



**SAVITRIBAI PHULE PUNE UNIVERSITY**

(Formerly University of Pune)

# Four Year B.Sc. Degree Program in **MICROBIOLOGY**

(Faculty of Science and Technology)

**Choice-Based Credit System Syllabus (2024 Pattern)**

As Per **NEP 2020**

**Third Year B.Sc. – Semester V & VI**

To be Implemented from Academic Year 2026–2027



*Prepared by:*

Board of Studies in Microbiology, SPPU

*Recommended by:*

Faculty of Science and Technology

*Approved by:*

Academic Council, SPPU

(For Colleges Affiliated to  
Savitribai Phule Pune University, Pune)

**Prof. Dr. Sunil T. Pawar**

Chairman, Board of Studies in Microbiology  
SPPU Pune



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## 1.Preamble & Introduction

### 1a.Preamble

Microbiology is a wide-ranging discipline of biology covering five major groups of microorganisms: bacteria, protozoa, algae, fungi, and viruses. This subject systematically studies the interactions of these microorganisms with their surroundings and focuses on how their potential can be harnessed to improve human life, impacting society and civilization. Being a branch of biology, microbes are used as study models in both conventional and modern areas of biology.

Microbiology has a great legacy of active research in pure and applied science since its establishment as a separate subject. Though microorganisms were discovered over five hundred years ago, there remain vast opportunities to explore their diversity. In the changing scenario of the world and environment, systematic knowledge of microbiology has become quintessential and crucial, with continuous demand for skilled and knowledgeable persons in education, research, and industry.

### 1b.Introduction

In the post-globalization world, higher education has to play a significant role in the creation of skilled human resources for the well-being of humanity and the environment. The barriers among the academic fields seem to have dissolved. However, disparities in the field of curriculum aspect, evaluation and mobility exist. With the changing situations at local and global levels, the syllabus restructuring should keep pace with developments in the education sector. National Education Policy (NEP) is being adopted and implemented to address the issues related to the traditional system and it also aims to maintain the best of the earlier curriculum. The student is at the center of NEP-2020. The present curriculum focuses on students' needs, skill development, interdisciplinary approach to learning and enhancing employability. Microbiology curricula are offered at two levels viz. undergraduate and postgraduate. The undergraduate curricula are prepared to impart basic knowledge of the respective subject from all possible angles. In addition, students are to be trained to apply this knowledge in day-to-day applications and to get a glimpse of research.

## 2. B.Sc. Microbiology Program Objectives

- To enrich students' knowledge and train them in the pure microbial sciences.
- To introduce the concepts of application and research in Microbiology.
- To inculcate a sense of scientific responsibility and social and environmental awareness.
- To help students build a progressive and successful career.

## 3. Eligibility Criteria for Admission – First Year B.Sc.

(a) Higher Secondary School Certificate (10+2) or equivalent with English and Biology, plus two science subjects such as Physics, Chemistry, Mathematics, Geography, or Geology.

OR

(b) Three-Year Diploma in Pharmacy (Board of Technical Education, Maharashtra) or equivalent.

OR

(c) HSC (10+2) with English and MCVC vocational subject – Medical Laboratory Technician (Subject Code P1/P2/P3).

## 4. Fee Structure

Admissions are as per selection procedures/policies of respective colleges in accordance with Savitribai Phule Pune University conditions. Reservation and relaxation as per Government rules.

## 5. Medium of Instruction: English.

## 6. Program Duration and Exit Options

The UG Program lasts for four years or six semesters. Student may leave the program after the third year if, he/she would like to receive a three- year undergraduate degree. If the student decides to withdraw after the first or second year, he/she will receive a UG Certificate or UG Diploma, depending on how many credits he/she is able to complete. Re-entering within three years to finish the degree program is allowed for students who leave with a UG certificate or UG diploma. A student must earn a minimum of 18 credits and a maximum of 26 credits each semester. It is recommended, nevertheless, that student should opt 22 credits per semester. This clause aims to give student the comfort of a flexible semester-based course load. However, Table 1 lists the minimum number of credits required to be earned in order to be awarded an Undergraduate Certificate/Undergraduate Diploma/Bachelor Degree/Bachelor's Degree.

**7. Duration of the Course**

- a) Certificate Course- 01 year (Completion of 02 Semesters)
- b) Diploma Course- 02 years (Completion of 04 Semesters)
- c) BSc Degree- 03 years (Completion of 06 Semesters)

**8. No. of semesters – Two semesters per year****9. Type of Awards and Stages of Exit**

| Sr. No. | Type of Award                                                                                                                                | Stage of Exit                                        | Mandatory Credits |
|---------|----------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|-------------------|
| 1.      | Undergraduate certificate in Major core course subject (Botany/Physics/Chemistry/Zoology /Microbiology.. Subject) with Restructuring courses | After successful completion of First year Semesters  | 44                |
| 2.      | Undergraduate Diploma in Botany/ Physics/Chemistry/Zoology/Microbiology... Subject with Restructuring courses                                | After successful completion of Second year Semesters | 88                |
| 3.      | Bachelor of Science in Botany/Physics/Chemistry/Zoology/Microbiology... Subject with Restructuring courses                                   | After successful completion of Third year Semesters  | 132               |

**10. Program Structure — B.Sc. (3-Year UG Program)-Third Year****B.Sc. Third Year Program Structure**

| Characteristic | Major Core | Major Elective | VSC    | Field Project | OJT    | Minor | Other                     | Total Credits |
|----------------|------------|----------------|--------|---------------|--------|-------|---------------------------|---------------|
| Semester V     | 8(T)+4(P)  | 2(T)+2(P)      | 2(T/P) | 2 (FP)        | -      | 2(T)  | -                         | 22            |
| Semester VI    | 8(T)+4(P)  | 2(T)+2(P)      | 2(T/P) | -             | 4(OJT) | -     | -                         | 22            |
| Total 3 Years  | 44         | 8              | 8      | 10            | 18     | -     | 8 · 8 · 6 · 4 · 8 · 4 · 6 | 132           |

**Exit Option:** Award of UG *degree* in Major with **132 credits** OR Continue with Major and Minor.

**11. Course Implementation criteria for Theory and Practical:**

- a. Each semester comprises of 15 weeks (12 weeks Actual Teaching + 3 weeks for Continuous Internal Evaluation).
- b. **One Credit of the Theory** is equal to 15 clock hours (Teaching 2 hour per week for each credit, 12 hours Actual Teaching + 3 hours Continuous Internal Evaluation – Assignments, Tutorials, Practice, Problem solving sessions, Group discussion, Seminars and Unit Tests.
- c. **One Credit of Practical** = 30 clock hours. (4 Contact hours per credit per week) One Credit = 30 clock hours (24 hours' Actual Table work + 6 hours for journal competition, and Continuous Internal Evaluation of each practical).
- d. **Practical for each course comprises of 02 Credits = 60 clock hours.** Therefore,
  - Minimum 12 laboratory/ Field sessions of 04 clock hours must be conducted in one semester.
  - In case of short practical, two practical's should be conducted in one session.
  - Each practical of 04 clock hours in the laboratory should consist of: Table performance for concerned practical, careful observations, calculation, writing results and conclusion, and submission of practical in written form.
  - Pre-laboratory reading and post laboratory assignments should be given on each practical as a part of continuous internal evaluation.

**12. Examination Pattern (For each Semester)**

The examinations will be conducted semester wise for both Theory as well as Practical courses.

- **Theory Paper of 02 Credits -**
  - Internal Exam (20 M) + University Theory Exam (30 M) = Total 50 M
  - Duration: For Internal exam = 40 Min. and For University Exam = 02 hours.
- **Practical Paper of 2 Credits -**
  - Internal Exam (20 M) + University Practical Exam (30 M) = Total 50 M
  - Duration: For Internal exam = 40 Min. and For University Exam = More than 04 hours.

**Award of Class/Grade:** The class / grade for the courses of each semester will be followed as per the norms and conditions laid down by SPPU, Pune.

**ATKT Rules:** As per the norms given by SPPU, Pune.

**13. Important Note:**

There shall be at least a short tour/field visit/industrial visit (1-2 days) per year for all UG students. Tours are the part of curriculum and obligatory to each student, failing which they will not be considered eligible to appear for the practical examination. Under unavoidable circumstances, if the student fails to attend the tour, he/she have to produce justifiable evidence for not attending the tour. However, in lieu of tour the candidate will have to complete the work assigned by the Department.

The documents to be produced by each student at the time of practical examination (at the end of each Semester) are:

- Submission of practical records compulsory (Journals).
- Submission of a Tour / Visit report duly signed by the concerned practical In-charge and Head of the Department.
- Any submissions / assignments, etc. based on the practical course.

**14. Program Outcomes (POs) for B.Sc Programme**

**After successful completion of the Under Graduate (UG) Degree program, the students would be able to:**

**PO1. Disciplinary Knowledge:** Demonstrate comprehensive knowledge of the disciplines that form a part of a graduate programme. Execute strong theoretical and practical understanding generated from the specific graduate programme in the area of work.

**PO2. Social competence:** Display the understanding, behavioural skills needed for successful social adaptation, work in groups, exhibit thoughts and ideas effectively in writing and orally.

**PO3. Research-related skills and Scientific temper:** Develop the working knowledge and applications of instrumentation and laboratory techniques. Able to apply skills to design and conduct independent experiments, interpret, establish hypothesis and inquisitiveness towards research.

**PO4. Trans-disciplinary knowledge:** Integrate different disciplines to uplift the domains of cognitive abilities and transcend beyond discipline-specific approaches to address a common problem.

**PO5. Environment and Sustainability:** Understand the impact of the scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.

**PO6. Self-directed and Life-long learning:** Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.



**SAVITRIBAI PHULE PUNE UNIVERSITY**  
(Formerly University of Pune)

# B.Sc. PROGRAMME (2026–27)

(Affiliated Colleges)



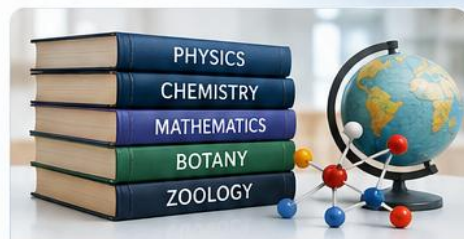
## PROGRAM OUTCOMES (POs)

PO  
1



### Disciplinary Knowledge:

Demonstrate comprehensive knowledge of the disciplines that form a part of a graduate programme. Execute strong theoretical and practical understanding generated from the specific graduate programme in the area of work.



PO  
2



### Social competence:

Display the understanding, behavioural skills needed for successful social adaptation, work in groups, exhibit thoughts and ideas effectively in writing and orally.



