M. Sc. MICROBIOLOGY
SYLLABUS (SEMESTER –WISE)
w. e. f. the academic Year 2014-2015
for University College

DEPARTMENT OF MICROBIOLOGY
KAKATIYA UNIVERSITY
WARANGAL
Department Microbiology  
Kakatiya University

The Department of Microbiology, Kakatiya University is an infant Department of ten years old. It has a humble beginning and made a steady progress to attain the full fledged status. Its origin can be traced back to 1983 – 1985 when it was started as one of the specializations in M.Sc Botany. In order to develop it into a full-fledged course, M.Sc. Microbiology, a two year course, was started during the year 1993-1994 in lieu with specialization. The staff engaging the classes of specialization was deputed to look after the course. In due course, a Ph.D. program was started and a separate Board of Studies was also constituted. Meanwhile, many affiliated colleges of University started offering both UG and PG courses in Microbiology. The dream of creation of independent department was realized during the year 2003-2004. Now, the department is exactly ten years old. So far 20 batches have come out of the portals of the Department.

Mission of the Department

- It shall develop competent, committed and compassionate leaders with advanced level of knowledge skills and attitude required manage changes in field.
- It shall endeavour to continuously acquire, upgrade, disseminate knowledge, creating and developing skills of highly adaptable employees capable of working in both laboratory and managerial roles
- It shall encourage students to go beyond the classroom and learn on the basis research and applications.
- Uncompromising commitment to teaching and to develop practical laboratory skills.

Achievements of the Department

The teachers have upgraded their subject knowledge time to time through research and undergoing specialized training at reputed universities and research institutes. The teachers have published a large number of papers in National and International journals and authored a number of books for undergraduate, postgraduate and research students. A number of research agencies like UGC, CSIR, DBT, AICTE, and ICMR have sponsored the research projects proposed by teachers. Recognizing the research potential of the department, UGC, New Delhi has identified this department for financial assistance under special Assistance Program (SAP-DRS). The research work is mostly of multidisciplinary nature. In less than ten years duration about twenty scholars were awarded Ph.D. degrees under the guidance of teaching faculty and all of them are well placed.

The students graduated from this department are getting job opportunities in teaching, industry, agriculture and health related fields. Many of the students are pursuing research in reputed National and International institutes and few of them have settled abroad. It is a matter of pride for the Department that all the students up to the last batch have been absorbed in one or other fields.

The department, through its research, is interacting with industry, research establishments in order to train the students. In brief, the department excels itself in teaching and research among all the departments of University.
Succession of Heads

Prof. S. Ram Reddy (Course Coordinator) 2001-2004
Prof. M.A. Singara charya 2004-2006
Prof. S. Girisham 2006-2008
Prof. S. Ram Reddy 2008-2010
Prof. M.A. Singara Charya 2010-2012
Prof. S. Girisham 2012-2014
Dr. Srinivas Munjam 2014-

Succession of Chairpersons, Board of Studies (BOS)

Prof. A. Subramanyam 1997-1999
Prof. S. M. Reddy 1999-2000
Prof. V. Thirupathiah 2000-2003
Prof. S Ram Reddy 2003-2003
Prof. M.A. Singara charya 2003-2004
Prof. S. Ram Reddy 2004-2006
Prof. M.A. Singara Charya 2006-2008
Prof. S. Girisham 2008-2010
Prof. M.A. Singara Charya 2012-2014
Dr. P. Venkataiah 2014-

Future plans of the Department

- **To develop the state-of-art laboratories to train the students in latest technologies**
- **To improve the teaching by computer aided, NET based methodologies**
- **To establish interaction and collaboration with industry to enhance job opportunities**
- **To develop computer lab with biostatistics and bioinformatics software. Providing the accessibility to online journals**
- **To establish language laboratory for improving the communication and writing skills**
- **To modernize the curriculum to suit the need of industry and competitive examinations**
- **Personality development of the students keeping in view global demands**
Members, Board of Studies in Microbiology – PG Courses

1) Dr. P. Venkataiah - Chairman
2) Dr. Srinivas Munjam - Head
3) Prof M. A. Singara Charya - Member
4) Prof S. Girisham - Member
5) Prof N. Vijay Kumar - Member
6) Prof V. Kishan - Member
7) Prof N. Rama Swamy - Member
8) Prof. M. Gopal Reddy - External Member
9) Prof M. Vijayalakshmi - External Member
10) Dr. R. S. Prakasham - External Member
11) Dr. G. Prabham - External Member
### Semester I

<table>
<thead>
<tr>
<th>Paper Code</th>
<th>Title of Paper</th>
<th>Instr. Hours</th>
<th>Duration of Exam</th>
<th>Internal Marks</th>
<th>External Marks</th>
<th>Min Marks</th>
<th>Total</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBT 101</td>
<td>Principles of Microbiology</td>
<td>4</td>
<td>3</td>
<td>20</td>
<td>80</td>
<td>32</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>MBT 102</td>
<td>Bacteriology &amp; Virology</td>
<td>4</td>
<td>3</td>
<td>20</td>
<td>80</td>
<td>32</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>MBT 103</td>
<td>Biological Chemistry</td>
<td>4</td>
<td>3</td>
<td>20</td>
<td>80</td>
<td>32</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>MBT 104</td>
<td>Cell biology &amp; Enzymology</td>
<td>4</td>
<td>3</td>
<td>20</td>
<td>80</td>
<td>32</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>MBP 101</td>
<td>Principles of Microbiology &amp; Bacteriology &amp; Virology</td>
<td>9</td>
<td>4</td>
<td>-</td>
<td>100</td>
<td>40</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>MBP 102</td>
<td>Biological Chemistry &amp; Cell biology &amp; Enzymology</td>
<td>9</td>
<td>4</td>
<td>-</td>
<td>100</td>
<td>40</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Seminar/Tutorials</td>
<td>1</td>
<td></td>
<td>25</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

### Semester II

<table>
<thead>
<tr>
<th>Paper Code</th>
<th>Title of Paper</th>
<th>Instr. Hours</th>
<th>Duration of Exam</th>
<th>Internal Marks</th>
<th>External Marks</th>
<th>Min Marks</th>
<th>Total</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBT 201</td>
<td>Microbial Physiology</td>
<td>4</td>
<td>3</td>
<td>20</td>
<td>80</td>
<td>32</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>MBT 202</td>
<td>Molecular Biology</td>
<td>4</td>
<td>3</td>
<td>20</td>
<td>80</td>
<td>32</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>MBT 203</td>
<td>Advanced Immunology</td>
<td>4</td>
<td>3</td>
<td>20</td>
<td>80</td>
<td>32</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>MBT 204</td>
<td>Biophysical Techniques &amp; Instrumentation</td>
<td>4</td>
<td>3</td>
<td>20</td>
<td>80</td>
<td>32</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>MBP 201</td>
<td>Microbial Physiology &amp; Molecular Biology</td>
<td>9</td>
<td>4</td>
<td>-</td>
<td>100</td>
<td>40</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>MBP 202</td>
<td>Adv. Immunology &amp; Biophy. Techn. &amp; Instrumentation</td>
<td>9</td>
<td>4</td>
<td>-</td>
<td>100</td>
<td>40</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Seminar/Tutorials</td>
<td>2</td>
<td>1</td>
<td>25</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>CBCS Paper</td>
<td></td>
<td>4</td>
<td>3</td>
<td>20</td>
<td>80</td>
<td>-</td>
<td>100</td>
<td>4</td>
</tr>
</tbody>
</table>

MBT = Microbiology Theory; MBP = Microbiology practical  
* Minimum marks required for pass out of University theory examination (80 Marks)
### Syllabus contents and Scheme of Examination

For the candidates admitted from the academic Year 2014-2015

<table>
<thead>
<tr>
<th>Semester/ Paper Code</th>
<th>Title of Paper</th>
<th>Instru. Hours</th>
<th>Duration of Exam</th>
<th>Internal Marks</th>
<th>External Marks</th>
<th>Min Marks*</th>
<th>Total</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Semester III</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MBT 301</td>
<td>Microbial Genetics &amp; Genetic Engineering</td>
<td>4</td>
<td>3</td>
<td>20</td>
<td>80</td>
<td>32</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>MBT 302</td>
<td>Bioinformatics &amp; Computational Methods</td>
<td>4</td>
<td>3</td>
<td>20</td>
<td>80</td>
<td>32</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>MBT 303</td>
<td>Bioprocess Technology</td>
<td>4</td>
<td>3</td>
<td>20</td>
<td>80</td>
<td>32</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>MBT 304</td>
<td>Agricultural Microbiology</td>
<td>4</td>
<td>3</td>
<td>20</td>
<td>80</td>
<td>32</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>MBP 301</td>
<td>Micro. Genetics &amp; Genetic Engi. &amp;Bioin. &amp;Comp. Methods</td>
<td>9</td>
<td>4</td>
<td>--</td>
<td>100</td>
<td>40</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>MBP 302</td>
<td>Bioprocess Technology &amp; Agri. Microbiology</td>
<td>9</td>
<td>4</td>
<td>--</td>
<td>100</td>
<td>40</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Seminar/Tutorials</td>
<td>1</td>
<td>1</td>
<td>25</td>
<td>-</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td><strong>Semester IV</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MBT 401</td>
<td>Environmental Microbiology</td>
<td>4</td>
<td>3</td>
<td>20</td>
<td>80</td>
<td>32</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>MBT 402</td>
<td>Medical Microbiology</td>
<td>4</td>
<td>3</td>
<td>20</td>
<td>80</td>
<td>32</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>MBT 403</td>
<td>Microbial Technology</td>
<td>4</td>
<td>3</td>
<td>20</td>
<td>80</td>
<td>32</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>MBT 404</td>
<td>Nanotechnology &amp; Regulations of Microbial Products</td>
<td>4</td>
<td>3</td>
<td>20</td>
<td>80</td>
<td>32</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>MBP 401</td>
<td>Envi. &amp; Medi. Microbiology, Microbial Technology &amp; Nanotech. &amp; Reg. of Micro. Products</td>
<td>9</td>
<td>4</td>
<td>--</td>
<td>100</td>
<td>40</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Internal Project</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Internal Project</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Seminar/Tutorials</td>
<td>1</td>
<td>1</td>
<td>25</td>
<td>-</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>CBCS Paper</td>
<td>4</td>
<td>3</td>
<td>20</td>
<td>80</td>
<td>32</td>
<td>100</td>
<td>4</td>
</tr>
</tbody>
</table>

**MBT = Microbiology Theory; MBP = Microbiology practical**

* Minimum marks required for pass out of University theory examination (80 Marks)

**CBCS Papers offered by the Department of Microbiology**

1. Agricultural and Environmental Microbiology
2. Medical and Food & Nutritional Microbiology
The syllabus is divided into four semesters. The first three semesters carry four theory papers and two practical papers and seminar. In the fourth semester four theory papers and one practical paper included. An Internal Project work is required to be completed in the fourth semester. Apart from the project, the student will also have to present a seminar in the fourth semester. Each theory paper is divided into four units and all the units carry equal weightage. All theory and practical papers are compulsory. Each theory and practical papers carries 100 marks. 100 marks allotted to the project work to be presented at the end of the fourth semester. Each seminar is allotted with 25 marks.

1. **Number of theory and practical periods:** The syllabus is based on 18 theory and 16 practical periods per week. Candidates are required to pass separately in theory and practical examinations.

2. **Seminar:** In all the semesters every student has to give at least one seminar and submit a written summary of the same.

3. **Project work:** The student will undergo training in the laboratory of faculty member allotted to him/her at the end of II semester. The reports of project work will be submitted at the end of the IV semester. The project work (Dissertation work) will be evaluated by the External and Internal (Chairperson, BOS, Microbiology) examiner at the end of fourth semester. 100 marks are allotted to the Project work. The Project work is compulsory.

