-W

**M.Sc. Microbiology**

**Third Semester Examination**
**Paper 3.6** MIC**6306 Lab Course VI (Based on elective papers)**

**Practical Exercises based on Biofuel and Bioenergy**

1. Qualitative and Quantitative estimation of solid waste from different sites.
2. Liquid bio- fuel production and characterization.
3. Biogas production by anaerobic digestion and analysis.
4. Production of energy from microbes (microbial fuel cell)
5. Production of Biodiesel from nonedible oil.
6. Biogas production and application.
7. Bioethanol production.
8. Cultivation of seaweeds.

**Practical Exercises based on Pharmaceutical Microbiology**

1. Spectrophotometric / Microbiological methods for the determination of Griseofulvin.
2. Bioassay of chloramphenicol by plate assay method or turbidimetric Assay method.
3. Treatment of bacterial cells with cetrimide, phenol and detection of Leaky substances such as potassium ions, amino acids, purines, Pyrimidines and pentoses due to cytoplasmic membrane damage.
4. To determine MIC, LD 50 of Beta-lactam/aminoglycoside/ tetracycline/annamycin's.
5. Sterility testing by *Bacillus stearothermophilus*
6. Sampling of pharmaceuticals for microbial contamination and load (syrups, suspensions, creams).
7. Determination of D value, Z value for heat sterilization in pharmaceuticals.
8. Determination of antimicrobial activity of a chemical compound (Phenol, resorcinol, thymol, formaldehyde) to that of phenol under Standardized experimental conditions.
9. Microbiological assay of antibiotics by cup plate method and other methods
10. Extraction of bioactive ingredients from plant and its activity fraction.

11. Estimation of antimicrobial activity using CLSI.
12. Determination of microbial load of non-sterile products – ointments, capsules.
13. Determination of drug sensitivity of *Streptococcus mutans.*

**Practical Exercises based on AntimicrobialResistance**

1. Antimicrobial Susceptibility Testing: Agar disk-diffusion method
2. Antimicrobial gradient method (E test)
3. Agar well diffusion method
4. Poisoned food method
5. Agar overlay bioassay
6. Broth dilution method
7. Agar dilution method
8. Time-Kill test (time- kill curve)

**Practical Exercises based on Microbial Nanotechnology**

1. Synthesis of Nanoparticles from plant materials: Green Synthesis.
2. Synthesis of nanoparticles from microbiological sources
3. Affinity purification of immunoglobulins & quantification
4. Demonstration of Imaging techniques: SEM/TEM/Bio-AFM (Natural Sample sources)
5. Bioconjugation of nanoparticles with proteins/antibodies/DNA
6. Protein quantification by spectroscopy/ELISA
7. Mining of biological databases: DNA/Protein search
8. Synthesis of Metal Oxide Nanoparticle using different techniques.
9. Synthesis of $TiO_2$, Cu and ZnO nano particles by Laboratory method
10. Biogenesis of Iron nano-particles for development of Microbial Emulsion.
11. To demonstrate Characterizations using UV visible spectrophotometer, FTIR, X-ray Analysis.
12. Synthesis of Polymeric Nanocomposite.
13. Demonstration of Drug Delivery by drug delivery Vehicles: Tectodentrimers and nanoparticles

## M.Sc. Microbiology

## Fourth Semester Examination

The students have to select one of the following specializations that shall be taught in fourth semesters:

Paper 4.1 MIC -6401– Industrial Microbiology **or**Paper 4.2 MIC -6402– Medical Microbiology.

### Paper 4.1 MIC -6401– **Industrial 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**

Novel microbes for future industry. Historical account of microbes in industrial microbiology. Industrial microorganisms: Sources and characters of industrially potent microbes (bacteria, fungi and actinomycetes). Industrial sterilization process for media, air and equipment.Fermentations technology: Principles of fermentation, Types of fermentations: Solid substrate fermentation (SSF) - Principles and application, Submerged Fermentation. Aerobic and anaerobic fermentation, Components of fermentation process.