PO  
3



### Research-related skills and Scientific temper:

Develop the working knowledge and applications of instrumentation and laboratory techniques. Able to apply skills to design and conduct independent experiments, interpret, establish hypothesis and inquisitiveness towards research.



PO  
4



### Trans-disciplinary knowledge:

Integrate different disciplines to uplift the domains of cognitive abilities and transcend beyond discipline-specific approaches to address a common problem.



PO  
5



### Environment and Sustainability:

Understand the impact of the scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.



PO  
6



### Self-directed and Life-long learning:

Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.



Building Competent Graduates for a Better Tomorrow



Knowledge  
Driven



Skill  
Oriented



Ethical  
& Responsible



Innovative  
Thinking



Sustainable  
Future

**15. Program Specific Outcomes for B.Sc. Microbiology**

- PSO 1** Demonstrate knowledge of the importance of microbes in various aspects of life.
- PSO 2** Differentiate among various categories of microorganisms.
- PSO 3** Acquire skills in basic experimental techniques in microbiology.
- PSO 4** Understand and apply the principles of experimental setups and methodologies.
- PSO 5** Analyze and interpret stained microbial slides and morphological features.
- PSO 6** Develop critical thinking and problem-solving skills related to microbiological research.
- PSO 7** Communicate scientific findings and concepts effectively in microbiology.
- PSO 8** Understand the implications of microbiology in health, medicine, and biotechnology.
- PSO 9** Foster collaborative skills and contribute to team-based scientific projects.
- PSO 10** Cultivate a mindset for lifelong learning and professional development in the field of microbiology.



**SAVITRIBAI PHULE PUNE UNIVERSITY**  
(Formerly University of Pune)

# B.Sc. Microbiology (2026–27)

(Affiliated Colleges)



## PROGRAM SPECIFIC OUTCOMES (PSOs)

|               |  |                                                                                                      |  |
|---------------|--|------------------------------------------------------------------------------------------------------|--|
| <b>PSO 1</b>  |  | Demonstrate knowledge of the importance of microbes in various aspects of life.                      |  |
| <b>PSO 2</b>  |  | Differentiate among various categories of microorganisms.                                            |  |
| <b>PSO 3</b>  |  | Acquire skills in basic experimental techniques in microbiology.                                     |  |
| <b>PSO 4</b>  |  | Understand and apply the principles of experimental setups and methodologies.                        |  |
| <b>PSO 5</b>  |  | Analyze and interpret stained microbial slides and morphological features.                           |  |
| <b>PSO 6</b>  |  | Develop critical thinking and problem-solving skills related to microbiological research.            |  |
| <b>PSO 7</b>  |  | Communicate scientific findings and concepts effectively in microbiology.                            |  |
| <b>PSO 8</b>  |  | Understand the implications of microbiology in health, medicine, and biotechnology.                  |  |
| <b>PSO 9</b>  |  | Foster collaborative skills and contribute to team-based scientific projects.                        |  |
| <b>PSO 10</b> |  | Cultivate a mindset for lifelong learning and professional development in the field of microbiology. |  |

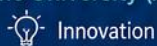
**PSOs for B.Sc. Microbiology (2026–27)**  
Savitribai Phule Pune University (Affiliated Colleges)



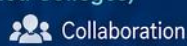
Knowledge



Skills



Innovation



Collaboration

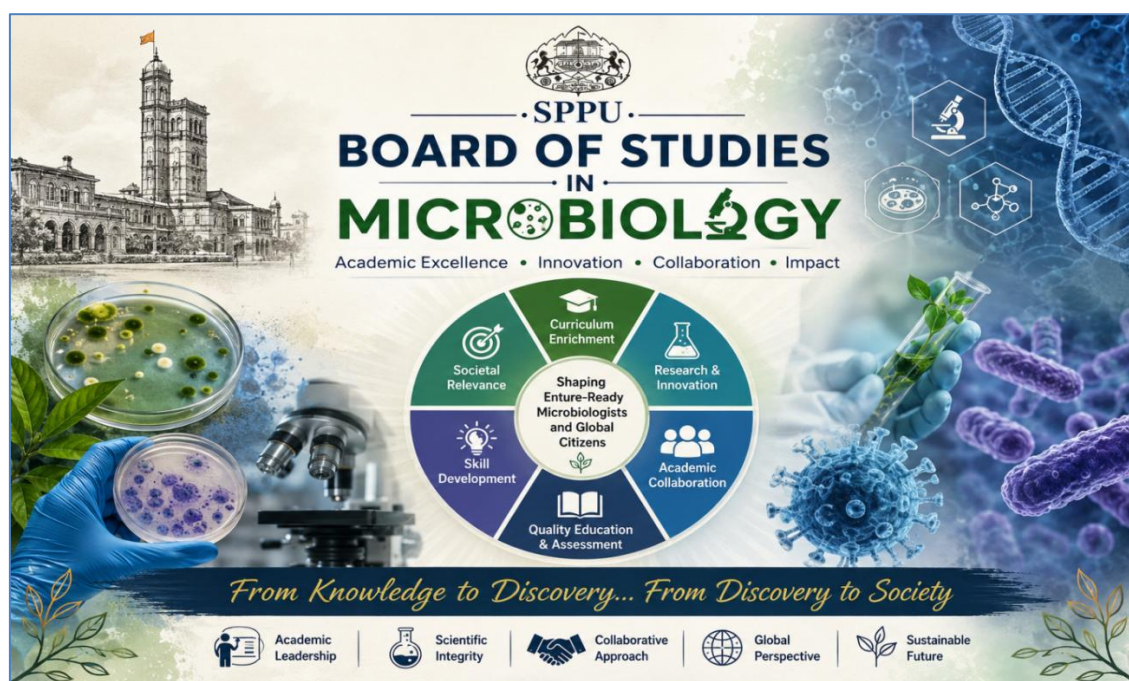


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## 16. The Board of Studies of Microbiology, SPPU, Pune

Tenure: 2023–24 to 2027–28

| Sr. No. | Name                                 | Designation |
|---------|--------------------------------------|-------------|
| 1       | Prof. Dr. Pawar Sunil Trimbak        | Chairman    |
| 2       | Prof. Dr. Pardesi Karishma Rajendra  | Member      |
| 3       | Dr. Pable Anupama Ashok              | Member      |
| 4       | Prof. Dr. Wagh Pratima Pandit        | Member      |
| 5       | Prof. Dr. Abhyankar Pragati Sunil    | Member      |
| 6       | Dr. Pathak Leena Pradeep             | Member      |
| 7       | Prof. Dr. Kulkarni Snehal Vivekanand | Member      |
| 8       | Dr. Kale Avinash Sudhakar            | Member      |
| 9       | Prof. Dr. Shinde Shubhangi Rajkumar  | Member      |
| 10      | Prof. Dr. Puranik Pravin Ramchandra  | Member      |
| 11      | Dr. Rajwade Jyutika Milind           | Member      |
| 12      | Prof. Dr. Mali Gajanan Vishnu        | Member      |
| 13      | Dr. Shete Ashwini Monish             | Member      |
| 14      | Dr. Patil Hemant Jagatrao            | Member      |



## 17. B.Sc. Microbiology Degree Programme- Course Structure for FYBSc Microbiology

Course Structure for F.Y. B.Sc. Microbiology (NEP 2020) – 2024–25



**SAVITRIBAI PHULE  
PUNE UNIVERSITY**  
(Formerly University of Pune)

# F.Y. B.Sc. MICROBIOLOGY

— Course Structure —

As per NEP 2020 & 2024 Pattern

Implemented From A.Y. 2024–25

*Building*  
Strong Foundation  
for a Brighter  
Tomorrow

## CREDIT FRAMEWORK — FIRST YEAR B.Sc. MICROBIOLOGY

### SEM-I (Level 4.5)



| Course Code   | Type      | Course Title                              | Course Type             | Credits |
|---------------|-----------|-------------------------------------------|-------------------------|---------|
| MB-101-T      | Theory    | Introduction to Microbiology              | Subject 1               | 2       |
| MB-101-P      | Practical | Laboratory Techniques in Microbiology-I   | Subject 1               | 2       |
| OE-101-MB     | Theory    | Microorganisms and Human Life             | Open Elective           | 2       |
| SEC-101-MB    | Practical | Basic Skills in Microbiology Laboratory-I | Skill Enhancement       | 2       |
| IKS-100-T     | Theory    | IKS Generic                               | Indian Knowledge System | 2       |
| AEC-101-MB    | Theory    | English / Hindi / Marathi                 | Ability Enhancement     | 2       |
| VEC-101-MB    | Theory    | Environmental Science                     | Value Education         | 2       |
| Total Credits |           |                                           |                         | 22      |

### SEM-II (Level 4.5)



| Course Code   | Type      | Course Title                               | Course Type         | Credits |
|---------------|-----------|--------------------------------------------|---------------------|---------|
| MB-151-T      | Theory    | Basic Microbiology                         | Subject 1           | 2       |
| MB-151-P      | Practical | Laboratory Techniques in Microbiology-II   | Subject 1           | 2       |
| OE-151-MB     | Practical | Dealing With Microorganisms                | Open Elective       | 2       |
| SEC-151-MB    | Practical | Basic Skills in Microbiology Laboratory-II | Skill Enhancement   | 2       |
| AEC-151-MB    | Theory    | English / Hindi / Marathi                  | Ability Enhancement | 2       |
| VEC-151-MB    | Theory    | Environmental Science                      | Value Education     | 2       |
| CC-151-MB     | —         | PE / NSS / NCC                             | Co-curricular       | 2       |
| Total Credits |           |                                            |                     | 22      |



Outcome Based  
Education  
Aligned with  
NEP 2020



Holistic &  
Multidisciplinary  
Learning



Skill  
Enhancement  
& Employability



Value Based  
& Sustainable  
Future



Choice Based  
Credit System  
(CBCS)



Exit options, award of credits, evaluation pattern  
and ATKT rules are as per SPPU guidelines.