4. **Distribution of Theory/Practical/Seminar/Project (Dissertation) marks:**

<table>
<thead>
<tr>
<th>Paper Code</th>
<th>Paper Title</th>
<th>Internal Marks</th>
<th>Examination</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Maximum</td>
<td>Pass</td>
</tr>
<tr>
<td>MBT 101</td>
<td>Principles of Microbiology</td>
<td>20</td>
<td>80</td>
<td>32</td>
</tr>
<tr>
<td>MBT 102</td>
<td>Bacteriology &amp; Virology</td>
<td>20</td>
<td>80</td>
<td>32</td>
</tr>
<tr>
<td>MBT 103</td>
<td>Biological Chemistry</td>
<td>20</td>
<td>80</td>
<td>32</td>
</tr>
<tr>
<td>MBT 104</td>
<td>Cell biology &amp; Enzymology</td>
<td>20</td>
<td>80</td>
<td>32</td>
</tr>
<tr>
<td>MBP 101</td>
<td>Principles of Microbiology &amp; Bacteriology &amp; Virology</td>
<td>100</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>MBP 102</td>
<td>Biological Chemistry &amp; Cell biology &amp; zymology</td>
<td>100</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Seminar/Tutorials</td>
<td></td>
<td>25</td>
<td>--</td>
<td>1</td>
</tr>
</tbody>
</table>
### M.Sc. Microbiology

#### Semester – II

<table>
<thead>
<tr>
<th>Paper Code</th>
<th>Paper Title</th>
<th>Internal Marks</th>
<th>Examination</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBT 201</td>
<td>Microbial Physiology</td>
<td>20</td>
<td>80</td>
<td>32</td>
</tr>
<tr>
<td>MBT 202</td>
<td>Molecular Biology</td>
<td>20</td>
<td>80</td>
<td>32</td>
</tr>
<tr>
<td>MBT 203</td>
<td>Advanced Immunology</td>
<td>20</td>
<td>80</td>
<td>32</td>
</tr>
<tr>
<td>MBT 204</td>
<td>Biophysical Techniques &amp; Instrumentation</td>
<td>20</td>
<td>80</td>
<td>32</td>
</tr>
<tr>
<td>MBP 201</td>
<td>Microbial Physiology &amp; Molecular Biology</td>
<td>--</td>
<td>100</td>
<td>40</td>
</tr>
<tr>
<td>MBP 202</td>
<td>Advanced Immunology &amp; Biophysical Techniques &amp; Instrumentation</td>
<td>--</td>
<td>100</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Seminar/Tutorials</td>
<td>--</td>
<td>25</td>
<td>--</td>
</tr>
<tr>
<td>CBCS Paper</td>
<td></td>
<td>20</td>
<td>80</td>
<td>32</td>
</tr>
</tbody>
</table>

### M.Sc. Microbiology

#### Semester – III

<table>
<thead>
<tr>
<th>Paper Code</th>
<th>Paper Title</th>
<th>Internal Marks</th>
<th>Examination</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBT 301</td>
<td>Microbial Genetics &amp; Genetic Engineering</td>
<td>20</td>
<td>80</td>
<td>32</td>
</tr>
<tr>
<td>MBT 302</td>
<td>Bioinformatics &amp; Computational Methods</td>
<td>20</td>
<td>80</td>
<td>32</td>
</tr>
<tr>
<td>MBT 303</td>
<td>Bioprocess Technology</td>
<td>20</td>
<td>80</td>
<td>32</td>
</tr>
<tr>
<td>MBT 304</td>
<td>Agricultural Microbiology</td>
<td>20</td>
<td>80</td>
<td>32</td>
</tr>
<tr>
<td>MBP 301</td>
<td>Micro. Genetics &amp; Genetic Engineering &amp; Bioinformatics &amp; Computational Methods</td>
<td>--</td>
<td>100</td>
<td>40</td>
</tr>
<tr>
<td>MBP 302</td>
<td>Bioprocess Technology &amp; Agricultural Microbiology</td>
<td>--</td>
<td>100</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Seminar/Tutorials</td>
<td>--</td>
<td>25</td>
<td>--</td>
</tr>
</tbody>
</table>
## M.Sc. Microbiology
### Semester – IV

<table>
<thead>
<tr>
<th>Paper Code</th>
<th>Paper Title</th>
<th>Internal Marks</th>
<th>Examination</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBT 401</td>
<td>Environmental Microbiology</td>
<td>20</td>
<td>80</td>
<td>32</td>
</tr>
<tr>
<td>MBT 402</td>
<td>Medical Microbiology</td>
<td>20</td>
<td>80</td>
<td>32</td>
</tr>
<tr>
<td>MBT 403</td>
<td>Microbial Technology</td>
<td>20</td>
<td>80</td>
<td>32</td>
</tr>
<tr>
<td>MBT 404</td>
<td>Nanotechnology &amp; Regulations of Microbial Products</td>
<td>20</td>
<td>80</td>
<td>32</td>
</tr>
<tr>
<td>MBP 401</td>
<td>Environmental Microbiology &amp; Medical Microbiology &amp; Microbial Technology &amp; Nanotechnology &amp; Regulation of Microbial Products</td>
<td>--</td>
<td>100</td>
<td>40</td>
</tr>
<tr>
<td>Internal Project</td>
<td>Internal Project</td>
<td>--</td>
<td>100</td>
<td>40</td>
</tr>
<tr>
<td>Seminar/Tutorials</td>
<td>Seminar/Tutorials</td>
<td>--</td>
<td>25</td>
<td>--</td>
</tr>
<tr>
<td>CBCS Paper</td>
<td></td>
<td>20</td>
<td>80</td>
<td>32</td>
</tr>
</tbody>
</table>

| Theory Papers | 16 (16x4) | 64 Credits |
| Practical Papers | 07 (07x4) | 28 Credits |
| Seminars | 04 (04x1) | 04 Credits |
| Internal Project | 01 (01x4) | 04 Credits |
| CBCS Papers | 02 (02x4) | 08 Credits |

Total Credits: 108 Credits
A. Pattern of Question Paper

1. There will be four units in each paper.
2. Question paper will consist of five questions.
3. First question will be compulsory with four short-answer questions from each of the four units having equal weightage and there will be no internal choice.
4. Four questions will be on four units with internal choice (One question on each unit).
5. Maximum marks of each paper will be 80.
6. Each paper examination will be of 3 hours duration.
7. Practical/Laboratory Examination of 100 marks.
8. Minimum passing marks in each paper (Theory and Practical) will be 40%.
9. Project/Dissertation Work shall be evaluated by both internal and external examiners.

B. Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA)

1. On clearing of a paper, based on the cumulative score (out of 100) in that paper a student will be given GRADE POINT AVERAGE (maximum of 10, and minimum of 4) for that paper on the following basis. The description for each of the grades for each of the grades is as follows:

<table>
<thead>
<tr>
<th>Grade Proposed Norms:</th>
<th></th>
<th>Grade Point</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Range of % of Marks</strong></td>
<td><strong>Grade Letter</strong></td>
<td><strong>Grade Point</strong></td>
</tr>
<tr>
<td>90 to 100</td>
<td>O (Outstanding)</td>
<td>10</td>
</tr>
<tr>
<td>80 to 89</td>
<td>A+ (Excellent)</td>
<td>9</td>
</tr>
<tr>
<td>70 to 79</td>
<td>A (Very Good)</td>
<td>8</td>
</tr>
<tr>
<td>60 to 69</td>
<td>B+ (Good)</td>
<td>7</td>
</tr>
<tr>
<td>50 to 59</td>
<td>B (above Average)</td>
<td>6</td>
</tr>
<tr>
<td>40 to 49</td>
<td>D (Satisfactory)</td>
<td>5</td>
</tr>
<tr>
<td>Less than 40</td>
<td>F (Fail)</td>
<td>0</td>
</tr>
</tbody>
</table>

2. On clearing all he papers in a semester, a student will be allotted a Semester Grade Point Average (SGPA) for that particular semester. As the pattern given above does not have differential weights for papers, the SGPA of a student for a particular semester will be calculated as per following computation.

\[
SGPA = \frac{C_1 \times G_1 + C_2 \times G_2 + \cdots + C_n \times G_n}{C_1 + C_2 + \cdots + C_n}
\]

Where $C_1$ = Credits of individual Theory/Practical $G_1$ = Corresponding Grade Point obtained in the Respective Theory/Practical.
3. A student will be allotted a **Cumulative Grade Point Average (CGPA)** after clearing all the four semesters. Again as there is no differential weight system for semesters, the CGPA of a student will be average of the four SGPA’s of that student. The CGPA would be as follows:

<table>
<thead>
<tr>
<th>CGPA</th>
<th>Final Grade</th>
<th>Equivalent Class/Division</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.00 – 10.0</td>
<td>O</td>
<td>First Division with Distinction (Outstanding)</td>
</tr>
<tr>
<td>8.00 – 8.99</td>
<td>A+</td>
<td>First Division with Distinction (Excellent)</td>
</tr>
<tr>
<td>7.00 – 7.99</td>
<td>A</td>
<td>First Division with Distinction</td>
</tr>
<tr>
<td>6.00 – 6.99</td>
<td>B</td>
<td>First Division</td>
</tr>
<tr>
<td>5.00 – 5.99</td>
<td>C</td>
<td>Second Division</td>
</tr>
<tr>
<td>4.00 – 4.99</td>
<td>D</td>
<td>Pass Division</td>
</tr>
<tr>
<td>Below 4.00</td>
<td>F</td>
<td>Fail</td>
</tr>
</tbody>
</table>

4. The computation of Semester Grade Point Average (SGPA) and Cumulative Grade Point (CGPA) of an examinee shall be given below:

   a. The Marks will be given in all examinations which will include the internal assessment marks, and the total marks for each Theory/Practical shall be converted into Grades as per above table. SGPA shall be calculated based on grade Points corresponding to grade as given in table and the credits allotted to respective Theory/Practical shown in the scheme for respective semester.

   b. SGPA shall be computed for every semester and CGPA shall be computed only after IV semester. The CGPA will be calculated based on SGPA of all four semesters as per following computation:

   \[
   CGPA = \frac{(SGPA)\ I \times (Cr)\ I + (SGPA)\ II \times (Cr)\ II + (SGPA)\ III \times (Cr)\ III + (SGPA)\ IV \times (Cr)\ IV}{(Cr)\ I + (Cr)\ II + (Cr)\ III + (Cr)\ IV}
   \]

   Where,
   
   \( (SGPA) \ I = \text{SGPA I Semester}; \ (Cr)\ I = \text{Total Credits for I Semester}; \)
   
   \( (SGPA) \ II = \text{SGPA II Semester}; \ (Cr)\ II = \text{Total Credits for II Semester}; \)
   
   \( (SGPA) \ III = \text{SGPA III Semester}; \ (Cr)\ III = \text{Total Credits for III Semester}; \)
   
   \( (SGPA) \ IV = \text{SGPA IV Semester}; \ (Cr)\ IV = \text{Total Credits for IV Semester}; \)
Semester – I
Paper – I

MBT 101: PRINCIPLES OF MICROBIOLOGY

Unit – I

a. History and scope of Microbiology: Discovery of microorganisms, Germ theory of diseases; Major contributions and events in the field of microbiology. Relevance of Microbiology.
b. Scope of Microbiology - Cycle of matter in nature. Microbial interactions - mutualism, symbiosis, commensalisms, predation, parasitism, amensalism and competition.
d. Recent Trends in exploitation of microbial diversity. Community level physiological profile, fatty acid methyl esterase analysis, G+C ratio, nucleic acid reassociation and hybridization and DNA micro arrays.

Unit – II

a. Details of the ultra structure of prokaryotic cell. Differences between Prokaryotic and Eukaryotic cells.
b. Structure and functions of Cell wall and Cell membrane of Bacteria and Archea.
c. Types of culture media, isolation, purification and preservation techniques.
d. Microbial growth kinetics, growth measurements and factors effecting the growth.

Unit – III

a. General characters, thallus organization, cell structure, reproduction and classification of fungi.
b. Physiology of fungi: Growth, nutrition, reproduction, heterothallism and heterokaryosis.
c. Parasexuality, sex hormones, spore dormancy and germination of fungi. General characters, reproduction, life cycles and economic importance of
   i. Mastigomycotina - *Albugo, Perenospora*
d. General characters, reproduction, life cycles and economic importance of
   i. *Zygomycotina - Mucor, Pilobolus*
   ii. *Ascomycotina – Penicillium, Neurospora*

Unit – IV

a. Structure, reproduction, molecular and biotechnological aspects of yeasts.
b. General characters, reproduction, life cycles and economic importance of
   i. Basidiomycotina- *Puccinia, Agaricus*
   ii. Deuteromycotina-General characters and classification.
c. General characters, thallus organization, pigments, reproduction, classification and economic importance of green algae; diatoms, euglenoids.
d. Morphology, reproduction and life cycles of *Trypanosoma, Plasmodium* and *Balantidium*.