**UNIT-II** **15-18L**

Downstream processing: Biomass separation by centrifugation, filtration, flocculation and other recent developments. Cell disintegration methods**.**
Extraction: Solvent, two phase, liquid extraction, supercritical fluid extraction, whole broth, aqueous multiphase extraction. Product Purification: precipitation, Crystallization, chromatographic methods, ultra-filtration, reverse osmosis. Drying devices.

**UNIT-III** **15-18L**

Industrial production of antibiotics: Streptomycin, Penicillin. Industrial production of: Vitamin B12, Riboflavin,Citric acid, Lactic acid, Vinegar; Glutamic acid, L – lysine; Acetone, glycerol, alcohol. Steroid biotransformation. Production of alcoholic beverages.Microbial Enzymes**:**Tannases, Proteases, Amylases,
Production of biopharmaceuticals through GEMs: Insulin, Interferons, Tissue plasminogen activator, Streptokinase.Immobilization of enzymes and cells: Types & applications.

**UNIT- IV** **15-18L**

Microbiology of food: sources and types of microorganisms in food, food borne pathogens, microbiological examination of food, spoilage of food, food preservation. Starter cultures their biochemical activities, production and preservation of the following fermented foods: Soy sauce fermentation by Moulds, Fermented vegetables – Sauerkraut, Fermented Meat – Sausages. Production and application of Baker's Yeast. Role of microorganisms in beverages – tea and coffee fermentations. Genetically modified foods. Biosensors in food.

**UNIT- V** **15-18L**

Dairy microbiology: sources and types of microorganisms in milk, microbial examination of milk, pasteurization and phosphatase test, sterilization of milk, grades of milk, Microbiology of fermented milk products (acidophilus milk, yoghurt), butter &cheese. Applications of microbial enzymes in dairy industry (Protease, Lipases). Quality assurance: Microbiological quality standards of food. Government regulatory practices and policies. FDA, EPA, HACCP, ISI.

**Reference Books:**

1. Microbiology an Introduction by Gerard J Tortora, Berdell R Funke and Christine L Case. Pearson Publisher (11th Edition) 2016.
2. Basic and Industrial Microbiology by S. M. Reddy.
3. Microbes: Concepts & Applications- P.S. Bisen, Mousumi Debnath, Godavarthi B.K.S. Prasad, John Wiley & Sons Publication 2012.
4. Industrial Microbiology by David B. Wilson, Hermann Sahm, Klaus-Peter Stahmann, MattheosKoffas. Wiley Publisher 2019.
5. Reed G (2004). Industrial Microbiology. CBS Publishers (AVI Publishing Co.)
6. Stanbury PF, Whittakar A. and Hall (2006). Principles of Fermentation Technology. Pergaman. McNeul and Harvey.
7. Creuger and Creuger (2004). Biotechnology- A textbook of Industrial Microbiology, Sinaeur Associates.
8. Casida LE (2001). Industrial Microbiology, Wiley Eastern.
9. Manual of Industrial Microbiology and Biotechnology, Demain & Davies, 2nd ed.
10. Microbial Biotechnology A. N. Glazer and H. Nikaido
11. Biotechnology An Introduction Susan R. Barnum
12. Topics in Enzyme & Fermentation Biotechnology by Wisemen
13. S.N. Jogdand. Medical Biotechnology

14. S.N. Jogdand. Biopharmaceuticals

**M.Sc. Microbiology**

**Fourth Semester Examination**

Paper 4.2 MIC -6402– **Medical 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**

Human microbiome & its significance. Probiotics: Gut microbiota, Gut brain interaction. Infection: types, sources, reservoirs and vehicles of infection, predisposing factors. Host-parasite relationship governing the infection and establishment of disease, factors affecting virulence. Mode of spread of infection.

Emerging epidemics, Re-emerging epidemics. Epidemics fundamentals: Types of epidemics, investigation, management and control. Biosafety:components,laboratory safety management.Management of biomedical waste. Biosafety levels.Introduction of center for Disease Control (CDC) and National center for disease control (NCDC).