*Explore Microbes.  
Understand Life. Create Impact.*



**18. B.Sc. Microbiology Degree Programme- Course Structure for SYBSc Microbiology****Course Structure for S.Y. B.Sc. Microbiology (NEP 2020) – 2025–26****Course Structure for S.Y. B.Sc. Microbiology (NEP 2020) – 2025–26****SEM III- Level 5.0**

| Course Type                                                                                                   | Course Code    | Theory / Practical | Course Title                          | Credits |
|---------------------------------------------------------------------------------------------------------------|----------------|--------------------|---------------------------------------|---------|
|  Major core                  | MB-201-MJ      | Theory             | Medical microbiology and Immunology   | 2       |
|  Major core                  | MB-202-MJ      | Theory             | Bacterial Physiology and fermentation | 2       |
|  Major core                  | MB-203-MJP     | Practical          | Applications of microbiology I        | 2       |
|  Vocational Skill Course     | MB-221-VSC     | Theory             | Dairy Technology                      | 2       |
|  Field project               | MB-231-FP      | Field project      |                                       | 2       |
|  Minor                       | MB-241-MN      | Theory             | Avenues in Microbiology               | 2       |
|  Minor                       | MB-242-MNP     | Practical          | Utilization of Microbes               | 2       |
|  Open Elective               | OE-201-MB      | Theory             | Scope of Microbiology                 | 2       |
|  Indian Knowledge System     | IKS-201-MB     | Theory             | IKS major subject Specific            | 2       |
|  Ability Enhancement Course | AEC-201-MB     | Theory             | English/Hindi/Marathi                 | 2       |
|  Co curricular Course      | CC-201-PE, NSS | ---                | NSS/NCC/PE                            | 2       |

**SEM IV- Level 5.0**

| Course Type                                                                                                            | Course Code | Theory / Practical | Course Title                                                                 | Credits |
|------------------------------------------------------------------------------------------------------------------------|-------------|--------------------|------------------------------------------------------------------------------|---------|
|  Major core                         | MB-251- MJ  | Theory             | Bacterial Genetics                                                           | 2       |
|  Major core                         | MB-252- MJ  | Theory             | Air and water Microbiology                                                   | 2       |
|  Major core                         | MB-253- MJP | Practical          | Applications of Microbiology-II                                              | 2       |
|  Vocational Skill Course [VSC]      | MB-271-VSC  | Practical          | Techniques in Dairy Microbiology                                             | 2       |
|  Community Engagement Program [CEP] | MB-232-CEP  |                    |                                                                              | 2       |
|  Minor                              | MB-291-MN   | Theory             | Environmental Microbiology                                                   | 2       |
|  Minor                              | MB-292-MNP  | Practical          | Practices in Environmental Microbiology                                      | 2       |
|  Open Elective                      | OE -251-MB  | Practical          | Use of Microbes in Daily Life                                                | 2       |
|  Skill Enhancement Course           | SEC-251-MB  | Practical          | Standard Operating Procedures (SOP)<br>Preparation of laboratory Instruments | 2       |
|  Ability Enhancement Course         | AEC-251-MB  | Theory             | English/Hindi/Marathi                                                        | 2       |
|  Co curricular course               | CC-251-MB   | --                 | PE/NSS/NCC                                                                   | 2       |

**Total 44**

**19. B.Sc. Microbiology Degree Programme- Course Structure for TYBSc Microbiology****Course Structure for T.Y. B.Sc. Microbiology (NEP 2020) – 2026–27**

| Sem / Level             | Course Type    | Course Code | Theory / Practical | Course Title                       | Credits |
|-------------------------|----------------|-------------|--------------------|------------------------------------|---------|
| <b>SEM V<br/>(5.5)</b>  | Major Core     | MB 301 MJ T | Theory             | Medical Microbiology – I           | 2       |
|                         | Major Core     | MB 302 MJ T | Theory             | Immunology – I                     | 2       |
|                         | Major Core     | MB 303 MJ T | Theory             | Molecular Biology – I              | 2       |
|                         | Major Core     | MB 304 MJ T | Theory             | Enzymology                         | 2       |
|                         | Major Core     | MB 305 MJ P | Practical          | Practical Course MJ P-5            | 2       |
|                         | Major Core     | MB 306 MJ P | Practical          | Practical Course MJ P-6            | 2       |
|                         | Major Elective | MB 310 MJ T | Theory             | Fermentation Technology I          | 2       |
|                         | Major Elective | MB 311 MJ T | Theory             | Agricultural Microbiology          | 2       |
|                         | Major Elective | MB 312 MJ P | Practical          | Practical Course MJ P-7            | 2       |
|                         | Major Elective | MB 313 MJ P | Practical          | Practical Course MJ P-8            | 2       |
|                         | VSC            | MB 321 VSC  | Theory             | Waste Water Treatment & Management | 2       |
|                         | FP             | MB 331 FP   | Field Project      | Field Project                      | 2       |
|                         | Minor          | MB 341 MN T | Theory             | Applied Microbiology               | 2       |
|                         |                |             |                    |                                    |         |
| <b>SEM VI<br/>(5.5)</b> | Major Core     | MB 351 MJ T | Theory             | Medical Microbiology – II          | 2       |
|                         | Major Core     | MB 352 MJ T | Theory             | Immunology – II                    | 2       |
|                         | Major Core     | MB 353 MJ T | Theory             | Molecular Biology – II             | 2       |
|                         | Major Core     | MB 354 MJ T | Theory             | Metabolism                         | 2       |
|                         | Major Core     | MB 355 MJ P | Practical          | Practical Course MJ P-9            | 2       |
|                         | Major Core     | MB 356 MJ P | Practical          | Practical Course MJ P-10           | 2       |
|                         | Major Elective | MB 360 MJ T | Theory             | Fermentation Technology – II       | 2       |
|                         | Major Elective | MB 361 MJ T | Theory             | Food Microbiology                  | 2       |
|                         | Major Elective | MB 362 MJ P | Practical          | Practical Course MJ P-11           | 2       |
|                         | Major Elective | MB 363 MJ P | Practical          | Practical Course MJ P-12           | 2       |
|                         | VSC            | MB 371 VSC  | Practical          | Vocational Skill Course            | 2       |
|                         | OJT            | MB 381 OJT  | OJT                | On-the- Job Training               | 4       |
|                         |                |             |                    |                                    |         |

Note: Select any one Theory & practical from elective courses. Practical course should be related with theory course


**SAVITRIBAI PHULE PUNE UNIVERSITY**

(Formerly University of Pune)

(Affiliated Colleges)

# B.Sc. MICROBIOLOGY

**DEGREE PROGRAMME – COURSE STRUCTURE**
**FOR T.Y. B.Sc. MICROBIOLOGY (NEP 2020)**
**— 2026–27 —**

 NEP 2020  
Compliant

 Outcome  
Based  
Education

 Skill  
Enhancement  
& Employability

 Holistic  
& Sustainable  
Learning

 Research  
& Innovation  
Driven

**Implemented From  
Academic Year  
2026–27**
**COURSE STRUCTURE FOR T.Y. B.Sc. MICROBIOLOGY (NEP 2020) – 2026–27**

## SEM V (5.5)



| Sem / Level          | Course Type | Course Code   | Theory / Practical                 | Credits   |
|----------------------|-------------|---------------|------------------------------------|-----------|
| Major Core           | MB 301 MJ T | Theory        | Medical Microbiology – I           | 2         |
| Major Core           | MB 302 MJ T | Theory        | Immunology – I                     | 2         |
| Major Core           | MB 303 MJ T | Theory        | Molecular Biology – I              | 2         |
| Major Core           | MB 304 MJ T | Theory        | Enzymology                         | 2         |
| Major Core           | MB 305 MJ P | Practical     | Practical Course MJ P-5            | 2         |
| Major Core           | MB 306 MJ P | Practical     | Practical Course MJ P-6            | 2         |
| Major Elective       | MB 310 MJ T | Theory        | Fermentation Technology I          | 2         |
| Major Elective       | MB 311 MJ T | Theory        | Agricultural Microbiology          | 2         |
| Major Elective       | MB 312 MJ P | Practical     | Practical Course MJ P-7            | 2         |
| Major Elective       | MB 313 MJ P | Practical     | Practical Course MJ P-8            | 2         |
| VSC                  | MB 321 VSC  | Theory        | Waste Water Treatment & Management | 2         |
| FP                   | MB 331 FP   | Field Project | Field Project                      | 2         |
| Minor                | MB 341 MN T | Theory        | Applied Microbiology               | 2         |
| <b>Total Credits</b> |             |               |                                    | <b>22</b> |

## SEM VI (5.5)



| Sem / Level          | Course Type | Course Code | Theory / Practical           | Credits   |
|----------------------|-------------|-------------|------------------------------|-----------|
| Major Core           | MB 351 MJ T | Theory      | Medical Microbiology – II    | 2         |
| Major Core           | MB 352 MJ T | Theory      | Immunology – II              | 2         |
| Major Core           | MB 353 MJ T | Theory      | Molecular Biology – II       | 2         |
| Major Core           | MB 354 MJ T | Theory      | Metabolism                   | 2         |
| Major Core           | MB 355 MJ P | Practical   | Practical Course MJ P-9      | 2         |
| Major Core           | MB 356 MJ P | Practical   | Practical Course MJ P-10     | 2         |
| Major Elective       | MB 360 MJ T | Theory      | Fermentation Technology – II | 2         |
| Major Elective       | MB 361 MJ T | Theory      | Food Microbiology            | 2         |
| Major Elective       | MB 362 MJ P | Practical   | Practical Course MJ P-11     | 2         |
| Major Elective       | MB 363 MJ P | Practical   | Practical Course MJ P-12     | 2         |
| VSC                  | MB 371 VSC  | Practical   | Vocational Skill Course      | 2         |
| OJT                  | MB 381 OJT  | OJT         | On-the- Job Training         | 4         |
| <b>Total Credits</b> |             |             |                              | <b>22</b> |


**Note:**

- Select any one Theory & practical from elective courses.
- Practical course should be related with theory course.


 Exit options, award of credits, evaluation  
pattern and ATKT rules are as per  
SPPU guidelines.