Recommended Books

8. Davis R.Y. E.A. Adeberg and J.L. Ingram,1991 General Microbiology
13. Bacterial (Prokaryotic) phylogeny web page. 2006, http:
22. Structure and Reproduction of algae FE Fritsch vol I & II
23. Fresh water algae of united States G. M. Smith
24. Introduction to the algae- Bold H.D and M.J. Wynne, Printice Hall.
Semester – I
Paper – II

MBT 102: BACTERIOLOGY AND VIROLOGY

Unit – I

b. Historical account of bacterial classification systems and their utility – Archaea, Eubacteria.
c. Detailed account of bacterial classification according to the 1st edition of Bergey’s Manual of Systematic Bacteriology (up to sections).
d. Detailed account of bacterial classification according to the 2nd edition of Bergey’s Manual of Systematic Bacteriology (up to orders).

Unit – II

b. Mycoplasma, Endospore-forming Gram-positive rods and cocci; Mycobacteria, Anoxygenic photosynthetic bacteria.
c. Oxygenic photosynthetic bacteria, Aerobic chemolithotrophic bacteria and Actinomycetes.
d. Archaeabacteria: Evolutionary trends in relation to archaeabacteria, phylogenetic overview, properties of archae bacteria and difference from eubacteria and eukaryotes.

Unit – III

a. Brief account of discovery of viruses, chemical composition, morphology and symmetry with reference to T4, TMV, Adeno, Influenza, Rhabdo and HIV viruses.
b. Subviral particles, Viroids, DI particles and Prions.
c. Taxonomy of viruses: Classification and nomenclature of viruses as per ICTV.
d. Isolation, purification, cultivation, assay and characterization of plant, animal and bacterial viruses.

Unit – IV

b. Replication patterns of specific plant viruses TMV and CaMV.
c. Replication strategies employed by animal viruses: Herpes, Hepatitis, Adeno, Influenza and Retroviruses.
d. Antiviral strategies, Prevention and control of viral diseases (Interferons, Antiviral drugs and Viral vaccines).

Recommended Books


Prescott, L.M., J.P Harroy and D.AKlein, 2007 Microbiology VII Ed. Mc Grow Hill,

Davis R.Y. E.A. Adeberg and J.L. Ingram,1991 General Microbiology

Stainer General Microbiology, V Ed. Printice Hall of India Pvt.Ltd. New Delhi


Brun,Y.V. and Schinketes 2000 Prokaryotic developments ASM press


Molecular Biology, Pathogenesis and Control, ASM Press, Washinton D.C.-


Knipe, DM et all/eds ) 2001 Fields Virology Vol I , Lippincott Williams and Wilkins


Krik.L.K. et al., 2004 Methods of studying soil microbial Diversity 58: 169-188
Semester – I
Paper –III

MBT 103: BIOLOGICAL CHEMISTRY

Unit – I

d. Functions of carbohydrates-Energy storage, structural elements, and metabolic intermediates, carbohydrates as informational molecules.

Unit – II

c. Proteins classification, Physico-chemical properties and biological functions of proteins. Structure organization-Primary, secondary, tertiary and quaternary structures and specificity of proteins, supramolecular assemblies of proteins, glycoprotein and proteoglycans.

Unit – III

a. Lipids - classification of lipids; physico - chemical and biological properties, separation, distribution in nature, characterization and saponification and iodine number.
b. Nomenclature, outline structure, properties and functions of fatty acids, glycerides, neutral lipids (waxes, fats and oils).

Unit – IV

a. Types and composition of purine and pyrimidine bases and their nomenclature, nucleosides, nucleotides and polynucleotides. Nucleic acids:Types of RNA and DNA their structure, properties and functions.
b. Vitamins: Classification: Definition and general characteristics, classification of water soluble vitamins structure and their biochemical properties.
c. Vitamins: Classification of fat soluble vitamins, structure and their biochemical properties. Deficiency and human requirement of different vitamins.

Recommended Books

5. Gottschalk G. 1985 Bacterial metabolism – Springer Verlag
10. White, Handler and Smith – Biochemistry
13. Upadhyaya and Nath – Biophysical chemistry (Himalaya Publications)
17. Dixon and Webb – Enzymes
Semester – I
Paper – IV

MBT 104: CELL BIOLOGY AND ENZYMEOLOGY

Unit – I

b. Chemiosmotic hypothesis and proton motive force and energy transformations. Electron transport, oxidative phosphorylation, structure of ATP synthase; mechanism of ATP synthesis. Inhibitors and uncouplers
c. Membrane structure and dynamics; diversity structure and physiology of membrane pumps, carriers and channels.
d. Cell signaling pathways: Basic elements of signaling system; extracellular signal molecules, receptors-ion linked, G-protein linked and enzyme linked receptors; calcium and NO as intracellular messengers. Convergence, divergence and crosstalk among different signaling pathways.

Unit – II

a. Cell cycle: Overview, phases of the cell cycle, cell growth and extracellular signals, Regulations of cell cycle progression (cyclins and cyclin dependent kinases), cell differentiation and cell cycle check points.

Unit – III

a. Introduction and historical perspective of enzymes; properties, classification and nomenclature; structures and biological functions; theory of enzymatic catalysis, specificity. Concept of active site and enzyme substrate complex.
b. Fisher's lock and key hypothesis, Koshland induced fit hypothesis, Haldane and Pauling concept.
c. Enzyme kinetics: Effect of substrate concentration, derivation of Michaelis-Menten equation, Ks, Km, Vmax and Kcat and their significance, methods to determine Km and Vmax; Briggs-Haldane steady state approach, Lineweaver-Burk plots, Eadie-Hofstee and Hanes plots.

Unit – IV

a. Enzyme regulation: Product inhibition, feedback control, enzyme induction and repression and covalent modification, allosteric regulation, chemical modifications, calmodulin mediated regulation.
b. Immobilization of enzymes: Methods of immobilization, ionic binding, adsorption, covalent bonding, micro-encapsulation and gel entrapment, membrane confinement; Practical and economic advantage for industrial use.
d. Enzyme stabilization by selection and genetic engineering, molecular graphics in protein engineering – Biosensors (glucose oxidase, cholesterol oxidase, urease and antibodies as biosensors).
1. Preparation of different types of media
2. Isolation and enumeration of bacterial and fungal population in air.
3. Enumeration of bacterial population in water.
4. Isolation and enumeration of bacterial and fungal population in soil
5. Demonstration of bacterial motility by Hanging drop technique
7. IMVIC tests (Inole, methylred, Voges prausker and citrate test )
8. Oxidast test
9. Carbohydrate fermentation & Gas production
10. Catalase test
11. Gelatinase test
12. Caseinase test
13. H₂S production test
14. Nitrate reduction test
15. Litmus milk reactions
16. Urease test
17. Estimation of proteins in healthy and viral diseased plants
18. Estimation of DNA in healthy and viral diseased plants
19. Estimation of RNA in healthy and viral diseased plants
20. Transmission of viruses by grafting
21. Transmission of viruses by aphids
22. Sap transmission of plant viruses
23. Isolation of phages from sewage
24. Propagation of animal viruses in embryonated eggs: a) Amniotic cavity b) Chorioallantoic cavity c) Yolk sac
25. One step growth curve experiments.
26. Problems on: i) Phage enumeration ii) Acid end point iii) Hemagglutination assay
27. Micrometry-measure the fungal spore dimensions by using ocular and stage micrometers and calculation of the mean and standard deviation.
28. Demonstration of mycorrhizal association
29. Identification of fungal cultures, algal cultures, and Protozoa
30. Electron photo micrographic study of virus
<table>
<thead>
<tr>
<th>Semester - I</th>
<th>Question Bank</th>
<th>Paper - I</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time:</strong> 4 Hrs</td>
<td><strong>Max. Marks:</strong> 100</td>
<td></td>
</tr>
</tbody>
</table>

1. **Major Experiment**
   25 Marks
   1. Micrometry-measurement of the fungal spore dimensions by using ocular and stage micrometers and calculation of the mean and standard deviation
   2. Demonstration of mycorrhizal association
   3. Demonstration of bacterial motility by hanging drop technique
   4. Gram staining
   5. Cell wall staining
   6. Endospore staining
   7. Flagella staining
   8. Capsule staining
   9. Staining of PHB granules
   10. Staining of phosphate granules
   11. Measurement of bacterial growth by turbidometric method

2. **Major Experiment**
   25 Marks
   1. Estimation of chlorophyll in healthy and viral diseased plants
   2. Study of symptomology of plant, animal and human diseases caused by viruses.
   3. Estimation of proteins in healthy and viral diseased plants
   4. Estimation of DNA in healthy and viral diseased plants
   5. Estimation of RNA in healthy and viral diseased plants
   6. Transmission of plant viruses by grafting
   7. Transmission of plant viruses by aphids
   8. Sap transmission of plant viruses
   9. Isolation of coliphages from sewage

3. **Minor Experiment**
   10 Marks
   1. Indole test
   2. Methyl red test
   3. Voges Proskauer test
   4. Citrate test
   5. Oxidase test
   6. Carbohydrate fermentation & Gas production
   7. Catalase test
   8. Gelatinase test
   9. Caseinase test
   10. Amylase test
   11. \( \text{H}_2\text{S} \) production test
   12. Nitrate reduction test
   13. Litmus milk reactions
   14. Urease test
   15. Growth kinetics (problems)
   17. Effect of pH on bacterial growth
4. Minor Experiment  
1. Cultivation of anaerobes by shake culture technique  
2. Cultivation of anaerobes pyrogallic acid method  
3. Cultivation of anaerobes by anaerobic gaspak jar system  
4. Propagation of animal viruses in amniotic cavity of embryonated eggs  
5. Propagation of animal viruses in chorioallantoic cavity of embryonated eggs  
6. Propagation of animal viruses in yolk sac of embryonated egg  
7. Preparation of bacteriophage stocks  
8. One step growth curve experiments.  
9. Problems on phage enumeration  
10. Problems on acid end point  
11. Problems on hemagglutination assay of viruses  

5. Spotters Identification (4 Nos)  
(Viruses = 1; Fungi = 1; Algae = 1; Protozoa = 1)  
   b) Symptomology; Small pox, FM disease, Tulip break, Leaf curl of papaya, Chilli mosaic, Phage plaques, pocks, animal virus plaques in monolayer cell culture, Golden yellow mosaic of beans.  
3. Algae: Nostoc, Scytonema, Oscillatoria, Anabaena, Spirulina, Volvox, Scenedesmus,  
4. Protozoa: Trypanosoma, Giardia, Balantidium, Leishmania, Entamoeba histolytica, Plasmodium (permanent slides)  
5. Photographs of eminent microbiologists & their contributions  

6. Record  

6. Record  
10 Marks
MBP 102: BIOLOGICAL CHEMISTRY & CELL BIOLOGY AND ENZYMEOLOGY

1. Quantitative estimation of glucose by Anthrone method
2. Quantitative estimation of reducing sugars by 3,5, DNS method
3. Quantitative estimation of fructose
4. Quantitative estimation of proteins by Lowry’s method
5. Quantitative estimation of Indole Acetic Acid
6. Quantitative estimation of Ascorbic acid
7. Quantitative estimation of Amino acid
8. Qualitative test of carbohydrates: Glucose, Xylose, Starch, Lactose, Maltose, Sucrose
9. Qualitative test of amino acids: Tryptophan, Tyrosine, Methionine, Arginine, Proline,
10. Qualitative test of proteins: Gelatin, Globulin, Albumin, Peptone, Casein
11. Determination of iodine number of fat
12. Qualitative test of lipids: Cholesterol
13. Demonstration of mitotic cell division stages
14. Demonstration of meiotic cell division stages
15. Evolution of kinetic constant of the purified enzyme.
16. Effect of different parameters on enzyme activity such as pH, temperature, time, enzyme concentration
17. Effect of inhibitors on enzyme activity
18. Immobilization of enzyme
19. Enzyme purification
20. Peroxidase isozyme separation by gel electrophoresis
21. Estimation of arginase activity
22. Estimation of catalase activity
<table>
<thead>
<tr>
<th>Question Bank</th>
<th>Paper – II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time: 4 Hrs</td>
<td>Max. Marks: 100</td>
</tr>
</tbody>
</table>