**UNIT-II** **15-18L**

Study of diseases caused by pathogenic bacteria: Pathogenicity, laboratory diagnosis, epidemiology and control measures– *Streptococcus, Staphylococcus, Neisseria, Salmonella, E.coli, Klebsiella, Proteus, Pseudomonas, Shigella, Corynebacterium, Vibrio, Corynebacterium, Bacillus,Clostridium, Vibrio, Mycobacterium, Spirochetes,Chlamydiae, Rickettsia, Mycoplasma.*

**UNIT-III** **15-18L**

Morphology, pathogenesis, immune response, diagnosis and prevention of Pox viruses, Herpes, Picorna viruses (Enteroviruses and Polioviruses).Paramyxo viruses, Orthomyxoviruses, Hepatitis viruses, Rhabdo viruses

(Rabies virus), Oncogenic viruses, HIV virus, Prion infection. Introduction to emerging diseases- Swine flu, chikungunya, Ebola, SARS-CoV-2.

**UNIT-IV** **15-18L**

Fungal diseases: Aetiology, clinical symptoms, laboratory diagnosis and treatment of Human mycotic infections caused by Dermatophytes, Histoplasma,Cryptococcus, Candida, opportunistic mycoses. Mycotoxins.
Important protozoal diseases: Route of entry, Life Cycles, Immunity, diagnosis & prophylaxis of *Plasmodium, Entamoeba, Leishmania, Giardia, Taenia.*

**UNIT-V** **15-18L**

Antimicrobial resistance: Drug resistance organisms, mechanisms and development of multidrug resistance.
Mechanism of drug action:Antibacterial, Antifungal and Antivirals. Methods of testing drug sensitivity. Preclinical development: Safety profile of drugs, Toxicological evaluation of drug, Mutagenicityand Carcinogenicity.Clinical studies.
Recent advances in medical microbiology-antiretroviral therapy, Plasma therapy. Probiotics as therapeutic agents, Aptamers, nanotechnology in medicines, Interferons.

**Reference Books:**

1. Emerging epidemics: Management and control P.S. Bisen and E. Raghuvanshi 2013. Wilay& Sons publication New Jersey
2. Molecular Diagnostics: Promises & Possibilities 2010. MousuniDabnath, G.B.K.S. Prasad P.S. Bisen. Principlesof Therapeutics, Burn J. H., Blackwell Scientific Pub. O. Ltd. Oxford.
3. Medical Microbiology, McGraw Hill Publication 2019, by Stefan Riedel, Stephen A. Morse, Timothy A. Mietzner, Steve Miller
4. Role of Novel Drug Delivery Vehicles in Nanomedicine Edited by R.K. Tyagi, N. Garg, R. Shukla & P.S. Bisen 2020.
5. Ananthanarayan and Jayaram Paniker. Textbook of Microbiology, 4th ed. Orient Longman, 2000.
6. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013)Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication.
7. Tille P (2013) Bailey's and Scott's Diagnostic Microbiology, 13th edition, Mosby.
8. Medical Microbiology-David Green wood
9. Jawetz-Medical Microbiology-Geo F.Brooks,Janet S Butel.
10. Microbiology: An introduction, G.J. Tortora, B.R. Funke and C.L. Funke.
11. Virology; Renato Dulbecco and Harold S. Ginsberg, Fourth edition, J.B. Lippincott Company,USA
12. An Introduction to viruses, S. B. Biswas and Amita Biswas. Fourth edition, Vikas Publishing House PVT LTD New Delhi.
13. Medical Bacteriology, Medical Mycology and AIDS; N.C.Dey, T.K. Dey and D. Sinha, New Central Book Agency (P) Ltd.

**M.Sc. Microbiology**

**Fourth Semester Examination**

Paper 4.2 **MIC** -6402**– Research Methodology, IPR & Bioethics**

| | | | |
|---|---|---|---|
| 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 statistics: Aim and Scope of statistics, Sample size & Sampling. Tabulation and graphics representation. Measure of central tendency, Measure of dispersion, Range, Standard deviation, Lorenz curve. Skewness and kurtosis: Definition, Types and measures of skewness. Kurtosis.
Correlation analysis: Definition,Types of Methods of correlation- scatter diagram,Karl Pearson'scoefficient, Rank correlation.
Regression analysis: Regression Line, regression equations. Multiple regression.