**Major Core**  
Core subjects  
of the discipline

**Major Elective**  
Specialized  
elective subjects

**VSC**  
Vocational Skill  
Courses

**FP**  
Field  
Project

**OJT**  
On-the-Job  
Training

**Minor**  
Interdisciplinary  
learning

*Explore Microbes. Understand Life. Create Impact.*

**MB 301 MJ T – Medical Microbiology – I**

|                             |                                 |
|-----------------------------|---------------------------------|
| <b>Semester</b>             | <b>V</b>                        |
| <b>Course Code</b>          | <b>MB 301 MJ T</b>              |
| <b>Course Title</b>         | <b>Medical Microbiology – I</b> |
| <b>Credits</b>              | <b>02</b>                       |
| <b>Total Teaching Hours</b> | <b>30 Hours</b>                 |

**Course Objectives**

| <b>CO No.</b> | <b>Course Objectives</b>                                                                          |
|---------------|---------------------------------------------------------------------------------------------------|
| <b>CO1</b>    | To provide fundamental knowledge of infectious diseases associated with major human body systems. |
| <b>CO2</b>    | To develop understanding of epidemiological principles and clinical research methodologies.       |
| <b>CO3</b>    | To familiarize students with systematic study of clinically important bacterial pathogens.        |
| <b>CO4</b>    | To encourage analytical thinking regarding disease diagnosis, prevention, and treatment.          |
| <b>CO5</b>    | To create awareness about public health importance of infectious disease control and vaccination. |

**Course Outcomes**

| <b>CO No.</b> | <b>Course Outcomes</b>                                                                          | <b>Bloom's Level</b> |
|---------------|-------------------------------------------------------------------------------------------------|----------------------|
| <b>CO1</b>    | Explain infectious diseases related to major human body systems.                                | Understand           |
| <b>CO2</b>    | Describe epidemiological concepts, transmission patterns, and preventive strategies.            | Understand           |
| <b>CO3</b>    | Apply microbiological knowledge for identification and characterization of bacterial pathogens. | Apply                |
| <b>CO4</b>    | Interpret clinical manifestations and laboratory diagnosis of infectious diseases.              | Analyze              |
| <b>CO5</b>    | Assess disease control measures, including vaccination and chemotherapy.                        | Evaluate             |

## Syllabus

| Credits          | Topics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Lectures                                                                                                                                    |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Credit I</b>  | <b>Foundations of Infectious Diseases and Epidemiology: Systems, Pathogens, and Disease Control</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>15</b>                                                                                                                                   |
|                  | <b>Unit I Introduction to infectious diseases of following human body systems:</b><br>(Brief anatomy and Physiology, Enlist Diseases and their causative agents, common symptoms)<br><br>a) Integumentary System (Skin)<br>b) Respiratory system<br>c) Gastrointestinal system and liver<br>d) Urogenital system<br>e) Central nervous system                                                                                                                                                                                                                                                                            | <b>(8)</b><br><br><br><br><br><br><br><br><br><br><br><br><br><br>1<br>2<br>2<br>2<br>1                                                     |
|                  | <b>Unit II Principles of Epidemiology and Clinical Research in Infectious Diseases:</b><br><b>a) Case-Control and Cohort Studies: Design and Applications in Epidemiology</b><br><b>b) Principles and Methods of Clinical Trials for Drugs and Vaccines: Randomized, Parallel, and Cross-Over Designs</b><br><b>c) Epidemiology of infectious diseases</b> <ol style="list-style-type: none"> <li>Sources and Reservoirs of Infection</li> <li>Modes of Transmission of Infections</li> <li>Strategies for Disease Prevention and Control, Vaccine-Preventable and Non-Vaccine-Preventable Bacterial Diseases</li> </ol> | <b>(7)</b><br><br><br><br><br><br><br><br><br><br><br><br><br><br>2<br><br><br><br><br><br><br><br><br><br><br><br><br><br>1<br>1<br>1<br>2 |
| <b>Credit II</b> | <b>Comprehensive Study of Major Bacterial Pathogens</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>15</b>                                                                                                                                   |
|                  | <b>Unit I Systematic Study of Clinically Important Bacterial Pathogens:</b><br>Classification, Biochemical characteristics, Antigenic structure, Viability, Pathogenicity, Pathogenesis, Clinical features, Laboratory Diagnosis, Epidemiology, Prophylaxis, and Chemotherapy<br><br><b>a. <i>Escherichia coli</i> – Urinary tract infection, Diarrhoea, Neonatal meningitis, Sepsis</b>                                                                                                                                                                                                                                 | <b>(7)</b><br><br><br><br><br><br><br><br><br><br><br><br><br><br>3                                                                         |

| Credits | Topics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Lectures                                              |
|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|
|         | <p>b. <i>Vibrio cholerae</i> – Cholera</p> <p>c. <i>Klebsiella pneumoniae</i> – Pneumonia, urinary tract infection, Hospital-acquired infections.</p> <p>d. <i>Streptococcus pyogenes</i> – Pharyngitis, Scarlet fever, skin infections, Rheumatic fever, Glomerulonephritis</p> <p>e. <i>Streptococcus pneumoniae</i> – Pneumonia, meningitis, Otitis media, Sinusitis.</p> <p>f. <i>Neisseria meningitidis</i> – Meningitis, Septicemia</p> <p>g. <i>Neisseria gonorrhoeae</i> – Gonorrhea (sexually transmitted infection)</p> <p>h. <i>Pseudomonas aeruginosa</i> – Opportunistic infections (burns, wounds, lungs, hospital infections)</p>                                                                                                                                                                                                                                                                                                                              | <p>3</p> <p>1</p>                                     |
|         | <p><b>Unit II Spirochetes, Anaerobes, Acid-fast bacteria, Rickettsial diseases</b></p> <p><b>a. Spirochetes</b></p> <ul style="list-style-type: none"> <li>· <i>Treponema pallidum</i> – Syphilis</li> <li>· <i>Leptospira interrogans</i> – Leptospirosis (Weil's disease; water- and rodent-borne infection)</li> </ul> <p><b>b. Anaerobes</b></p> <ul style="list-style-type: none"> <li>· <i>Clostridium tetani</i> – Tetanus</li> <li>· <i>Clostridium botulinum</i> – Botulism (paralytic illness)</li> </ul> <p><b>c. Acid-fast bacteria</b></p> <ul style="list-style-type: none"> <li>· <i>Mycobacterium tuberculosis</i> – Tuberculosis (pulmonary and extrapulmonary)</li> <li>· <i>Mycobacterium leprae</i> – Leprosy (Hansen's disease)</li> </ul> <p><b>d. Rickettsial diseases</b></p> <ul style="list-style-type: none"> <li>· <i>Rickettsia rickettsii</i> – Rocky Mountain spotted fever</li> <li>· <i>Orientia tsutsugamushi</i> – Scrub typhus</li> </ul> | <p><b>(8)</b></p> <p>2</p> <p>2</p> <p>2</p> <p>2</p> |

## Reference Books & E-Resources

1. Chakraborty P. (2013). A Textbook of Microbiology. 3rd edition. New Central Book Agency. India. ISBN-13: 978-8173818769
2. Champoux J. J., Neidhardt F. C., Drew W. L. and Plorde J. J. (2004). Sherris Medical Microbiology: An Introduction to infectious diseases. 4th edition. Ryan K. J. and Ray C. G. (editors). McGraw-Hill Companies. DOI: 10.1036/0838585299
3. Dey N. C., Dey T. K. and Sinha D. (2013). Medical Bacteriology Including Medical Mycology and AIDS. 17th Edition. New Central Book Agency (P) Ltd (Publisher). India
4. Dulbecco R., Eisen H. N. and Davis B. D. (1990). Microbiology. United States: Publisher -Lippincott. ISBN: 9780608072432
5. Finch R., Greenwood D., Whitley R. and Norrby S. R. (2010) Antibiotic and Chemotherapy. 9th Edition. Elsevier. ISBN: 9780702040641
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7. Goering R., Dockrell H., Zuckerman M., Roitt I. and Chiodini P. L. (2018). Mims' Medical Microbiology and Immunology. 6th Edition. Elsevier. ISBN: 9780702071546
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10. Kanungo Reba. (2017). Ananthanarayan and Paniker's Textbook of Microbiology. Tenth edition. The Orient Blackswan Publisher. ISBN-13: 978-9386235251
11. Kaslow R. A., Stanberry L. R. and Le Duc J. W. (2014). Viral Infections of Humans: Epidemiology and Control. 5th edition. Springer. ISBN 978-1-4899-7448-8
12. Mayers D. L., Sobel J.D., Ouellette M., Kaye K.S. and Marchaim D. (Eds.) (2017). Antimicrobial Drug Resistance: Mechanisms of Drug Resistance. Volume 1. Edition 2. Springer. ISBN 978-3-319-46718-4
13. Mayers D. L., Sobel J.D., Ouellette M., Kaye K.S. and Marchaim D. (Eds.) (2017). Antimicrobial Drug Resistance: Clinical and Epidemiological Aspects. Volume 2. Edition 2. Springer. ISBN 978-3-319-47266-9

14. Mukherjee K. L. and Ghosh S. (2010). Medical Laboratory Technology. Volume I: Procedure Manual for Routine Diagnostic Tests. 2nd edition. McGraw Hill Education (India) Private Limited. ISBN-13: 978-1259061233
15. Mukherjee K. L. and Ghosh S. (2010). Medical Laboratory Technology. Volume II: Procedure Manual for Routine Diagnostic Tests. 2nd edition. McGraw Hill Education (India) Private Limited. ISBN-13: 978-1259061240
16. Mukherjee K. L. and Ghosh S. (2010). Medical Laboratory Technology. Volume III: Procedure Manual for Routine Diagnostic Tests. 2nd edition. McGraw Hill Education (India) Private Limited. ISBN-13: 978-1259061257
17. Park K. (2019). Park's Preventive and Social medicine. 25th Edition. Banarsidas Bhanot Publisher, Jabalpur. ISBN-13: 978-9382219156
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22. Tortora G. J., Funke B. R. and Case C. L. (2016). Microbiology: An introduction 12th Edition, Pearson. ISBN-13: 9780321929150

#### E-Learning Resources

- WHO Infectious Disease Information Portal – <https://www.who.int>
- CDC Microbial Diseases Resources – <https://www.cdc.gov>
- NCBI PubMed Database – <https://pubmed.ncbi.nlm.nih.gov>
- Microbiology Virtual Learning Platforms – MicrobeNotes /OpenStax

**MB 302 MJ T – Immunology – I**

|                             |                       |
|-----------------------------|-----------------------|
| <b>Semester</b>             | <b>V</b>              |
| <b>Course Code</b>          | <b>MB 302 MJ T</b>    |
| <b>Course Title</b>         | <b>Immunology – I</b> |
| <b>Credits</b>              | <b>02</b>             |
| <b>Total Teaching Hours</b> | <b>30 Hours</b>       |

**Course Objectives**

| <b>CO No.</b> | <b>Course Objectives</b>                                                                             |
|---------------|------------------------------------------------------------------------------------------------------|
| CO1           | To provide advanced knowledge of immune system organization and function.                            |
| CO2           | To develop understanding of innate immune mechanisms and host defence.                               |
| CO3           | To enable students to analyze immunological techniques and molecular interactions.                   |
| CO4           | To understand concepts of MHC and their implication in transplantation technology.                   |
| CO5           | To understand hybridoma technology for monoclonal antibody production and its clinical applications. |

**Course Outcomes**

| <b>CO No.</b> | <b>Course Outcomes</b>                                                      | <b>Bloom's Level</b> |
|---------------|-----------------------------------------------------------------------------|----------------------|
| CO1           | Explain structural and functional aspects of immune system.                 | Understand           |
| CO2           | Describe innate immune mechanisms and defence strategies.                   | Understand           |
| CO3           | Apply principles of antigen-antibody interactions in laboratory techniques. | Apply                |
| CO4           | Interpret the role of MHC in immune responses and transplantation.          | Analyze              |
| CO5           | Assess applications of monoclonal antibodies in diagnostics and therapy.    | Apply                |