1. **Major Experiment**
   - Preparation of buffers, titration curve of glycine
   - Quantitative estimation of glucose by Anthrone method
   - Quantitative estimation of reducing sugars by 3,5 DNS method
   - Quantitative estimation of fructose
   - Quantitative estimation of proteins by Lowry’s method
   - Quantitative estimation of Indole Acetic Acid
   - Quantitative estimation of Ascorbic acid
   - Quantitative estimation of Amino acids
   - Determination of iodine number of fat

2. **Major Experiment**
   - Demonstration of mitotic cell division stages
   - Demonstration of meiotic cell division stages
   - Enzyme purification – Ammonium sulphate precipitation
   - Estimation of arginase activity
   - Estimation of catalase activity
   - Evaluation of kinetic constant of the purified enzyme.
   - Immobilization of enzyme

3. **Minor Experiment**
   - Qualitative test of carbohydrates: Glucose, Xylose, Starch, Lactose, Maltose, Sucrose
   - Qualitative test of amino acids: Tryptophan, Tyrosine, Methionine, Arginine,
   - Qualitative test of proteins: Gelatin, Globulin, Albumin, Peptone, Casein
   - Qualitative test of lipids: Cholesterol

4. **Minor Experiment**
   - Mitosis cell division stages
   - Meiotic cell division stages
   - Influence of PH on enzyme activity
   - Influence of temperature on enzyme activity
   - Influence of time on enzyme activity
   - Influence of enzyme concentration on enzyme activity
   - Influence of enzyme inhibitors on enzyme activity.

5. **Spotters Identification (4 Nos)**
   - Structures of monosaccharides
   - Structures of oligosaccharides
   - Structures of polysaccharides
   - Structures of amino acids
5. Structures of proteins
6. Structures of lipids
7. Structure of a typical chromosome
8. Heterochromatin in metaphase
9. Giant chromosomes
10. Polytene chromosome
11. Lampbrush chromosome
12. Cell cycle
13. Interphase
14. Prophase
15. Metaphase
16. Anaphase
17. Telophase
18. Leptotene
19. Zygotene
20. Pachytene
21. Diplotene
22. Diakinesis
23. Immobilised cells
24. Lock and key model
25. Allosteric inhibitors
26. Competitive enzyme activity
27. Un-Competitive enzyme activity
28. Non-Competitive enzyme activity
29. Isozyme Patterns
30. L-B Plots

6. Record 10 Marks
Unit – I

c. Chemotrophism: (sulphur, ammonia, nitrite, iron, hydrogen, carbon monoxide oxidizers) and their importance, reverse electron transport, CO₂ assimilation, reductive acetyl COA pathway.
d. Chemoheterotrophism: Acetogens, Methanogens, Methanogenenesis and its importance. Physiology and economic importance of methylotrophs.

Unit – II

a. Phototrophism: Oxygenic and anoxygenic phototrophs and their diversity, photosynthetic pigments and their light absorption, basic photochemistry of PSI, PSII and light driven electron transport.
b. Modes of CO₂ fixation (Calvin cycle, reverse TCA cycle, HP pathway), Halobacterial photosynthesis. Anaplerotic reactions.
d. Outlines of inter relationship between carbohydrate, protein and lipid metabolisms.

Unit – III

b. Anaerobic respirations: sulphate, nitrate, carbonate respirations and their ecological significance.
c. Fermentations: Types of fermentations, alcoholic, lactate, propionate, mixed acid, butyrate and butanol fermentations and their industrial importance.

Unit – IV

Recommended Books

1. Caldwell, D.R. 1995 Microbial Physiology and Metabolism, Wm. C. Brown Publishers, USA
7. White, D. 1995 The Physiology and Biochemistry of Prokaryotes, Oxford University Press,
Semester – II
Paper – II

MBT 202: MOLECULAR BIOLOGY

Unit – I

a. Chromosome organization in prokaryotes and eukaryotes.
b. DNA replication: General principles, enzymes involved in DNA replication, various models of replication (semi conservative, rolling circle, unidirectional and bidirectional). DNA synthesis by reverse transcription, inhibitors of DNA replication.
c. DNA damage: Types of damage (deamination, oxidative damage, alkylation, and pyrimidine dimers).
d. DNA Repair pathways: Methyl-directed mismatch repair, very short patch repair, nucleotide excision repair, base excision repair, recombination repair and SOS system.

Unit – II

a. Structural features of rRNA, tRNA and mRNA and their functions.
b. Transcription: General principles, basic apparatus, RNA polymerases, promoters, enhancers and other regulatory sequences.
c. Mechanism of transcription and inhibitors of transcription in prokaryotes and eukaryotes.
d. Post-transcriptional modifications: Transcriptional attenuation, cutting and trimming of rRNA, mRNA modifications (capping, polyadenylation and splicing), cutting and modification of tRNA, catalytic RNA, group I and group II intron splicing and RNase P.

Unit – III

a. Translation: Basic features of genetic code, Wobble concept, prokaryotic and eukaryotic ribosomes.
b. Details of translation: Initiation, elongation and termination, factors that control the translation, inhibitors of protein synthesis.
c. Post-translational modifications: Chemical modifications of proteins, proteolytic degradation, Intein splicing and protein folding.
d. Protein sorting and targeting: Signal hypothesis-signal sequences, signal recognition particle and role of molecular chaperones in protein folding and targeting.

Unit – IV

a. Regulation of gene expression: Operon concept, regulatory elements of operon - inducers, apo-repressors and co–repressors, positive and negative regulations, catabolite repression and regulation attenuation.
b. Detailed account of structure, function and regulation of lac operon, trp operon and ara operon.
c. Global regulatory responses: Heat shock response, stringent response, SOS response and Regulation by small molecules such as ppGPP, pppGPP and cAMP.
d. Hormone and Environmental factors affecting gene expression, coordinate regulation of unlinked genes. Regulatory RNA.

Recommended Books

19. Snyder, L. and Champness, W. 1997 Molecular Genetics of Bacteria. ASM press, USA.
Semester – II  
Paper – III  
MBT 203: ADVANCED IMMUNOLOGY

Unit – I  
a. History and scope of Immunology, Haematopoisis, structure and function of cells and organs involved in immune system.  
b. Types of immunity (innate and acquired, active and passive) Immune response (Cell mediated and Humoral response).  
c. Immunohaemotology: Blood groups, blood transfusion, Rh-incompatibility.  
d. Antigens: Antigen types, haptens, epitopes, adjuvants, Antigen specificity.  
Antibodies: Immunoglobulins structures, distribution and function. Theories of antibody production.

Unit – II  
a. Immunological reactions: In vitro methods: Agglutination, Precipitation, Complement fixation, Immunofluoresence, ELISA and RIA.  
b. In vivo methods: Phagocytosis, Opsonization and Neutralization.  
c. Complement components, complement activation pathways (Classical, Alternative and Lectin pathways).  
d. Regulation of complement system, biological consequences of complement, and complement deficiencies.

Unit – III  
a. Transplantation immunology: Structure and functions of MHC (Major histo-compatibility complex).  
b. HLA tissue typing and Organ transplantation (graft versus host reaction and rejection).  
c. Tumor Immunology: Tumor antigens, Host immune response to tumors.  
d. Tumors escape mechanisms, immunodiagnosis of tumors and immuno-therapy of tumors.

Unit – IV  
a. General account of immuno deficiency disorders: Primary and Secondary Immumodeficiency. Phagocytic cell disorder, Autoimmunity and autoimmune disorders.  
d. Types of Vaccines: whole organism vaccines, Recombinant vaccines, DNA vaccines, synthetic peptide vaccines, Subunit vaccines, Immunization procedures.

Recommended Books
2. Coleman, R.M. Lambard , M. F.and Siccard , 1992 Fundamental of Immunology II Ed.  
7. Ross. G.D. Immunology of the complement System  
10. Weir, Hand Book of experimental Immunology Vol,II  
11. Sitter, Terr and Parlow Basic and Clinical Immunology  
15. Hue Davis, 1997 Introductory Immunology Champman and Hall Publisher.  
Semester – II
Paper – IV

MBT 204: BIOPHYSICAL TECHNIQUES & INSTRUMENTATION

Unit – I

b. Osmosis: Osmosis in relation to molecular size and molecular weight, osmometer; Dialysis, Membrane filtration and application.
d. Cell and tissue culture techniques: Primary and secondary/established cell lines, Monolayer & suspension cultures.

Unit – II

a. Centrifugation techniques: Basic principles of centrifugation, standard sedimentation coefficient and measurement of sedimentation coefficient.
b. Analytical and preparative centrifugation, differential, rate zonal and equilibrium density gradient centrifugation. Applications in determination of molecular weight.
c. Chromatography: General principles. Types - partition, adsorption; paper and thin layer chromatography.
d. Column chromatography, HPLC, GLC, Gel filtration, Ion exchange chromatography and Affinity chromatography.

Unit – III

a. Electrophoresis: General principles, Types - moving boundary electrophoresis, paper electrophoresis, cellulose acetate, starch gel electrophoresis, polyacrylamide electrophoresis and agarose gel electrophoresis.
d. Detection and measurement of radioactivity, Geiger-Muller counter, scintillation counter, Autoradiography, tracer techniques, commonly used isotopes in biology, labeling procedures and safety aspects.

Unit – IV

b. Spectroscopy: The two most important tools used in nanotechnology research – Infrared spectroscopy and Raman spectroscopy.
c. Instrumentation: Measuring the absorption and application of UV-visible spectrophotometer, Fluorescence spectroscope.
d. Instrumentation: Measuring the absorption and application of NMR, ESR and Mossbauer spectroscopic method.

Recommended Books

Semester – II
Practical Paper – I

MBP 201: MICROBIAL PHYSIOLOGY & MOLECULAR BIOLOGY

1. Bacteria growth curve
2. Growth of the bacteria at different pH
3. Effect of different temperatures
4. Effect of osmotic pressure
5. Isolation of photosynthetic bacteria from sewage water
6. Estimation & characterization of bacterial chlorophylls
7. Enrichment cultivation of photosynthetic bacteria – Winogradsky column
8. Cultivation of anaerobic bacteria: i) Shake culture technique ii) Pyrogallic acid
   iii) Candle method iv) Liquid paraffin method v) Gaspak jar method
10. Biochemical tests for identification of bacteria: i) Phenylalanine test
    ii) Digestion of casein iii) Digestion of meat iv) Starch hydrolysis
11. Carbohydrate catabolism by microorganisms through oxidation and fermentation of glucose.
12. Enrichment cultures of sulphate reducing bacteria
14. Estimation of lactic acid in fermentation broth.
15. Estimation of DNA by DPA method
16. Estimation of RNA by orcinol method
17. Determination of purity of DNA
18. Isolation of RNA from plant sample
19. Isolation of RNA from viral infected plant sample
20. Isolation of DNA from sheep Liver / yeast/ E.coli
21. Problems on DNA characteristics
22. Problems related to Transcription, Genetic code, Translation and Gene regulation.
1. Major Experiment 25 Marks
   1. Bacteria growth curve
   2. Growth of the bacteria at different pH
   3. Effect of different temperatures
   4. Effect of osmotic pressure
   5. Isolation of photosynthetic bacteria from pond water
   6. Estimation and characterization of bacterial chlorophylls
   7. Estimation of ethanol in fermentation broth.
   8. Estimation of lactic acid in fermentation broth.