**Unit-II** **15-18L**

Probability theory: Types and Theorems. Theoretical distributions: Binomial, Poisson and Normal distribution. Hypothesis Testing: population and sample, sampling and non-sampling error. Steps in tests of hypothesis. Sampling and non-sampling error. Test of significance for attributes. Test for number of success and proportion of success. Test of significance for variables (Large samples)- tests of differences between means of two samples and between two standard deviations.Tests of significance for variables (Small samples)- Students t-distribution, F-Test. Chi-square, ANOVA

**UNIT-III** **15-18L**

Research Methodology: Introduction-Basic research, applied research, need based research. Identification of the problem, defining the problem. Research Project planning. Literature search-information sources, library resources-books, abstracts hand books, procedure manuals, encyclopedias, annual report, data banks, CDROMS, online literature search- internet access, websites, directories of information resources.
Progress of research- evaluation of results, statistical approach, comparison with existing methodologies, validation of findings, research communication, impact factor of journals, plagiarism. Software packages for statistical analysis.

**UNIT IV** **15-18L**

Intellectual Property Rights (IPR): Introduction to Intellectual Property & IPR, patent, copyrights, trademarks, trade secret, geographical indications, Industrial designs. Patent laws, Legislations covering IPR‟s in India, Patenting of living organisms, procedure involved in patenting, patent infringement, patent filing and international patent law, PCT, provisional and complete specification, patentable and non-patentable materials, product planning and development, Trade related aspects (TRIPS), WTO, WIPO.

**UNIT-V** **15-18L**

Introduction to Ethics, Bioethics and Biosafety. Personal ethics: Profession and professionalism, Moral Reasoning, Ethical theories, ethics in biotechnology, benefits and risks of genetic engineering, ethical aspects of genetic testing, ethical aspects relating to use of genetic information, genetic engineering and biowarfare. Ethical implications of cloning. Ethical, legal and socio-economic aspects of gene therapy, Human genome project and ELSI of human genome project. Ethical issues in genetically modified food and crops. Regulatory affairs.

**Reference Book:**

1. A.R. Leach, Molecular Modeling- Principles and Applications, Second Edition, Pearson.
2. B.L. Wadera, Patents, trademarks, copyright, Designs and Geographical Judications.
3. Bioethics and Biosafety, M.K. Sateesh, I.K. International 2008
4. C.R., Kothari, Research methodology.
5. D.P. Mittal (Taxman Publication), Indian Patents Law and Procedure
6. David W. Mount. 2003. Bioinformatics: Sequence & Genome Analysis.CBS Publishers and Distributors. New Delhi.
7. Fundamentals of Statistics, Goon, Gupta and Dasgupta –World Press, Kolkata
8. Guide to Research Methodology and Biostatistics. Edited by KMK Masthan 2017 CBS Publisher.
9. Hilarry Pearson and Clifford Miller, Commercial Exploitation of Intellectual Property.
10. N.S. Gopalakrishnan & T.G. Agitha, Principles of Intellectual Property (2009), Eastern Book Company, Lucknow
11. P. Narayanan (Eastern Law House), Intellectual Property Law
12. Principles of Technical Writing by Robert Hays. Addison-Wesley, 1965.
13. Rastogi. S. C, Mendiratta. N and Rastogi. P. Bioinformatics Methods and Applications: Genomics, Proteomics and Drug Discovery. Prentice-Hall of India Pvt. Ltd.3rd edition.
14. Statistical Methods, Gupta SP. Sultanchand& Sons.
15. Zhumur Ghosh &Bibekanand Mallick, Bioinformatics: Principles and Applications, Oxford University Press, Second Edition

**M.Sc. Microbiology**

**Fourth Semester Examination**
**Paper 4.3** MIC **-6403–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 related research laboratories/industries/university department. Project work for the dissertation will involve experimental work and the student will have to complete this in stipulated time i.e., 3 months. The final evaluation of the project work will be through a Panel involving internaland external supervisors and examiners. The students shall compulsorily submit the certificate of completion and report to the Department during the practical examination.
This process includes: Conceptualization of the independent research, Collection, analysis, and interpretation of data, Thesis writing, Oral presentation of findings and Viva-Voce.
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. The distribution of marks for project work will be:

**Project work** **: 200 Marks**

1. Experimental Work & Thesis :100
2. Research work presentation :50
3. Viva-voce :50

**M.Sc. Microbiology**

**Fourth Semester Examination**
**Paper 4.4 MIC 6404 Lab Course VII**

**Practical Exercises** based onPaper 4.1 MIC -6401-Industrial Microbiology

1. Components and Operation of a Bioreactor
2. Batch fermentation in conical flask
3. Solid state fermentation
4. Optimization of conditions for optimal production of enzyme: - Media composition, Incubation temperature, Aeration, Incubation time.
5. Purification of antimicrobial metabolites from a microbe.
6. Production of amylase and cellulase by SmF and SSF.
7. Production of antibiotics by SmF technology
8. Immobilization of cells and enzymes.
9. Instrumentation of fermenter. Design of various types of fermenters& bioreactors
10. Production of ethanol & wine from grapes.
11. DSP for microbial enzymes/antibiotics/organic acids.
12. Determination of TDT of microbes.
13. Determination of TDP of microbes.
14. Production and estimation of lactic acid by *Lactobacillu*s Sp. or *Streptococcus* Sp.
15. Sauerkraut fermentation
16. Isolation of food poisoning bacteria from contaminated foods,
17. Production of Dairy products:yoghurt,cheese.
18. Extraction and detection of aflatoxin for infected foods.
19. Preservation of potato/onion by UV radiation
20. Production of fermented milk by *Lactobacillus acidophilus*.
21. Rapid analytical techniques in food quality control using microbial Biosensors.

**Practical Exercises** based on Paper 4.2 MIC -6402- Medical Microbiology

1. To prepare various basic, selective, enrichment and enriched media used for isolation of medically important bacteria from clinical samples.
2. To perform various biochemical tests (IMVC, oxidase, catalase, urea utilization test, sugar utilization and H2S production on TSI agar slant) used for identification.
3. To perform sugar fermentation tests used for identification of medically important bacteria.
4. Preparation of transport media for different clinical samples.
5. Demonstration normal microbial flora of skin, mouth and throat.
6. Isolation and identification of *Staphylococcal* species using suitable media, staining techniques andbiochemical tests.
7. Identification of bacterial species belonging to *Enterobacteriaceae* family using suitable biochemical tests (*E.coli, Proteus, Pseudomonas, Klebsiella)*
8. Isolation and identification of enteric fever causing bacteria (*Salmonella typhi*) using suitable media and biochemical tests.
9. Isolation and identification of *Bacillus* species using suitable media, staining techniques and biochemical tests.
10. Microbiological analysis of urine specimens.
11. Microbiological analysis of sputum specimens
12. Isolation dermatophytes and their identification based on colony morphology and microscopic characteristics.
13. To determine antibiotic sensitivity for Gram negative and Gram-positive bacteria by disc diffusion method
14. To determine Minimal Inhibitory Concentration (MIC) and Minimal Bactericidal concentration of an antibiotic for test bacteria.
15. Identification of human blood groups.
16. Estimation of blood haemoglobin.
17. Perform Total Leukocyte Count of the given blood sample.
18. Perform Differential Leukocyte Count of the given blood sample
19. Separate serum from the blood sample.

**Practical Exercises** based on Paper 4.2 MB-642-Research Methodology, IPR & Bioethics

1. Representation of statistical data by
a. Histogram 2. O give curves 3. Pie diagrams
2. Collection of data using different sampling methods
3. Determination of Averages or Central tendencies (Mean, Mode, Median)
4. Determination of measures of dispersion (Mean deviation, Standard deviation and Coefficient of variation, Quartile deviation)
5. Application of Tests of significance (Chi-Square test, student t-test, Standard error)
6. Applications of computers in biology using MS-office (MS-Word, Excel, Power point)
7. Searching of India Patent databases
8. Drafting and filing of Indian Patent databases
9. Searching of International Patent application
10. Drafting and filing of International Patent application

**M.Sc. Microbiology**

**Fourth Semester Examination**

**Paper 4.4** MIC **6404 Comprehensive Viva Voce**

A grand viva-voce of all the papers of all the semesters will be conducted at the end of semester by a board of examiners.