## Syllabus

| Credits         | Topics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Lectures                          |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|
| <b>Credit I</b> | <b>Organs of immune system, Innate immunity, Antigen and Immunoglobulins</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>15</b>                         |
|                 | <b>Unit I Organs of immune system:</b><br><b>a. Primary lymphoid organs (Thymus and Bone Marrow):</b><br>Thymus – Structure, thymic education (positive and negative selection)<br>Bone marrow –Structure, Positive & Negative selection<br><b>b. Secondary lymphoid organs – Structure and functions of spleen and Lymph node, Mucous associated lymphoid tissue, Lymphatic system and lymph circulation</b>                                                                                                                                           | <b>(4)</b><br>2<br><br>2          |
|                 | <b>Unit II Innate immunity:</b><br><b>a. Humoral components: Defensins, pattern recognition Proteins and pathogen associated molecular patterns (PAMPs), kinins, and acute phase reactants.</b><br><b>b. Cellular components: Phagocytic cells – PMNL, Macrophages (reticuloendothelial cell system) and Dendritic cells.</b><br><b>c. Phagocytosis (oxygen dependent and independent systems), Complement activation (Classical, Alternative and lectin pathway), Inflammation (Process, cardinal signs, mediators, vascular and cellular changes)</b> | <b>(7)</b><br>1<br><br>1<br><br>5 |
|                 | <b>Unit III Antigen and Antibody</b><br><b>a. Factors affecting immunogenicity</b><br><b>b. Epitopes (B and T cell epitopes), haptens, Carrier, Adjuvants and their applications.</b><br><b>c. Advanced aspects of antibodies: antigenic determinants of Immunoglobulins (isotypic, allotypic, idiotypic determinants), antibody engineering concepts.</b>                                                                                                                                                                                              | <b>(4)</b><br>1<br>1<br><br>2     |

| Credits          | Topics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Lectures                            |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|
| <b>Credit II</b> | <b>Immunological Techniques, Major Histocompatibility Complex, Transplantation Immunology, Hybridoma Technology and Monoclonal Antibodies</b>                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>15</b>                           |
|                  | <b>Unit I Immunological Techniques:</b> <ul style="list-style-type: none"> <li>a. Complement Fixation Test (Wasserman's test for Syphilis)</li> <li>b. Immunofluorescence techniques: direct and indirect, fluorescence-activated cell sorting (FACS).</li> <li>c. Enzyme-linked immunosorbent assay (ELISA), Immunoglobulin M (IgM) Antibody Capture Enzyme-Linked Immunosorbent Assay [MAC ELISA].</li> <li>d. Immunosensors: Types (electrochemical, piezoelectric) and applications (home COVID test, Cancer screening,)</li> <li>e. Radio Immune Assay (RIA)</li> </ul> | <b>(7)</b><br>1<br>1<br>2<br>2<br>1 |
|                  | <b>Unit II Major Histocompatibility Complex:</b> <ul style="list-style-type: none"> <li>a. Structure of MHC in human and Mouse</li> <li>b. Structure and functions of MHC class-I and class-II molecules</li> <li>c. MHC antigen typing (micro-cytotoxicity and mixed lymphocyte reaction)</li> </ul>                                                                                                                                                                                                                                                                        | <b>(3)</b><br>1<br>1<br>1           |
|                  | <b>Unit III Transplantation Immunology</b> <ul style="list-style-type: none"> <li>a. Types of Grafts, Allograft rejection mechanisms</li> <li>b. Prevention of allograft rejection</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                | <b>(2)</b><br>1<br>1                |
|                  | <b>Unit IV Hybridoma Technology and Monoclonal Antibodies:</b> <ul style="list-style-type: none"> <li>a. Principle of HAT selection. Preparation and propagation of Hybridomas secreting monoclonal antibodies</li> <li>b. Applications of monoclonal antibodies</li> </ul>                                                                                                                                                                                                                                                                                                  | <b>(3)</b><br>2<br>1                |

## Reference Books & E-Resources

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2. Abbas, A. K., Lichtman, A. H., & Pillai, S. (2022). Cellular and Molecular Immunology (10th ed.). Elsevier, Philadelphia.
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11. Owen, J. A., Jones, P. P., Kubly, J., Punt, J., & Stranford, S. A. (2013). Kubly immunology (7th Ed.). New York: W.H. Freeman.

## E learning resources

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<https://pmc.ncbi.nlm.nih.gov/articles/PMC5058633/>
2. Phage display as a powerful platform for antibody drug discovery. Nagano, K., Tsutsumi, Y.  
10.3390/v13020178
3. Immunosensors: The future of real time pathogen detection.  
<https://pmc.ncbi.nlm.nih.gov/articles/PMC9785510/>

**MB 303 MJ T – Molecular Biology – I**

|                             |                              |
|-----------------------------|------------------------------|
| <b>Semester</b>             | <b>V</b>                     |
| <b>Course Code</b>          | <b>MB 303 MJ T</b>           |
| <b>Course Title</b>         | <b>Molecular Biology – I</b> |
| <b>Credits</b>              | <b>02</b>                    |
| <b>Total Teaching Hours</b> | <b>30 Hours</b>              |

**Course Objectives**

| <b>CO No.</b> | <b>Course Objectives</b>                                        |
|---------------|-----------------------------------------------------------------|
| <b>CO1</b>    | To familiarize students with mechanisms of gene expression.     |
| <b>CO2</b>    | To introduce the concept of regulation of gene.                 |
| <b>CO3</b>    | To encourage students to learn about gene transfer in bacteria. |
| <b>CO4</b>    | To introduce the concept of gene mapping.                       |
| <b>CO5</b>    | To develop genetic problem-solving skills.                      |

**Course Outcomes**

| <b>CO No.</b> | <b>Course Outcomes</b>                                                   | <b>Bloom's Level</b> |
|---------------|--------------------------------------------------------------------------|----------------------|
| <b>CO1</b>    | Explain the processes of DNA replication, transcription and translation. | Remember             |
| <b>CO2</b>    | Describe operon for regulation of gene.                                  | Understand           |
| <b>CO3</b>    | Explain the modes of gene transfer in bacteria.                          | Apply                |
| <b>CO4</b>    | Apply the knowledge of gene mapping for solving problems.                | Analyze              |
| <b>CO5</b>    | Interpret the data of experiments carried out for genetic analysis.      | Evaluate             |

## Syllabus

| Credits  | Topics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Lectures   |
|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| Credit I | DNA Replication and Gene Expression                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 15         |
|          | <b>Unit I Process of prokaryotic &amp; Eukaryotic DNA replication- Molecular approach</b> <ol style="list-style-type: none"> <li>Bacterial DNA as a Single replicon, Importance of Ori C, A-T rich sequence at Ori C</li> <li>Bidirectional movement of replication fork-Semiconservative and semi discontinuous replication</li> <li>Pre-priming and Priming reaction.</li> <li>Role of DNA Gyrase, Helicase, Primase, SSB proteins, DNA polymerases, DNA ligase - Primosome and Replisome</li> <li>DNA synthesis of leading, lagging strand -Okazaki fragments.</li> <li>Termination- Structure of terminator-Ter sequence, Function of Tus protein</li> <li>Distinguished features of prokaryotic and eukaryotic DNA replication</li> </ol>                                                                                        | 3          |
|          | <b>Unit II Transcription</b> <ol style="list-style-type: none"> <li>Transcription in Prokaryotes               <ol style="list-style-type: none"> <li>Structure and function of promoter</li> <li>Structure and function of RNA polymerase</li> <li>Steps in transcription: Initiation, Elongation and termination (rho dependent and independent)</li> </ol> </li> <li>Transcription in Eukaryotes with Respect to Protein Coding Gene:               <ol style="list-style-type: none"> <li>Core Promoter, promoter proximal elements and enhancers</li> <li>Transcription regulatory proteins</li> <li>RNA polymerases</li> <li>Steps in transcription: Initiation, Elongation, Termination</li> <li>e. Post transcriptional modifications: 5' capping, 3' polyadenylation and introduction to RNA splicing</li> </ol> </li> </ol> | 3<br><br>4 |

| Credits          | Topics                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Lectures  |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|                  | <b>Unit III Regulation of Transcription in Prokaryotes</b><br><b>Concept and components of operon:</b> <ul style="list-style-type: none"> <li>a. Lac operon: Inducible operon</li> <li>b. Trp operon: Repressible operon</li> </ul>                                                                                                                                                                                                                                             | 2         |
|                  | <b>Unit III Translation</b><br><b>i. Translation in Prokaryotes</b> <ul style="list-style-type: none"> <li>a. Structure and role of m-RNA, t-RNA and Ribosomes in Translation</li> <li>b. Role of Aminoacyl t-RNA synthetase in translation</li> <li>c. Steps in translation: Initiation, elongation, translocation and termination of protein synthesis</li> </ul> <b>ii. Salient features of Eukaryotic translation</b>                                                       | 3         |
| <b>Credit II</b> | <b>Gene transfer and Mapping Techniques</b>                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>15</b> |
|                  | <b>Unit I Introduction to Gene Transfer- Important Terms</b><br>Donor, Recipient, Endogenote, Exogenote, Merozygote, Fates of exogenote                                                                                                                                                                                                                                                                                                                                         | 1         |
|                  | <b>Unit II Gene Transfer by Transformation</b> <ul style="list-style-type: none"> <li>i. Discovery of Transformation</li> <li>ii. Natural transformation Systems-<br/><i>Streptococcus pneumoniae</i> and <i>Haemophilus influenzae</i>.</li> <li>iii. Artificial transformation</li> <li>iv. Factors affecting transformation <ul style="list-style-type: none"> <li>a. Competence development</li> <li>b. Size of DNA</li> <li>c. Concentration of DNA</li> </ul> </li> </ul> | 3         |
|                  | <b>Unit III Gene Transfer by Conjugation</b> <ul style="list-style-type: none"> <li>a. Discovery of Conjugation,</li> <li>b. Properties of F plasmid, F+, F-, Hfr and F' strains, tra operon</li> <li>c. Formation of Hfr strains</li> <li>d. Process of conjugation</li> </ul>                                                                                                                                                                                                 | 3         |

| Credits | Topics                                                                                                                                                                                                                                                                                                                                  | Lectures |
|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
|         | e. Result of Cross between F <sup>+</sup> and F <sup>-</sup> , Hfr and F <sup>-</sup> , F' and F <sup>-</sup>                                                                                                                                                                                                                           |          |
|         | <b>Unit IV Gene Transfer by Transduction</b><br>a. Discovery of Transduction<br>b. Generalized transduction mediated by P22 phage<br>c. Specialized transduction mediated by lambda phage                                                                                                                                               | 3        |
|         | <b>Unit V An Introduction to Gene Mapping in Bacteria</b><br>a. Gene linkage and concept of genetic recombination<br>b. Recombination mapping: Map unit, recombination frequency, linkage distance<br>c. Mapping of genes by co-transformation<br>d. Mapping of genes by co-transduction<br>e. Mapping by interrupted mating experiment | 5        |