2. Major Experiment 25 Marks
   1. Estimation of DNA by DPA method
   2. Estimation of RNA by orcinol method
   3. Determination of purity of DNA
   4. Isolation of RNA from plant sample
   5. Isolation of DNA from sheep Liver / yeast/ E.coli

3. Minor Experiment 10 Marks
      i) Phenylalanine test  ii) Malonate test  iii) Nitrate reduction test
      iv) Digestion of casein  v) Urease test  vi) Digestion of meat
      vii) H₂S production  viii) Starch hydrolysis  ix) Decarboxylase test
   2. Carbohydrate catabolism by micro-organisms through oxidation and fermentation of glucose.
   3. Fermentation of carbohydrates.
   4. Isolation of sulphate reducers.
   5. Isolation of Thiobacillus ferroxidans
   6. Setting of Winogradsky column
   7. Isolation and enumeration of nitrifiers

4 Minor Experiment 10 Marks
   1. Problems on DNA characteristics
   2. Problems related to DNA characteristics, Transcription, Genetic code, Translation and Gene regulation

5. Spotters Identification (4 Nos) 20 Marks
   1. Cultivation of anaerobic bacteria - Shake culture technique
   2. Cultivation of anaerobic bacteria - Pyrogallic acid
   3. Cultivation of anaerobic bacteria - Candle jar method
   4. Cultivation of anaerobic bacteria - Liquid paraffin method
   5. Cultivation of anaerobic bacteria - Gaspak jar method
   6. Photosynthetic bacteria
   7. Phenylalanine test
8. Nitrate reduction test
9. Digestion of casein
10. Digestion of meat
11. H₂S production
12. Starch hydrolysis
13. Decarboxylase test
14. Fermentation of carbohydrates.
15. Winogradsky column
16. Bacteria growth curve
17. Plasmid DNA
18. Denitrification and evolution of N₂
19. ATPase
20. Structure of lac operon
21. Semiconservative model of DNA replication
22. Rolling circle replication
23. Nucleosomes
24. Prokaryotic chromosomes
25. Action of topoisomarases
26. t RNA
27. RNA splicing & spliceosome
28. DNA damages

6. Record

10 Marks
1. Typing of human blood groups.
2. Differential staining of WBC by Leishman stain
3. Enumeration of RBC and WBC
4. Estimation of haemoglobin count in blood
5. Widal tests: i) Slide agglutination ii) Tube agglutination methods
6. VDRL test (Venereal disease research laboratory)
8. HCG test (Agglutination inhibition test)
9. ELISA test.
10. Tridot test
11. Detection of rheumatoid factor
12. Spot test for infections of Mononucleosis
13. RAPITEX CRP Test: i) Qualitative CRP ii) Quantitative CRP
14. Febrile Antigen tube test
15. ASO Test- Anti streptolysin 'O' test
17. Isolation of lymphocytes
18. Rocket immuno electrophoresis
19. Tube flocculation test
20. Determination of $P^k$ value of amino acid
21. Determination of $y_{max}$ of a given solution
22. Separation of Carbohydrates by Paper Chromatography
23. Separation of Amino acids by Paper Chromatography
24. Separation of Lipids by Thin Layer Chromatography
25. Demonstration Column Chromatography
26. Demonstration HPLC and GC
27. Verification of Lambert-Beers Law by UV-VIS Spectrophotometer, scanning
28. Separation of Proteins by Electrophoresis
29. Ultraviolet spectroscopy of Proteins
30. Membrane separation - Dialysis
1. Major Experiment

1. Differential staining of WBC by Leishman stain
2. Enumeration of RBC and WBC
3. Estimation of haemoglobin content in blood
4. HCG test (Agglutination inhibition test)
5. Detection of rheumatoid factor
6. RAPITEX CRP Test: i) Qualitative CRP ii) Quantitative CRP
7. Febrile Antigen tube test
8. ASO Test- Anti streptolysin 'O' test
9. Isolation of lymphocytes
10. Rocket immuno electrophoresis.

2. Major Experiment - (To be conducted on instruments)

1. Determination of $P_k$ value of amino acid
2. Determination of $y_{max}$ of a given solution
3. Separation of carbohydrates by paper chromatography
4. Separation of amino acids by paper chromatography
5. Separation of lipids by thin layer chromatography
6. Separation of proteins by electrophoresis
7. Ultraviolet spectroscopy of proteins

3. Minor Experiment

1. Typing of human blood groups.
2. Widal tests - Slide agglutination
3. Widal tests - Tube agglutination methods
4. VDRL test (Venereal disease research laboratory)
5. Hepatitis-B surface antigen test.
6. ELISA test (Direct and sandwich)
7. Tridot test
8. Spot test for infections of Mononucleosis
9. Immuno diffusion test - Single radial immune-diffusion
10. Immuno diffusion test - Double immuno-diffusion
11. Tube flocculation test

4. Minor Experiment

Comment on principle and applications of two instruments
1. Paper chromatography
2. Thin layer chromatography
3. Column chromatography
4. HPLC
5. GLC
6. Gel filtration
7. Ion exchange chromatography
8. Affinity chromatography.
9. pH meter
10. Spectrophotometer
11. Colorimeter
12. Centrifuge
13. Electrophoretic unit
14. Southern blotting
15. Western blotting
16. Northern blotting

5. Spotters Identification (4 Nos) 20 Marks

1. Immunoelectrophoresis
2. Lymph node
3. Spleen
4. Thymus gland
5. Structure of IgG, IgM, IgA, IgE
6. Monoclonal antibodies
7. Immunotoxins
8. ELISA plate
9. Immuno precipitation
10. Flow cytometry
11. Immunofluorescence
12. RIA
13. Hypersensitive reactions Type-I, II, III, IV
14. Severe combined Immunodeficiency
15. Grave’s disease
16. Autoimmune diseases - SLE
17. Myasthenia gravis disease
18. Graft acceptance rejection in transplantation
19. Tissue typing methods
20. Tumor
21. Recombinant antibodies
22. Animal inoculation
23. Buffers
24. Circular Paper Chromatography
25. Ascending Paper Chromatography
26. Descending Paper Chromatography
27. Thin Layer Chromatography
28. GLC
29. Gel filtration
30. Column Chromatography
31. HPLC
32. Ion exchange chromatography
33. Affinity chromatography.
34. Electrophoretic Unit
35. Agarose vertical gels with bands
36. Agarose horizontal gels with bands
37. pH meter
38. Spectrophotometer
39. Colorimeter
40. Centrifuge
41. Southern blotting
42. Western blotting
43. Photographs and contributions of Nobel laureates in immunology

6. Record 10 Marks
Semester – III
Paper – I

MBT 301: MICROBIAL GENETICS & GENETIC ENGINEERING

Unit – I

a. Genetic recombination in bacteria: Conjugation (including sexduction), Transformation and transduction; Models of homologous recombination - The Holliday model and Double strand break repair model. Site specific recombination.
b. Gene mapping in prokaryotes: Deletion mapping, complementation, intragenic complementation, heteroduplex mapping, DNA footprinting, chromosome walking and jumping.
c. Plasmids: Types and Characteristics of plasmids, F plasmids, R-plasmids, Colicinogenic plasmids, Ti-plasmid and other plasmids, broad host range plasmids.
d. Transposable elements: Types of bacterial transposons, mechanism and types of transposition. Genetic phenomena mediated by transposons, transposons as genetic tools.

Unit – II

a. Mutations: Types of mutagens (physical, chemical and environmental), mutagenesis, types of mutations-Molecular basis of mutations-frame shift mutations, transitions, transversions.
b. Site-directed mutagenesis: Different types of site-directed mutagenesis – Kunkel Method, cassette mutagenesis, PCR based mutagenesis and Plasmid based mutagenesis, applications of site directed mutagenesis.
d. Molecular methods for detection of mutations: Genotyping of Bacteria and Viruses, DNA sequencing, AFLP, RFLP and RAPD methods.

Unit – III

a. Recombinant DNA technology: DNA manipulating enzymes, restriction endonucleases - specificity, sticky ends and blunt ends.
b. Cloning vectors: Plasmids, phasmids, phagemids, cosmids, YAC and BAC vectors and their advantages and disadvantages. Ligation, optimizing ligation conditions- linkers, adapters, homopolymer tailing.
c. Selection of transformants: Insertion inactivation and Blue and white selection. Identification of cloned genes-colony hybridization.
d. DNA libraries: Construction and screening of genomic libraries; isolation of mRNA, cDNA synthesis and cDNA libraries.

Unit – IV

a. Polymerase chain reaction (PCR) technology: Theoretical aspects of PCR- PCR cycle, thermostable DNA polymerases, primers and their importance, optimizing the conditions for PCR, factors limiting PCR efficiency.
b. Different versions of PCR: AP-PCR, Multiplex PCR, Broad range PCR, Inverse PCR, Nested PCR, Real time PCR and their applications; Applications of PCR technology-Forensic, clinical diagnosis, detection of pathogens in food, water; PCR in molecular evolution.
c. Applications of rDNA technology in medicine and industry: Production of heterologous protein products, role of expression vectors, production of insulin, human growth hormone and hepatitis vaccine.
Recommended Books

   General and Molecular Bacteriology, ASM Press, Washington D.C.
5. Glick, B.R. and Pasternak, J.J. 1998 Molecular Biotechnology – Principles and Applications of
   Recombinant DNA, ASM Press, Washington D.C.
9. Winnacker, E.L. 1987 From genes to Clones: Introduction to Gene technology. VCH Publications,
   Federal Republic of Germany.
10. Antony, J.F., Griffiths, Gilbert, W.M., Lewontin, R.C. and Miller, J.H. 2002 Modern genetic analysis,
    Publishers.
    Publishers.
    Gene, 4th edition, Benjamin/Cummings publishing company.
20. Snyder, L. and Champness, W. 1997 Molecular Genetics of Bacteria. ASM Press, USA.
    London.
    Himalaya Publishers Hyderabad
Semester – III
Paper – II

MBT 302: BIOINFORMATICS & COMPUTATIONAL METHODS

Unit – I

a. Bioinformatics: definition, concept, scope, relevance of bioinformatics, development of bioinformatics, applications of bioinformatics. Operating systems (Linux) and programming languages (Perl, CORBA) in bioinformatics.

b. Databases: Gene banks, objectives, types of databases- flat files, relational databases, objective oriented databases, hypertext databases, web interfaces; Resource databases-Generalized (DNA, protein) and specialized databases.

c. Search tools: Data mining, BLAST and FASTA.

d. Sequence analysis of biological data: terminology, methods for alignment- pairwise & multiple sequence alignments, algorithm for alignment of sequencing fragments

Unit – II

a. Phylogenetic analysis: Concept of phylogenetic trees, phylogenetic trees and multiple alignment methods - distance matrix, character based evaluation of methods, evaluation of phylogenies, steps in constructing alignments and phylogenies, working with phylogeny trees-with suitable software-EMBOSS


c. Genomics: Gene mapping, sequence assembly and gene expression, DNA microarrays, microarray design and data analysis.


Unit – III

a. Biostatistics: Definition, scope, applications in biology, terminology, sampling techniques-random and non-random methods.

b. Measures of central tendencies: Mean, mode, median, standard error and standard deviation.


d. Chi Square test: Characteristics of chi-square test, degrees of freedom, test of goodness of fit, null hypothesis.

Unit – IV

a. Analysis of variance (ANOVA): Methods of ANOVA, one way and two way classifications, F-test, steps involved in ANOVA, importance of ANOVA.

b. Correlation: Definition, methods of studying the correlation, types of correlations-scatter diagram, Karl Pearson's efficient of correlation and rank correlation method.

c. Regression: Definition, types of regression analysis, regression equation, methods of studying regression, graphic and algebraic methods, importance of regression.

d. Importance of statistical software in data analysis.