## Reference Books & E-Resources

1. Birge E. A. (2013). Bacterial and Bacteriophage Genetics. Springer, New York. ISBN: 9781475732580
2. Brooker R. J. (2012). Genetics: Analysis and Principles. 4th edition. McGraw- Hill Publication.
3. Freifelder D. (2005). Molecular Biology. 2nd Edition. Narosa Publishing House Pvt. Limited, India.
4. Gardner E. J., Simmons M. J. and Snustad D. P. (2006). Principles of Genetics. 8th edition. John Wiley and Sons Publication. ISBN-13: 9788126510436
5. Goodenough U. (2016). Genetics. Publisher: Holt, Rinehart and Winston. ISBN- 13: 978-0030197161
6. Gupta P. K. (2020). Elements of Biotechnology. 4th Reprint (2nd Edition). Product Code: BC-22. Rastogi Publications. Meerut, India. ISBN: 978-81-7133-937
7. Hartwell L., Goldberg M., Fischer J. and Hood L. (2018). Genetics: from genes to genomes. McGraw-Hill. ISBN13: 9781259700903
8. Hayes W. (1968). Genetics of Bacteria and their Viruses. 2nd Edition. Oxford- Edinburgh: Blackwell Scientific Publications.
9. Klug W. S., Cummings M. R., Spencer C. A., Michael A. and Palladino M. (2019). Genetics. Pearson Publisher. ISBN 13: 978-0-134-60471-8
10. Kohli D. V. and Vyas S. P. (2009). Pharmaceutical Biochemistry. Published by CBS Publishers and Distributors CBS. ISBN 13: 9788123916903
11. Lewin's GENES X (2011). Krebs J., Kilpatrick S. T., Goldstein E. S. (Editors). 10th Edition. Sudbury, Mass.: Jones and Bartlett, c2011.
12. Pal J. K. and Ghaskadabi S. (2009). Fundamentals of Molecular Biology. Oxford University Press. ISBN: 9780195697810
13. Russel P. J. (2010). I Genetics: A Molecular Approach. 3rd Edition. Benjamin Cummings. ISBN: 9780321569769
14. Singh B. D. (2016). Biotechnology. 5th Edition. Reprint. Kalyani Publishers, India.
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18. Watson J.D., Baker, T.A., Bell, S.P., Gann A., Levine M. and Losick R. (2014).
19. Molecular Biology of the gene. 7th edition. Pearson. ISBN: 9780321762436

**Reference-Links:**

1. Potential biohazards of recombinant DNA molecules:  
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC388511/?page=1>
2. National Academies Press: Introduction of Recombinant DNA-Engineered Organisms into the Environment: Key Issues: <https://www.nap.edu/download/18907#>
3. Guidelines and Handbook for Institutional Biosafety Committees (DBT, Govt. of India and BCIL) : <https://thsti.res.in/pdf/IBG.pdf>
4. University of North Carolina's Biosafety Guidelines (Principles, Risk assessment, Biosafety levels, Guidelines): <https://ehs.unca.edu/laboratory-safety/biological-safety>

**MB 304 MJ T – Enzymology**

|                             |                    |
|-----------------------------|--------------------|
| <b>Semester</b>             | <b>V</b>           |
| <b>Course Code</b>          | <b>MB 304 MJ T</b> |
| <b>Course Title</b>         | <b>Enzymology</b>  |
| <b>Credits</b>              | <b>02</b>          |
| <b>Total Teaching Hours</b> | <b>30 Hours</b>    |

**Course Objectives**

| <b>CO No.</b> | <b>Course Objectives</b>                                                                                                     |
|---------------|------------------------------------------------------------------------------------------------------------------------------|
| <b>CO1</b>    | To understand methods of active site determination, role of enzymes and cofactors in microbial physiology.                   |
| <b>CO2</b>    | To learn enzyme assay, purification, and quantification; enzyme kinetics including $K_m$ , $V_{max}$ , and initial velocity. |
| <b>CO3</b>    | To correlate regulation of metabolism at enzymatic levels.                                                                   |
| <b>CO4</b>    | To apply methodology for commercial applications of enzymes.                                                                 |
| <b>CO5</b>    | To apply the enzymes at industrial level.                                                                                    |

**Course Outcomes**

| <b>CO No.</b> | <b>Course Outcomes</b>                                                                                             | <b>Bloom's Level</b> |
|---------------|--------------------------------------------------------------------------------------------------------------------|----------------------|
| <b>CO1</b>    | Explain methods of active site determination, role of enzymes and cofactors in microbial physiology.               | Understand           |
| <b>CO2</b>    | Describe enzyme assay, purification, kinetics ( $K_m$ , $K_s$ , $V_{max}$ ), and mathematical expressions thereof. | Analyze              |
| <b>CO3</b>    | Apply the significance of regulation of metabolism at enzymatic levels.                                            | Apply                |
| <b>CO4</b>    | Apply methodology for commercial applications of enzymes.                                                          | Apply                |
| <b>CO5</b>    | Apply the application of enzymes in industries                                                                     | Apply                |

## Syllabus

| Credit          | Topic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Lectures                                             |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|
| <b>Credit I</b> | <b>Enzymes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>15</b>                                            |
|                 | <b>Unit I Structure of Enzymes:</b><br><br>a. Methods to determine amino acid residues at active site (Physical method e.g. X-ray crystallography and chemical methods such as trapping of ES complex and use of pseudo- substrate) Concept of amino acid analyzer<br><br>b. Role of vitamins in metabolism<br><br>Occurrence, Structure and Biochemical role of the following:<br>i) Thiamine (Vitamin B1)<br>ii) Nicotinic Acid (Niacin) and the Pyrimidine nucleotides.<br>iii) Riboflavin (Vitamin B2) and the Flavin nucleotides<br>iv) Biotin<br>v) Vitamin D | <b>(5)</b><br><br>3<br><br>2                         |
|                 | <b>Unit II Principles and Methods of Enzyme purification</b><br><br>a. Methods of cell fractionation<br><br>b. Principles and methods of enzyme purification:<br>i. Based on molecular size<br>ii. Based on charge<br>iii. Based on solubility differences<br>iv. Based on specific binding property and selective adsorption                                                                                                                                                                                                                                       | <b>(7)</b><br><br>1<br><br>2<br><br>1<br>1<br>1<br>1 |
|                 | <b>Unit III Enzyme Assays</b><br><br>Definition of : Enzyme Unit ( SI ), katal, Enzyme turnover Number<br><br>a. Principles of enzyme assays<br><br>b. Determination of enzyme activity & specific activity<br><br>c. Enzymes assays with examples by<br>i. Spectrophotometric methods<br>ii. Radioisotope assay                                                                                                                                                                                                                                                    | <b>(3)</b><br><br>1<br><br>2                         |

| Credit           | Topic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Lectures                                          |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|
|                  | d. Construction of enzyme purification chart                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                   |
| <b>Credit II</b> | <b>Enzyme Kinetics, metabolic regulation and Immobilized Enzymes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>15</b>                                         |
|                  | <b>Unit I Enzyme Kinetics</b><br><br>a. Concept of initial velocity<br>b. Michaelis Menton equation for the initial velocity of single substrate enzyme catalyzed reaction. Brigg's Haldane modification of Michaelis Menton equation. Michaelis Menton plot<br>c. Lineweaver and Burk plot.<br>d. Definition with significance of $K_m$ , $K_s$ , $V_{max}$ .<br>e. Comparative account of Competitive, noncompetitive and uncompetitive inhibition (without derivation) (effect on $K_m$ & $V_{max}$ ) | <b>(6)</b><br><br>1<br>5                          |
|                  | <b>Unit II Metabolic Regulations</b><br><br>a. Enzyme compartmentalization at cellular level<br>b. Allosteric enzymes<br>c. Feedback mechanisms<br>d. Covalently modified regulatory enzymes (Glycogen phosphorylase)<br>e. Proteolytic activation of zymogens<br>f. Isozymes - concept and examples<br>g. Multienzyme complex e.g. Pyruvate dehydrogenase complex (PDH)                                                                                                                                 | <b>(7)</b><br><br>1<br>1<br>1<br>1<br>1<br>1<br>1 |
|                  | <b>Unit III Immobilization of enzymes:</b><br>Concept, methods of immobilization and applications in textile industry, waste water treatment and pharmaceutical industry.                                                                                                                                                                                                                                                                                                                                | <b>(2)</b>                                        |

### Reference Books & E-Resources

1. Berg J. M., Stryer L., Tymoczko J. and Gatto G. (2019). Biochemistry. 9th Edition. Palgrave Macmillan. ISBN-978-1319114657.
2. Conn E. E., Stumpf P. K., Bruening G. and Doi R. H. (1987). Outlines of Biochemistry. 5th Edition. John Wiley and Sons. ISBN-13: 9780471052883
3. Hall D. A. and Krishna Rao K. (1994). Photosynthesis (Studies in Biology). 6th Edition. Cambridge University Press, London. ISBN-13: 978-1-133-10629-6
4. Garrett R. H. and Grisham C. M. (2013). Biochemistry. 5th Edition. Brooks/Cole, Publishing Company, California. ISBN-13: 978-1-133-10629-6
5. Katoch R. (2011). Analytical Techniques in Biochemistry and Molecular Biology. Springer New York. ISBN 978-1-4419-9785-2.
6. Nelson D. L. and Cox M. M. (2021). Lehninger's Principles of Biochemistry. 8th Edition. Mac Millan Worth Pub. Co. New Delhi. ISBN: 9781319228002
7. Palmer T. (2001) Enzymes: Biochemistry, Biotechnology and Clinical chemistry. Horwood Pub. Co. Chinchester, England. ISBN-9781898563785.
8. Segel I. H. (2010). Biochemical Calculations. 2nd Ed. Wiley India Pvt. Limited. ISBN: 9788126526437
9. Stanier R. Y., Adelberg E. A. and Ingraham J. L. (1985). General Microbiology. 4th Edition. London: Macmillan.
10. Wilson K. and Walker J. (Editors) (2010). Principles and Techniques of Biochemistry and Molecular Biology. 7th edition. Cambridge University Press, New York. ISBN-13: 978-0521731676

**MB 305 MJ P– Practical Course MJ P-5**

|                             |                                |
|-----------------------------|--------------------------------|
| <b>Semester</b>             | <b>V</b>                       |
| <b>Course Code</b>          | <b>MB 305 MJ P</b>             |
| <b>Course Title</b>         | <b>Practical Course MJ P-5</b> |
| <b>Credits</b>              | <b>02</b>                      |
| <b>Total Teaching Hours</b> | <b>60 Lectures</b>             |

**Course Objectives**

| <b>CO No.</b> | <b>Course Objectives</b>                                                                                                                                          |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO1           | To provide fundamental knowledge of clinical microbiology techniques, including sample collection, processing, and diagnostic procedures                          |
| CO2           | To develop practical skills in performing microbiological tests such as staining, culturing, biochemical characterization, and haematological analysis            |
| CO3           | To familiarize students with the use of laboratory equipment, selective and differential media, and standard operating procedures (SOPs) in clinical laboratories |
| CO4           | To encourage analytical and critical thinking in interpreting laboratory results for identification and diagnosis of human pathogens                              |
| CO5           | To create awareness about biosafety practices, biomedical waste management, and the role of microbiology in disease prevention and public health                  |

**Course Outcomes**

| <b>CO No.</b> | <b>Course Outcomes</b>                                                                                                                                   | <b>Bloom's Level</b> |
|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| CO1           | Explain the principles of clinical sample collection, handling, transport, and basic diagnostic procedures in medical microbiology                       | Understand           |
| CO2           | Describe the characteristics of human pathogens and their growth on selective, differential, and enrichment media                                        | Understand           |
| CO3           | Apply microbiological techniques such as staining, culturing, biochemical tests, agglutination tests, and haematological analysis in laboratory settings | Apply                |
| CO4           | Interpret laboratory results including microscopic observations, biochemical reactions, agglutination tests, and clinical data analysis                  | Analyze              |
| CO5           | Assess the significance of microbiological findings in diagnosis, infection control, biosafety practices, and biomedical waste management                | Evaluate             |

## Syllabus

| Sr. No.      | Title of the practical                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | No. of Practicals |
|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| 1.           | <b>Clinical Sample Handling &amp; Diagnosis:</b> <ol style="list-style-type: none"> <li>Procedure for various Sample collections (Urine, Pus, Stool, sputum and Blood), processing, transport and storage in clinical laboratories.</li> <li>Physical, microscopic examination and Chemical analysis of Urine sample</li> <li>Study of identification key for human pathogens as per Bergey's Manual of Determinative Bacteriology 9<sup>th</sup> Edition and preparation of keys.</li> <li>Isolation and identification of human pathogens from Clinical samples - Urine, Stool and Pus. (<i>Klebsiella</i> spp., <i>Salmonella</i> spp., <i>Pseudomonas</i> spp., <i>Streptococcus</i> spp. and <i>Enterococcus</i> spp. Any three pathogens, one pathogen per sample)</li> <li>SOPs for disposal of clinical laboratory and hospital waste</li> </ol> | 7                 |
| 2.           | <b>Study of growth characteristics of human pathogens on microbiological media</b> <ol style="list-style-type: none"> <li>Selective media- Cetrimide agar, Wilson Blair agar</li> <li>Differential media- Salmonella Shigella agar, Mannitol salt agar</li> <li>Enrichment media and special media- Tetrathionate broth, Selenite F broth, Alkaline peptone broth</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 2                 |
| 3.           | <b>Advanced Diagnostic Techniques (Demonstration)</b> <ol style="list-style-type: none"> <li>Enzyme-Linked Immunosorbent Assay (ELISA)</li> <li>Real-Time Polymerase Chain Reaction (RT-PCR)</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 2                 |
| 4.           | <b>Serological Diagnostic Tests based on Agglutination:</b> <ol style="list-style-type: none"> <li>Widal test (Slide test and Tube Test)</li> <li>Rapid Plasma Reagin (RPR) test</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 2                 |
| 5.           | <b>Clinical Statistical Data Analysis and Medical Coding</b> <ol style="list-style-type: none"> <li>Basic statistical analysis of any clinical data using Excel</li> <li>Introduction to Medical Coding (Demonstration)</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 1                 |
| 6.           | <b>Visit to clinical diagnostic Laboratory</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 1                 |
| <b>Total</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>15</b>         |

## Reference Books & E-Resources

1. Abramson J. and Abramson Z. H. (2011). Research Methods in Community Medicine: Surveys, Epidemiological Research, Programme Evaluation, Clinical Trials. Sixth Edition. Wiley. ISBN:978-0-470-98661-5
2. Baveja C. P. and Baveja V. (2019). Text and Practical Microbiology for MLT. 3rd Edition. Arya Publishing Company. ISBN-13: 9788178558387
3. Bergey's Manual of Systematic Bacteriology. (2005). Volume Two: The Proteobacteria, Part A: Introductory Essays. Garrity G. editor. Springer. ISBN 978-0-387-24143-2
4. Bergey's Manual of Systematic Bacteriology. (2005). Volume Two: The Proteobacteria, Part B: The Gammaproteobacteria. Garrity G. Brenner D. J., Krieg N. R., and Staley J. R. (Eds.). Springer. ISBN 978-0-387-24144-9
5. Bergey's Manual of Systematic Bacteriology. (2005). Volume Two: The Proteobacteria, Part C: The Proteobacteria. Garrity G. Brenner D. J., Krieg N. R., and Staley J. R. (Eds.). Springer. ISBN 978-0-387-24145-6
6. Bergey's Manual of Systematic Bacteriology. (2009). Volume Three: The Firmicutes. Part C: The Proteobacteria. Vos, P., Garrity, G., Jones, D., Krieg, N.R., Ludwig, W., Rainey, F.A., Schleifer, K.-H., Whitman, W. (Eds.). Springer. ISBN 978-0-387-95041-9
7. Cruickshank R and J.P. Duguid (1980) Medical Microbiology Volume II, 12th Edition. The Practice of Medical Microbiology, Churchill Livingstone Edinburgh, London and New York
8. Godkar P. B. (2020). Textbook of Medical Laboratory Technology Volume 1 and 2. 3rd edition Bhalani Publishing House. ASIN: 9381496196. ISBN-13: 978- 9381496190
9. Greer D. L., Kane J., Summerbell R., Sigler L., Krajden S. and G. Land (Editors). (1999). Laboratory handbook of dermatophytes: a clinical guide and laboratory manual of dermatophytes and other filamentous fungi from skin, hair, and nails. Mycopathologia. 147: 113–114
10. Maheshwari N. (2017). Clinical Pathology Hematology and Blood Banking (For Dmlt Students). 3rd edition. Jaypee Brothers Medical Publishers. ISBN-13: 978- 9386261182
11. Mukherjee K. L. and Ghosh S. (2010). Medical Laboratory Technology, Volume I: Procedure Manual for Routine Diagnostic Tests. 2nd edition. McGraw Hill Education (India) Private Limited. ISBN-13: 978-1259061233

**MB 306 MJ P– Practical Course MJ P-6**

|                             |                                |
|-----------------------------|--------------------------------|
| <b>Semester</b>             | <b>V</b>                       |
| <b>Course Code</b>          | <b>MB 306 MJ P</b>             |
| <b>Course Title</b>         | <b>Practical Course MJ P-6</b> |
| <b>Credits</b>              | <b>02</b>                      |
| <b>Total Teaching Hours</b> | <b>60 hours</b>                |

**Course Objectives**

| <b>CO No.</b> | <b>Course Objectives</b>                                                                                                                                                                                                                                                                        |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>CO1</b>    | To provide fundamental knowledge of enzymology, genetics, and biochemical techniques including enzyme production, purification, and characterization.                                                                                                                                           |
| <b>CO2</b>    | To develop practical skills in enzyme assays, immobilization techniques, spectrophotometric analysis, and chromatographic separation of biomolecules.                                                                                                                                           |
| <b>CO3</b>    | To familiarize students with molecular biology techniques such as isolation, purification, and quantification of genomic DNA.                                                                                                                                                                   |
| <b>CO4</b>    | To enable understanding of basic cytological techniques including the study of mitotic cell division and chromosomal behavior                                                                                                                                                                   |
| <b>CO5</b>    | To create awareness about safe handling of enzymes, chemicals, and biological samples, and to inculcate good laboratory practices during enzyme extraction, DNA isolation, spectrophotometric analysis, and cytological preparations, with relevance to enzymology and genetic experimentation. |

**Course Outcomes**

| <b>CO No.</b> | <b>Course Outcomes</b>                                                                                                                                     | <b>Bloom's Level</b> |
|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| <b>CO1</b>    | Explain the principles of enzyme kinetics, enzyme purification, immobilization, molecular genetics, and cytological techniques                             | Understand           |
| <b>CO2</b>    | Describe methods for enzyme production, biochemical analysis, chromatographic separation, and DNA isolation and quantification                             | Remember             |
| <b>CO3</b>    | Apply laboratory techniques such as enzyme assays, spectrophotometry, chromatography, DNA extraction, and preparation of buffers in experimental settings. | Apply                |
| <b>CO4</b>    | Interpret experimental data including enzyme activity, absorption spectra, chromatographic results, and DNA purity using analytical methods.               | Analyze              |
| <b>CO5</b>    | Assess the significance of enzymatic and genetic experiments in biotechnology, industrial applications, and basic biological research.                     | Evaluate             |

## Syllabus

| Sr. No. | Title of the practical                                                                                                          | No. of Practicals |
|---------|---------------------------------------------------------------------------------------------------------------------------------|-------------------|
| 1       | Determination of absorption spectra and molar extinction co-efficient of two different dyes (by colorimetry /spectrophotometry) | 2                 |
| 2       | Preparation of buffer- Phosphate buffer by using Handerson & Hasselbach equation.                                               | 1                 |
| 3       | Quantitative Estimation of Reducing sugar by 3,5 Dinitro Salicylic Acid ( DNSA) Method                                          | 1                 |
| 4       | Quantitative Estimation of Total Proteins by by Folin & Lowry's Method                                                          | 1                 |
| 5       | Microbial Amylase Production, Purification, Quantification and Immobilization:                                                  |                   |
|         | a. Isolation of amylase producing organism and Lab scale production of amylase using isolates                                   | 2                 |
|         | b. Precipitation of amylase from fermentation broth (salt/solvent)                                                              | 1                 |
|         | c. Determination of Enzyme activity & specific activity of crude & Purified amylase                                             | 1                 |
|         | d. Immobilization of amylase using calcium alginate                                                                             | 1                 |
| 6       | Paper chromatography                                                                                                            |                   |
|         | a. Separation and Identification of amino acids from mixture by ascending paper chromatography                                  | 1                 |
|         | b. Separation and Identification of sugars from mixture by descending paper chromatography                                      | 1                 |
| 7       | Isolation of genomic DNA from Bacteria                                                                                          | 1                 |
| 8       | Determination of purity of DNA and its quantification:<br>Estimation of DNA by UV- spectrophotometric method, 260/280 ratio     | 1                 |
| 9       | Study visit to a Research Laboratory/Industry                                                                                   | 1                 |
| Total   |                                                                                                                                 | 15                |