Recommended Books

1. Andreas D. Baxevanis, B.F. Francis Ouellete. 2004 Bioinformatics A practical guide to the analysis of genes and proteins,

2. Attwood, T.K. and D.J Parry-Smith. Introduction to Bioinformatics

3. Bishop, M. J. and C.J. Rawlings Nucleic acid and protein sequence analysis-A practical approach
8. Cynthia and Perk Jambeck Bioinformatics computer skills, Wiley
9. Dan E. Krane, Michaell Raymer. 2003 Fundamental Concepts of bioinformatics,
10. David Mount. 2003 Bioinformatics sequence and genome analysis
Semester – III  
Paper – III  
MBT 303: BIOPROCESS TECHNOLOGY

Unit – I

a. An overview of fermentation technology, range of fermentation processes, primary and secondary metabolites, components of fermentation process.
b. Industrial microorganisms: Isolation, preservation, screening and strain improvement and maintenance.
c. Formulation of industrial media: Medium requirements for fermentation processes, carbon, nitrogen, mineral sources, buffers, antifoam agents, medium optimization.
d. Stoichiometry of cell growth and product formation, Sterilization of media and fermenters, scale up process and starter culture technology

Unit – II

a. Basic design of a microbial fermentor, types of fermentation vessels. aseptic operation, containment,
b. Body construction (stirrer glands, bearing, valves, steam traps) baffles, spargers and impellors.
c. Types of fermentations: batch, continuous, fed-batch, solid state and submerged fermentations.
d. Aerobic and anaerobic, dual and multiple fermentations, their advantages and disadvantages.

Unit – III

a. Importance of downstream processing in industrial fermentation processes. Problems and requirements of bio product recovery and purification.
b. Physico-chemical basis of bio separation processes.
c. Fermentation economics - Market potential, some effects of maintenance legislation on production of antibiotics and recombinant proteins, plant and equipment.
d. Continuous culture, recovery costs, water usage and recycling and effluent treatment.

Unit – IV

A brief outlines of processes for the production of the following commercially important products:

a) Primary metabolites
   i. Organic acids  :  Citric acid, Lactic acid,
   ii. Amino acids  :  Glutamic acid, L-lysine,
   iii. Solvents    :  Acetone, Ethyl alcohol

b) Secondary metabolites
   i. Antibiotics    :  Streptomycin, Penicillin
   ii. Vitamins      :  B_{12}, Riboflavin,
   iii. Biofuels     :  Hydrogen, Methane

Recommended Books

2. Berry, D.R. (Ed) 1998 Physiology of Industrial fungi BSP, Oxford University.
4. Dellweg  Biotechnology Vol III.
5. Demain, A.L  Biology of Industrial Microorganisms
6. Diliello  Methods in Food and Dairy Microbiology
10. Patel, A.H. Industrial microbiology
12. Prescott & Dunn, Industrial microbiology,
13. Prescott & Dunn’s Fundamentals of Applied Microbiology (2nd edition)
15. Reed, G. Industrial Microbiology, CBS Publishers
16. Rose. Microbial enzymes and bioconversions
17. Shuler, M.L., and F. Kargi Bioprocess engineering, Prentice Hall of India
19. Tampion & Tampion Immobilized cells: Principles and Application
20. Walker, G.M. 1998 Yeast physiology and Biotechnology Wiley
Semester – III
Paper – IV

MBT 304: AGRICULTURAL MICROBIOLOGY

Unit – I

a. Natural and man engineered ecosystems - suitability of soil for agriculture, soil chemistry, humus formation, soil fertility, micro/macro nutrients, frequency/density and abundance of soil microbes, biological significance of soil enzymes.
d. Rhizosphere – Nature, extent, influence of root exudates on microflora, plant growth promoting rhizobacteria (PGPR) and siderophore production, nature and ecological significance of ectotrophic and endotrophic mycorrhizal associations, role of microbes in transformation of phosphorus, sulphur and iron.

Unit – II

a. Principles of plant disease resistance, entry and establishment of pathogens in plants, host-parasite interaction, role of enzymes and toxins in pathogenesis.
b. Protection and defense, mechanism of disease resistance (performed and induced defense, local signals), programmed cell death, induced structural barriers, phytoalexins.
c. Biochemical basis of disease resistance – Systemic acquired resistance (SAR), Local acquired resistance (LAR) and Pathogenesis related proteins (PR-proteins) - chitinases and glucanases.
d. Transgenic resistance - Horizontal and vertical resistance, classification and functions of resistance genes, transformation for disease resistance, Bt genes and resistance to insects.

Unit – III

a. Plant disease triangle, disease forecasting, reproduction, inoculum, virulence, dissemination.
b. Symptoms, disease cycle and management of the following plant diseases: Fungal diseases – late blight of potato, downy mildew of grapes, loose smut of wheat, smut of bajra, covered smut of barley, blast disease of paddy, red rot of sugarcane.
c. Bacterial diseases – Bacterial blight of paddy, angular leaf spot of cotton, common scab of potato.
d. Viral diseases – Tobacco mosaic, leaf curl of tomato, yellow vein mosaic of bhindi.

Unit – IV

a. Cultural methods, agronomic practices (crop rotation, field and crop sanitation), chemical control (fungicides, fumigants, inorganic copper/sulphur compounds, dithiocarbomates).
b. Organic agriculture and disease control: Biofertilizers – development and the concept, Rhizobium, Bradyrhizobium, Azotobacter, Azospirillium, Acetobacter, Frankia, algal fertilizers, mass cultivation techniques, quality control of bioferlizers, field performance of biofertilizers, problems and prospects.


**Recommended Books**

1. Agrio, G.N. Plant pathology
2. Alexander, M Soil Microbiology
3. Benjamin Cunnings, Merio pank. California 1987 Microbial ecology, fundamentals an application
4. Bilgrami,K.S. and H.C. Dube Modern Plant pathology
5. Biofertilizedrs by N.S. Subba Rao
6. Lynch J.M.Soil Biotechnology
7. Lynch Poole Microbial ecology : A conceptual approach
8. Mehrotra,R.S. Plant Pathology
10. R.S. Singh An introduction to principles of plant pathology
11. Rangaswami, G. and A. Mahadevan Diseases of crop plants
13. Richard, B.N. An introduction to soil ecosystem
14. Singh,R.S. Plant diseases R
15. Stolop H. Microbial ecology : Organisms, habitats, Activities
16. Subba Rao N. S Advances in Agriculture Microbiology by
17. Subba Rao, N.S. Soil microorganisms and plant growth
19. Vander Plank Plant disease resistance
20. Vidyasekaran Molecular Plant Pathology
Semester – III
Practical Paper – I

MBP 301: MICROBIAL GENETICS & GENETIC ENGINEERING & BIOINFORMATICS & COMPUTATIONAL METHODS

1. Isolation of auxotrophic mutants by Replica plate technique.
2. Mutagenesis and UV survival curve.
3. Isolation of petite mutants.
4. Restriction analysis of DNA and agarose gel electrophoresis.
5. Diauxic growth experiment.
6. Preparation of competent cells.
7. Isolation of Plasmid DNA.
9. Amplification of DNA by PCR.
10. Problems related to: (a) Mutation (b) Recombination (Conjugation, transformation, transduction), (c) Gene mapping (d) Restriction mapping (e) Primer design and PCR amplifications (f) DNA libraries.
11. Aligning sequences using Clustal-X
12. Sequence data retrieval in FASTA format from NCBI database.
13. Similarity search in BLAST for protein or nucleotide sequence.
14. Prediction of secondary structure of protein
15. Viewing the Protein Data Box (PDB) files using Rasmol software.
16. Conversion of raw sequences into different sequence format by using Read Seq Tool.
17. Calculation of data using mean, mode, medium, standard deviation and standard error.
18. Problems related to Chi-square test.
20. ANOVA- one way classified data- two way classified data.
22. Problems related to Correlation coefficient (Karl Pearson and Rank Correlation Coefficient).
23. Problems related to Regression coefficient.
1. Major Experiment  
   1. Isolation of auxotrophic mutants by replica plate technique.  
   2. Mutagenesis and plotting of U.V survival curve  
   3. Isolation of petite mutants of Yeast  
   4. Restriction digestion of DNA and analysis of fragments by electrophoresis  
   5. Preparation of competent cells  
   6. Transformation – selection of recombinants – Blue and white selection (X-gal method)  
   7. Amplification of DNA fragments by PCR and visualisation of amplicons  

2. Major Experiment  
   1. Aligning sequences using Clustal-X  
   2. Sequence data retrieval in FASTA format from NCBI database  
   3. Similarity search in BLAST for protein or nucleotide sequence  
   4. Prediction of secondary structure of protein  
   5. ANOVA-one way and two-way classified data.  
   6. Problems related to Correlation (Karl Pearson and Rank Correlation methods).  

3. Minor Experiment  
   Problems related to  
   I. Mutation studies  
   II. Recombination (Conjugation, transformation and transduction)  
   III. Gene mapping  
   IV. Restriction digestion  
   V. Primer design and PCR amplifications  
   VI. DNA libraries  

4. Minor Experiment  
   1. Computation of mean, mode, median, standard deviation and standard errors.  
   2. Problems related to theorems of probability  
   3. Problems related to Chi-square test.  
   4. Problems related to Correlation Coefficient (Karl Pearson and Rank Correlation methods).  
   5. Problems related to Regression Coefficient.  

5. Spotters Identification (4 Nos)  
   1. Restriction digestion-sticky ends and blunt ends.  
   2. RNA polymerase activity  
   3. pBR 322  
   4. pUC 18  
   5. Ti plasmid
6. Replica plating
7. DNA ladders
8. PCR unit
9. Electrophoresis unit
10. Gene gun
11. Identification of recombinants (Blue and white colonies)
12. Ames test
13. Transgenic plants (Tobacco luciferase)
14. Transgenic animals (Dolly)
15. Protocols for cDNA and genomic libraries
16. Carcinogenic chemicals
17. Colon cancer
18. Retinoblastoma cancer
19. Recombination-Holliday model
20. Transposons (T5, T10)
21. DNA damage-molecular models
22. Gene therapy—*in vivo, ex vivo* models

6. Record

10 Marks
1. The use of Logarithms in Microbial growth study, in fermentation process.
2. Determination of the midpoint of the Logarithmic phase of microbial growth in fermentation process.
3. Harvesting the microbial cells and determination of the yield of Fermentation products.
4. Manometric study in Fermentation process.
5. Isolation and identification of secondary metabolites in the fermentation process.
6. Design and construction of microbial fermentor.
7. Screening of microorganisms through war cup method in strain improvement.
14. Solubilization of rock phosphate by microorganisms
15. Estimation of organic matter in agricultural soils to assess the soil fertility
16. Estimation of cell wall degrading enzymes: cellulases (exo-and endo glucanases), polymethyl esterase, poly galacturunase, pectic lyase in hostpathogen interactions
18. Isolation and identification of cyanobacteria used as biofertilizers- Nostoc, Anabaena, Scytonema
19. Isolation of Rhizobium from root nodules
20. Classification and symptomology of plant diseases covered in theory (unit III)
21. Determination of Disease Tolerance Index (DTI) in crop plants
22. Biochemical changes in healthy and diseased crop plants: carbohydrates, proteins, amino acids, chlorophyll
23. Quantification of phytoalexins in healthy and diseased crop plants
24. Analysis of PR proteins in healthy and diseased plants through electrophoresis
25. Enumeration of Rhizosphere microflora and comparision with normal soil microflora
26. Enumeration of ammonifiers, nitrifiers and denitrifiers in soil samples
27. Assay of fungicides by humid chamber technique and calculation of LD50 value
28. Section cutting of infected plant parts.
FACULTY OF SCIENCE
M.Sc. MICROBIOLOGY
Practical Examination

MBP 302: BIOPROCESS TECHNOLOGY & AGRICULTURAL MICROBIOLOGY

Semester - III Question Bank Paper - II

Time: 4 Hrs Max. Marks: 100

1. Major Experiment  25 Marks

1. Estimation of Streptomycin.
2. Estimation of Lactic acid.
4. Estimation of Penicillin.
5. Estimation of Indole Acetic Acid (IAA).
6. Solubilization of rock phosphate by micro organisms

2. Major Experiment  25 Marks

1. Estimation of cell wall degrading enzymes (in vivo & in vitro) involved in pathogenesis
   a) cellulases (exo-and endo gluconases),
   b) polymethyl esterase,
   c) poly galacturonase,
   d) pectic lyase
2. Determination of Disease Tolerance Index (DTI) in crop plants
3. Biochemical changes in healthy and diseased crop plants: carbohydrates, proteins, amino acids, chlorophyll
4. Quantification of phytoalexins in healthy and diseased crop plants
5. Analysis of PR proteins in healthy and diseased plants through electrophoresis
6. Enumeration of rhizosphere microflora and comparison with normal soil microflora
7. Assay of fungicides by humid chamber technique and calculation of LD50 value
8. Section cutting of infected plant materials.

3. Minor Experiment  10 Marks

1. The use of logarithms in microbial growth study, in fermentation process.
2. Determination of the midpoint of the Logarithmic phase of microbial growth in fermentation process.
3. Harvesting the microbial cells and determination of the yield of fermentation products.
4. Monometric study in fermentation process.
5. Isolation and identification of secondary metabolites in the fermentation process.
6. Design and construction of microbial fermentor.
7. Screening of microorganisms through war cup method for strain improvement.

4. Minor Experiment  10 Marks

1. Solubilization of rock phosphate by microorganisms
2. Estimation or organic matter in agricultural soils to asses the sol fertility
3. Estimation of accumulated soil enzymes : catalase / peroxidase, phosphatase, urease,
4. Isolation and identification of cyanobacteria used as biofertilizers- Nostoc, Anabaena, Scytonema
5. Isolation of Rhizobium from root nodules
6. Classification and symptomology of plant diseases covered in theory (unit III)
7. Enumeration of ammonifiers, nitrifiers and denitrifiers in soil samples by MPN method.
8. Identification of Rhizobium, Azotobacter and Azospirillium cultures.
9. Identification of phyllosphere and rhizosphere microorganisms.

5. Spotters Identification (4 Nos)  

1. Design of fermenter
2. Seed Flask
3. Seed fermenter
4. Production fermenter
5. Air sparger
6. Foam breaker
7. Stirrer gland
8. Baffles
9. impellers
10. Bread
11. Monometric fermenter
12. Strain improvement
13. Immobilized beads
14. Downy mildew of peas
15. Downy mildew of bajra
16. White rust of crucifers
17. Powdery mildew of cucurbits
18. Rust of beans
19. Rust of pea
20. Rust of ground nut
21. Whip smut of sugarcane
22. Wilt of pigeon pea
23. Wilt of cotton
24. Root rot of cotton
25. Stem rot of rice
26. Brown spot diseases of rice
27. Blast diseases of rice
28. Bacterial blight of paddy
29. Citrus canker
30. Angular leaf spot of cotton
31. Stalic rot of maize
32. Sesamum phylloidy
33. Tobacco mosaic virus
34. Yellow vein mosaic of bhendi
35. Nostoc
36. Anabaena
37. Scytonema
38. Rhizobium
39. Ammonifiers,
40. Nitrifiers
41. Denitrifiers

6. Record  

10 Marks
Unit – I: Microbial Diversity

a. Introduction to microbial diversity, types of micro-organisms - bacteria, archebacteria, eucarya, interaction between microorganisms, microbial succession.

b. Extremophiles – Habitat, effect of extreme conditions on cellular components, membrane structure, nucleic acids and proteins, adaptation mechanisms in microorganisms in diverse environments.

c. Study of thermophiles, psychrophiles, halophiles, piezophiles, acidophiles, alkaloiphiles, xerophiles, radiation resistant organisms, methanogens.

d. Biotechnological applications of extreme proteins from above groups, Geomicrobiology – biofouling, biocorrosion.

Unit – II: Soil Microbiology


b. Decomposition of organic matter – litter chemistry, carbon assimilation and immobilization, dynamics of organic matter, accumulated soil enzymes and their role in soil development.

c. Bioremediation of polluted soils – Microbes in polluted soils, strategies of their survival, mechanisms of the degradation of pesticides, biohydrometallurgy using recombinant microbes for recovery of precious metals.

d. Microbial leaching and biomining (copper and uranium) – dump, heap and agitated leaching, chemistry and microbiology of bioleaching, biomining (ex situ and in situ – hole to hole leaching), plasmids and genes in biomining.

Unit – III: Water Microbiology

a. Principles and concept of water microbiology: Global water reserves, physical/chemical/biological/microbiological characteristics of water, water consumption cycle, biomonitoring of the aquatic environment, pollution indices, eutrophication.

b. Waste water treatment through aerobic microorganisms – Biological filters, aeration tanks, activated sludge, biological ponds, irrigation fields.

c. Waste water treatment through anaerobic microorganisms – septic tanks, imhoff’s tank, upflow anaerobic sludge blanket (UASB), anaerobic filters, anaerobic attachment film expanded bed (AAFEB), anaerobic rotating biological contractor.

d. Pollution control biotechnology: Commercial blends of microorganisms and enzymes, immobilized cells and enzymes, biotechnological approaches for recovery of useful products from sewage and industrial wastes (methane).

Unit – IV: Microbiology of Air

a. Historical introduction: Nomenclature of atmospheric layers, microbes as source and sink of atmospheric pollutants, pollutant transformation by microbes, air borne microbes and their reservoirs, bioaerosols.

b. Air sampling techniques: Slit samples, cascade impactor, hirst trap, anderson’s air sampler, vertical cylinder trap, burkard trap. The impingers – proton impinger and pre-impinger.
c. Air quality in Indian cities: Mapping of the hot spots, air quality monitoring and measurement, impact of air-borne microorganisms on living beings, fungal allergy, immediate/delayed type of hypersensitivity, atopic allergy.

d. Air sanitation: Control of air borne pathogens, irradiation, chemical disinfection, dust control. Biotechnological methods for the abatement of environmental bio-pollution.

**Recommended Books**

1. Alexander M. Soil Microbiology
2. Anil Prakash (Ed.) Fungi in Biotechnology
3. Atlas & Batra Microbial Ecology
4. Benjamin Cunnings Microbial Ecology
5. Burns R.G & J.H.Slater Experimental Microbial Ecology -
6. Gabriel Bitton Wastewater Microbiology
7. Gilbert S. Omen Environmental Biotechnology
9. Gregory P.H. The Microbiology of Atmosphere
11. Lynch J.M The Rhizosphere
12. Lynch J.M and N.J. Poole Microbial Ecology: A conceptual approach
13. Michael S.Switzenbaury(Ed) Anaerobic Treatment of Sewage
14. Mishra R.R Soil Microbiology
15. Odum E.P. Fundamentals of Ecology
16. Omenn G.S. & M. Alexander Genetic control of Environmental Pollutants
17. Ralph Mitchell Environmental Microbiology
18. Ratledge C. Biochemistry of Microbial degradation
19. Spani J.C. Biodeterioration of non-aromatic compounds
20. Subba Rao N.S. Soil Microbiology
21. Thomas D. Brook Thermophiles
22. Tilak S.T Environmental Biopollution
23. Williams G.C Biofilms
Semester – IV
Paper – II
MBT 402: MEDICAL MICROBIOLOGY

Unit – I

b. Diagnosis of infectious diseases: Types of specimens, specimen collection, transport and processing of material, culture isolation and identification for microbiological diagnosis.
c. Immunodiagnosis: Immunological assays, Serological tests and Immunoblotting.
d. Molecular diagnosis: Nucleic acid hybridization techniques, PCR, Transcription Mediated Amplification (TMA), Nucleic acid Sequence Based Amplification (NASBA), Ligase chain reaction.

Unit – II

Morphology, cultural characteristics, antigenic structure, pathogenicity, clinical symptoms, laboratory diagnosis, prevention-control and treatment of diseases caused by the following organisms

a. Air borne infections: Streptococci, Corynebacterium diphtheria, M. tuberculosis and N. meningitis
b. Water born infections: E. coli, Salmonella, Shigella
c. Wound infections: Clostridium tetani, Staphylococci, Pseudomonas.
d. Sexually transmitted diseases: Treponema, Neisseria gonorrhea, LGV agent, Chlamydiae, and Haemophilus ducreyi.

Unit – III

Study of etiology, cultivation, antigenic structure, pathogenesis, laboratory diagnosis, prevention and treatment of

a. Airborne infections: Influenza virus, Rhinovirus, Adenovirus, Mumps, Measles.
b. Zoonotic viral infections: Rabies virus, Japanese encephalitis
c. Water born, contact and sexually transmitted diseases: HAV, HBV, Enterovirus, HSV and HIV.
d. Mode of action of antimicrobial drugs on cell wall, nucleic acids, protein synthesis, enzyme inhibitors, cell membrane disruptors, anti-metabolites, Drug resistance and side effects.

Unit – IV

a. Study of etiology, pathogenesis, epidemiology and prevention of Amoebiasis, Malaria, Ascarisasis, Ancylostomiasis and Filariasis.
b. Study of etiology, pathogenesis, epidemiology and prevention of Dermatophytosis (Microsporum, Trichophyton and Epidermophyton) and sub-cutaneous (Sporothrix, Mycetoma).
c. Endemic mycosis: Coccidiomycosis, Histoplasmosis.
d. Opportunistic mycosis: Candidiasis, Cryptococcosis, Aspergillosis.

Recommended Books

1. Arnold, 1998 Medical Microbiology, Volume 4
2. Bernard, Davia, Dulbecco Microbiology (4th edition)
4. Brooks, G.F., J.S. Butel and S.A. Morse, Mc Graw – Hill Medical Microbiology
10. Cruickshank Medical Microbiology Vol. I and II
11. DH et al (ed.) American Society for Microbiology, 1993 Diagnostic Molecular Microbiology,
13. Jawetz, Melnick & Adebery Reviews of Medical Microbiology
15. Jhon Bernard Clinical diagnosis and management – Laboratory methods
16. Joklik, Wille, Amos & Wilfert Zinser Microbiology
17. Longman, 2000 Test Book of Microbiology
20. Mosby Bailey and Scott’s Diagnostic microbiology
23. Reppon JW, Philadelphia: WB Saunders, 1988 Medical Mycology,
24. Richmann, DD et al Churchill Livingstone, 1997 Clinical virology,
28. Medical Microbiology by Sherries
Semester – IV
Paper – III

MBT 403: MICROBIAL TECHNOLOGY

Unit – I
a. Microbes important in food microbiology: yeasts, filamentous fungi and bacteria contamination of foods.
b. Factors influencing food spoilage (intrinsic and extrinsic)
c. Food poisoning and food borne infections (bacterial, viral, fungal and protozoa), bacterial and fungal toxins.
d. Detection of microbial contamination of foods: Direct microscopic count (DMC), standard plate count, MPN method, reductase tests, membrane filters and molecular methods

Unit – II
a. Contamination and spoilage of cereals, cereal products, fruits, vegetables, meats, meat products, fish, sea foods, eggs, poultry and canned foods.
b. General principles of food preservation- Physical and Chemical methods.
d. Microbial food fermentation: Fermentation in food processing, role of microorganisms in food fermentation. Microbial products of food; SCP, mushrooms, oriental foods, fermented beverages (fruit and cereal based) and fermented meat and meat products.

Unit – III
a. Yeasts fermentation and yeast products: Production of active dry baker’s yeast, instant yeast, quality of baker’s yeast, production of brewer’s yeast, wine yeast food and fodders yeast.
b. Industrial production of enzymes: cellulases, amylases, proteases, phytases, pectinases, lipases and glucose isomerases. Immobilization of enzymes and cells and their applications.
c. Scope, utility and methodology of biotransformation, biotransformation of antibiotics, steroids and non – steroids.
d. Probiotics and Synbiotics. Food sanitation, food control agencies and their regulations.

Unit – IV
Industrial production of
   i) Biopesticides – Bacterial, viral and fungal
   ii) Biofertilizers – Nitrogen fixers, PSM, mycorrhizae
   iii) Biopolymers – Extracellular polymers, xanthans, dextrans, poly β hydroxyl alkanates
   iv) Biosurfactants - Classification, production and application
   v) Vaccines – Bacterial and viral vaccines.

Recommended Books
2. Banwart, G.S. 1989 Basic Food Microbiology
4. Diliello Methods in Food and Dairy Microbiology
Unit – I: Nanotechnology - Concepts and Techniques

a. Basic definition – origin – fundamental concepts- longer to smaller(a material perspective); simple to complex (a molecular perspective)

b. Chemical precipitation and co-precipitation; Metal nano crystals by reduction, Sol gel synthesis- Micro emulsions or reverse micelles, micelle formation- Chemical Reduction-Emulsions, and dendrimers - Solvothermal synthesis- Thermolysis routes, Microwave heating synthesis- Sonochemical synthesis- Electrochemical synthesis- Photochemical synthesis.

c. Characteriazation of nanoparticles – UV-VIS, SEM, FTIR, NMR, XRD, Passive nanostructures, active nanostructures.


Unit – II: Nanotechnology – Applications

a. Environmental treatments: Air disinfection, water disinfection, groundwater and biological waste water disinfection, surface disinfection, Bioremediation. Nano membranes, nano filters, Environment sensing. Emerging opportunities for microbial control and integrated urban water management


c. Agriculture and food technology: Nanotechnology in Agriculture - Precision farming, Smart delivery system – Insecticides using nanotechnology – Potential of nano-fertilizers – Nanotechnology in Food industry - Packaging, Food processing - Food safety and biosecurity – Contaminant detection – Smart packaging.


Unit – III

a. The concept of intellectual property- The history and evolution of patents, the effect of intellectual property protection on economic and technological development- industrial property rights and development.

b. Patents: copy right and neighboring rights, patents for invention, utility models, industrial designs, trademarks, trade names and geographical relations, unfair competitions.

c. Forms of intellectual property protection, conditions for patentability: patentable subject matter, industrial applicability, novelty, inventive step, disclosure of the invention.

d. Drafting and filing a patent application, infringement, copyright and development, exploitation of patented invention. International treaties and conventions with special reference to biodiversity; Indian patent laws.

Unit – IV

a. Genetically engineered microorganisms and their products: release of genetically engineered microorganisms and their products and their impact on the environment (food, water, air) and
human health, hazard identification and risk management, field tests for genetically modified microorganisms.
b. Concept of biosafety, biosafety levels, biocontainment, good microbiological practices, biosafety guidelines.
d. Requirements and procedures for recombinant DNA: Registration, review and approval of rDNA research; general approval procedure for rDNA products and genetically modified microorganisms.

**Recommended Books**

1. Alexander I. Poltorak and Paul J. Lerner *Essentials of Intellectual Property*
4. Chawla A *Copyright and Related Rights*
5. Christopher May, Susan K. Sell *Intellectual Property Rights*
7. Virginia Baldwin *Patent and Trademark Information: Uses and Perspectives*
8. Indian Patent Law: Legal and Business Implications
9. Ajit Parulekar, Sarita D'Souza *Bioethics and Biosafety in Biotechnology* V Sree Krishna
10. WHO Laboratory manual 3rd edition 2004. *Laboratory Biosafety and Biosecurity Guidance*
11. CDC/NIH *Biosafety in Microbiological and Biomedical Laboratories* 5th edition, 2007
12. Gilbert P R *Biotechnology Ethics Risks and Code of Conduct*
13. Ashok Kumar *Agricultural Biotechnology*
14. Mark Kortepeter *Biohazard 9-1-1*
15. Young, Tomme *Genetically Modified Organisms: A Guide to Biosafety* Tzotzos, George
16. Sue Carson, Dominique Robertson *Manipulation and Expression of Recombinant DNA, 2nd Edition*
Semester – IV
Practical paper – I

MBP 401: ENVIRONMENTAL MICROBIOLOGY AND MEDICAL MICROBIOLOGY & MICROBIAL TECHNOLOGY & NANOTECHNOLOGY AND REGULATION OF MICROBIAL PRODUCTS

1. Determination of Biochemical Oxygen Demand (BOD) of sewage water
2. Determination of Chemical Oxygen Demand (COD) of industrial waste water
4. Estimation of Gross primary productivity (GPP), Net primary Productivity (NPP), and Respiratory Consumption (RC) to determine the autotrophic/heterotrophic status of aquatic bodies.
6. Air sampling by Petri plate method/gravity slide method/tilak air sampler.
7. Identification of pathogenic bacteria by Microscopy and biochemical tests.
8. Bacteriological examination of urine, blood, pus, sputum, stools etc. from patients for diagnosis.
9. Examination of pathogenic fungi.
10. Examination of stools for helminthes & Amoeba.
13. Production and assay of $\beta$ - amylase.
15. Production and assay of lipase.
17. Detection of microbial contamination in milk through direct microscopic count (DMC).
19. Preparation of immobilized cells.
21. SEM studies of nanoparticles.
22. Fill up an application form for the submission to patent office on a new given invention.
23. Awareness and knowledge of Indian patent laws.
24. Drafting and filing a patent application.
25. Hazard identification and risk management of GEMS and risk management.
1. Major Experiment 25 Marks

1. Determination of Biochemical Oxygen Demand (BOD) of sewage water
2. Determination of Chemical Oxygen Demand (COD) of industrial waste water
4. Estimation of Gross primary productivity (GPP), Net primary Productivity (NPP), and Respiratory Consumption (RC) to determine the autotrophic/heterotrophic status of aquatic bodies
5. Bacteriological examination of urine, blood, pus, sputum, stools etc. from patients for diagnosis.
6. Examination of stools for helminthes & Amoeba.

2. Major Experiment 25 Marks

1. Wine production.
5. Production and assay of asparaginase.

3. Minor Experiment 10 Marks

2. Air sampling by Petri plate method/gravity slide method/tilak air sampler.
3. Identification of pathogenic bacteria by Microscopy and biochemical tests.
4. Examination of pathogenic fungi.
5. Isolation, observation and identification of normal microbial flora of human body.
6. Fill up an application form for the submission to patent office on a new given invention.

4. Minor Experiment 10 Marks

1. Detection of microbial contamination in milk through direct microscopic count (DMC).
2. Isolation and identification of yeast and formulation of Baker's yeast.
3. Preparation of immobilized cells.
5. SEM studies of nanoparticles.
6. Awareness and knowledge of Indian patent laws.
7. Drafting and filing a patent application.
8. Hazard identification and risk management of GEMS and risk management.
5. Spotters Identification (4 Nos)  

1. Multiple tube fermenter  
2. Winogradsky column  
3. Aeroflora agar plate  
4. Dye effluent treatment  
5. Decomposed litter Humus  
6. Bioleaching rayon pulp  
7. Desulphurised coal (Clean coal)  
8. Drug sensitivity  
9. Mumps  
10. HSV infection  
11. Syphilis infection  
12. Measles  
13. Ring worm  
14. *Microsporum*  
15. *Madurella mycetomatis*  
16. *Histoplasma capsulatum*  
17. *Cryptococcus neoformans*  
18. *Plasmodium*  
19. Infected food  
20. Infected vegetables  
21. Infected fruits  
22. Aflatoxin  
23. Mushroom spawn  
24. Croping (Casing)  
25. Biopesticides  
26. Bakers Yeast  
27. Foods: Fermented Beverages  
28. Cheese  
29. Idly  
30. Curd  
31. Aspergillus  
32. Penicillium  
33. Fusarium  
34. Yeast  
35. Alternaria  
36. Trichoderma powder  
37. Antagonism microorganisms  
38. Immobilized cell

6. Record  

10 Marks
Unit – I

- Agriculture – definition, procedure, economically important plants, microbes in soil development, contribution of microorganisms in soil fertility.
- Biofertilizers – groups of biofertilizers, development and advantages, nitrogen fixation, legume root nodules, *Rhizobium*, methods of application of *rhizobium* to seeds, mycorrhizae and *Azolla*, multiplication techniques, field applications.

Unit – II

- Plant diseases and crop loss – Paddy blast, wheat rust, tikka disease, whip smut of sugar cane, citrus canker, bean mosaic.
- Plant disease control – Cultural methods, agronomic practices (crop rotation, field and crop sanitation), chemical control (fungicides, fumigants, copper and sulphur compounds), biological control (biopesticides – *Bacillus thuringiensis* (*Bt*), *Trichoderma*, *Beauveria*).
- Organic agriculture – Concepts and procedures, advantages and disadvantages.

Unit – III

- Waste water treatment – aerobic (oxidation ponds, trickling filters), anaerobic (septic tanks, anaerobic attachment beds)
- Treatment and disinfection of potable water (*Uv*-radiation, ultra sound, chlorination, ozonation).

Unit – IV

- Environment and Bioenergy (biofuels) – Energy production and consumption, renewable and non-renewable energy resources, energy planning and conservation strategies, agro-wastes and house hold garbage (wet and dry) as bioenergy source.
- Bioethanol – production, bioethanol vs. food crisis, bioethanol vs. climate change.
- Methane – production and applications- methane vs. green house effect.
- Hydrogen – production from biomass, hydrogen to reverse global warming.
KAKATIYA UNIVERSITY
Department of Microbiology
Paper 2: Medical and Food & Nutrition Microbiology
(CBCS Paper)

Unit – I

A. Study of bacterial infection transmitted by
   - Airborne: *Mycobacterium tuberculosis*, *Streptococcal* infections
   - Waterborne: *Escherichia coli*, *Salmonella typhi*, *Vibrio cholera*
   - Wound infections: *Clostridium tetani*, *Staphylococcus aureus*

B. Study of viral diseases transmitted by
   - Airborne: Measles, Mumps, Influenza
   - Waterborne: Hepatitis (HAV) virus, Poliomyelitis
   - Zoonotic diseases: Rabies
   - Sexually transmitted diseases: HIV (Human Immunodeficiency Virus)

Unit – II

A. Study of pathogenesis, epidemiology and prevention of Protozoan infections:
   (1) Malaria, (2) Amoebiasis and (3) Leishmaniasis

B. Study of pathogenesis, epidemiology and prevention of Helminth parasites:
   (1) Ascariasis, (2) Anchylostomiasis and (3) Filariasis

Unit – III


Unit – IV

A. Microbes important in food microbiology, contamination of foods. Detection of microbial contamination of foods, food borne infections, food spoilage, food poisoning and fungal toxins. General principles of food preservation.

FACULTY OF SCIENCE
M. Sc. MICROBIOLOGY
Model Question Papers (Theory)


Time: 3 Hrs  Max. Marks: 80

Answer ALL questions. All questions carry equal marks.

1. **Writ short notes on:**  (ONE question is to be set from each unit)
   Each question carries 4 marks \(4 \times 4 = 16\)
   a) Question from Unit I
   b) Question from Unit II
   c) Question from Unit III
   d) Question from Unit IV
   (TWO questions are to be set from each unit)
   Each question carries 16 marks \(4 \times 16 = 64\)

2. **From Unit I**
   a)  
   b)  
   Or
   3. **From Unit II**
   a)  
   b)  
   Or
   4. **From Unit III**
   a)  
   b)  
   Or
   5. **From Unit IV**
   a)  
   b)  
   Or
FACULTY OF SCIENCE
M.Sc. MICROBIOLOGY

Practical Examination

Scheme of Question Paper (Practical)
Semester – I / II / III / IV Paper - I, II, III, IV.

Time: 4 Hrs Max. Marks: 100

1. Major Experiment 25 Marks
   a) Principle & procedure-8
   b) Conducting experiment-12
   c) Interpretation of results & conclusions-5

2. Major Experiment 25 Marks
   a) Principle & procedure-8
   b) Conducting experiment-12
   c) Interpretation of results & conclusions-5

3. Minor Experiment 10 Marks
   a) Principle & procedure-3
   b) Conducting the experiment-5
   c) Interpretation of results & conclusions-2

4. Minor Experiment 10 Marks

5. Spotting (4 Nos) (4x5=20) 20 Marks
   a) Identification-2
   b) Critical notes-3

6. Record 10 Marks
<table>
<thead>
<tr>
<th>Day</th>
<th>Semester</th>
<th>Theory</th>
<th>1:00 – 2: 00 PM</th>
<th>Practicals</th>
</tr>
</thead>
<tbody>
<tr>
<td>MON</td>
<td>Sem I/II</td>
<td></td>
<td></td>
<td>L</td>
</tr>
<tr>
<td></td>
<td>Sem III/IV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TUE</td>
<td>Sem I/II</td>
<td></td>
<td></td>
<td>U</td>
</tr>
<tr>
<td></td>
<td>Sem III/IV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WED</td>
<td>Sem I/II</td>
<td></td>
<td></td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>Sem III/IV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>THU</td>
<td>Sem I/II</td>
<td></td>
<td></td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Sem III/IV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FRI</td>
<td>Sem I/II</td>
<td></td>
<td></td>
<td>H</td>
</tr>
<tr>
<td></td>
<td>Sem III/IV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAT</td>
<td>Sem I/II</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sem III/IV</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>