## Reference Books & E-Resources

1. Ausubel, F. M., Brent, R., Kingston, R. E., Moore, D. D., Seidman, J. G., Smith, J. A., & Struhl, K. (Eds.). (2003). *Current protocols in molecular biology*. John Wiley & Sons. ISBN: 047150338X
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3. Bollet, C., Gevaudan, M. J., de Lamballerie, X., Zandotti, C., & de Micco, P. (1991). A simple method for the isolation of chromosomal DNA from Gram-positive or acid-fast bacteria. *Nucleic Acids Research*, 19(8), 1955. <https://doi.org/10.1093/nar/19.8.1955>
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12. Sadashivam, S., & Manickam, A. (2018). *Biochemical methods* (3rd ed.). New Age International.
13. Wilson, K., & Walker, J. (Eds.). (2010). *Principles and techniques of biochemistry and molecular biology* (7th ed.). Cambridge University Press.
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**MB 310 MJ T – Fermentation Technology – I**

|                             |                                    |
|-----------------------------|------------------------------------|
| <b>Semester</b>             | <b>V</b>                           |
| <b>Course Code</b>          | <b>MB 310 MJ T</b>                 |
| <b>Course Title</b>         | <b>Fermentation Technology – I</b> |
| <b>Credits</b>              | <b>02</b>                          |
| <b>Total Teaching Hours</b> | <b>30 Hours</b>                    |

**Course Objectives**

| <b>CO No.</b> | <b>Course Objectives</b>                                                                |
|---------------|-----------------------------------------------------------------------------------------|
| <b>CO1</b>    | To impart technical understanding of commercial fermentations.                          |
| <b>CO2</b>    | To apply classical and advanced isolation & strain improvement techniques.              |
| <b>CO3</b>    | To optimize and sterilize media for commercially economical fermentations.              |
| <b>CO4</b>    | To recover products using suitable downstream methods ensuring quality by QA tests.     |
| <b>CO5</b>    | To comprehend large-scale production of commercially significant fermentation products. |

**Course Outcomes**

| <b>CO No.</b> | <b>Course Outcomes</b>                                                     | <b>Bloom's Level</b> |
|---------------|----------------------------------------------------------------------------|----------------------|
| <b>CO1</b>    | Explain commercial fermentations.                                          | Understand           |
| <b>CO2</b>    | Describe classical & advanced isolation and strain improvement techniques. | Understand           |
| <b>CO3</b>    | Relate sterilization and media optimization for economical fermentations.  | Apply                |
| <b>CO4</b>    | Analyse product quality using QA tests.                                    | Analyse              |
| <b>CO5</b>    | Assess large-scale productions of commercially significant products.       | Evaluate             |

## Syllabus

| Credits  | Topics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Lectures                                   |
|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|
| Credit I | <b>Upstream processes of fermentations</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>15</b>                                  |
|          | <b>Unit I Types of bioreactors</b><br>a. Continuous stirred-tank reactor (CSTR)<br>b. Bubble column reactor<br>c. Airlift reactor<br>d. Fluidized bed reactor<br>e. Packed bed reactor<br>f. Membrane bioreactor<br>g. Photo bioreactor                                                                                                                                                                                                                                                                                         | <b>(3)</b><br>1<br><br><br>1<br><br><br>1  |
|          | <b>Unit II Strain Improvement</b><br>a. Objectives of strain improvement<br>b. Methods for strain improvement:<br>i. Types of mutants used in strain improvement (altered cell permeability mutants, auxotrophs, analogue resistant mutants, revertants)<br>ii. Selection of different types of mutants (replica plate method, filtration enrichment, penicillin enrichment method, gradient plate technique)<br>iii. Application of rDNA technology (significance, technique for commercial recombinant products like insulin) | <b>(4)</b><br>1<br><br>1<br><br>1<br><br>1 |
|          | <b>Unit III Media optimization</b><br>a. Objectives of media optimization<br>b. Methods of media optimization:<br>i. Classical approach – One factor at a time, Full factorial design<br>ii. Plackett and Burman Design (with example)<br>iii. Response Surface Methodology (RSM)                                                                                                                                                                                                                                               | <b>(4)</b><br>1<br><br>1<br><br>1<br><br>1 |
|          | <b>Unit IV Sterilization of Media</b><br>a. Batch sterilization and Continuous sterilization (direct and indirect methods)<br>b. Concept of Del factor                                                                                                                                                                                                                                                                                                                                                                          | <b>(4)</b><br>1<br><br>1                   |

| Credits          | Topics                                                                                                                                                                                 | Lectures   |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
|                  | c. Filter sterilization of liquid media                                                                                                                                                | 2          |
| <b>Credit II</b> | <b>Downstream Processing and Quality Assurance of Fermentation Products</b>                                                                                                            | <b>15</b>  |
|                  | <b>Unit I Downstream processing of fermentation products</b><br>(method, principle, types, examples of fermentations, factors affecting, merits and demerits at large scale operation) | <b>(5)</b> |
|                  | a. Cell disruption methods                                                                                                                                                             | 1          |
|                  | b. Filtration                                                                                                                                                                          | 1          |
|                  | c. Centrifugation                                                                                                                                                                      | 1          |
|                  | d. Liquid-liquid extraction                                                                                                                                                            |            |
|                  | e. Distillation                                                                                                                                                                        | 1          |
|                  | f. Drying                                                                                                                                                                              | 1          |
|                  | <b>Unit II Quality assurance of fermentation products (as per IP, USP)</b>                                                                                                             | <b>(7)</b> |
|                  | a. Methods of detection and Quantification of the fermentation product: physicochemical, biological and enzymatic methods                                                              | 1          |
|                  | b. Sterility testing (direct inoculation method, membrane filtration method)                                                                                                           | 1          |
|                  | c. Bioburden test                                                                                                                                                                      | 1          |
|                  | d. Microbial limit test                                                                                                                                                                | 1          |
|                  | e. Pyrogen testing: Endotoxin detection (LAL test)                                                                                                                                     | 1          |
|                  | f. Ames test and modified Ames test                                                                                                                                                    | 1          |
|                  | g. Toxicity testing (Acute toxicity)                                                                                                                                                   | 1          |
|                  | h. Shelf life determination                                                                                                                                                            | 1          |
|                  | <b>Unit III Fermentation Economics</b>                                                                                                                                                 | <b>(3)</b> |
|                  | a. Contribution of various expense heads to a process (Recurring and nonrecurring expenditures) citing any suitable example.                                                           | 1          |
|                  | b. Introduction to Intellectual Property Rights – Types of IPR (patenting in fermentation industry)                                                                                    | 1          |
|                  | c. Concept of validation (significance of SOPs)                                                                                                                                        | 1          |

### Reference Books & E-Resources

- 1 Aiba S., Humphrey A. E. and Millis N.F. (1977). Biochemical Engineering. Academic Press, New York,
- 2.Arora D. K. (Editor). (2003). Fungal Biotechnology in Agriculture, Food and Environmental Applications (Mycology). CRC Press. ISBN 9780824747701.
3. Bailey J. A., Bailey J. E., Bailey J., Simpson R. J. and Ollis D. F. (1986). Biochemical Engineering Fundamentals. 2nd Edition. McGraw-Hill. Chemical Engineering Series. McGraw-Hill Publisher. ISBN: 0070032122, 9780070032125
4. BIOTOL series. (1992). Bioreactor Design and Product Yield. Butterworths- Heinemann (Publisher). ISBN-13: 978-0750615082
5. BIOTOL series. (1992). Operational Modes of Bioreactors. Butterworths-Heinemann. ISBN-13: 978-0750615082
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13. Moo-Young M. (2019). Comprehensive Biotechnology. Third edition. Volume 1: Scientific Fundamentals of Biotechnology. Volume 2: Engineering Perspectives in Biotechnology. Volume 3: Industrial Biotechnology and Commodity Products. Volume 4: Agricultural and Related Biotechnologies. Volume 5: Medical Biotechnology and Healthcare. Volume 6: Environmental and Related Biotechnologies. Pergamon Press Limited, England. ISBN: 978 0-444-64047-5

14. Patel. A. H. (2016). Industrial Microbiology. Trinity Press (Publisher). ISBN-13- 9789385750267
15. Peppler H. L. and Perlman D. (1979). Microbial Technology. Volume 1: Microbial Processes. Academic Press, New York. ISBN: 978-0-12-551501-6
16. Peppler H. L. and Perlman D. (1979). Microbial Technology. Volume II: Fermentation Technology (2nd Edition). Academic Press. ISBN: 9781483268279
17. Reed G. (Editor). (1982). Prescott and Dunn's Industrial Microbiology. Westport, CT, AVI Publishing Co Inc.
18. Stanbury P. F., Whitaker A. and Hall S. J. (2016). Principles of Fermentation Technology. 3rd Edition. Butterworth-Heinemann. ISBN: 9780080999531
19. Thomassen Y. E., van't Oever A. G., Vinke M, Spiekstra A., Wijffels R. H, van der Pol L. A. and Bakker W. A. M. (2013). Scale-down of the inactivated polio vaccine production process. Biotechnology and Bioengineering. 110(5):1354-1365. DOI: 10.1002/bit.24798.
20. Uzoigwe C., Burgess J.G., Ennis C.J. and Rahman P.K.S.M. (2015). Bioemulsifiers are not biosurfactants and require different screening approaches. Front. Microbiol.6:245. doi: 10.3389/fmicb.2015.00245.
21. Van Damme E. J. (1984) Biotechnology of Industrial Antibiotics. Marcel Dekker Inc. New York. ISBN-13: 978-0824770563
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**MB 311 MJ T – Agricultural Microbiology**

|                             |                                  |
|-----------------------------|----------------------------------|
| <b>Semester</b>             | <b>V</b>                         |
| <b>Course Code</b>          | <b>MB 311 MJ T</b>               |
| <b>Course Title</b>         | <b>Agricultural Microbiology</b> |
| <b>Credits</b>              | <b>02</b>                        |
| <b>Total Teaching Hours</b> | <b>30 Hours</b>                  |

**Course Objectives**

| <b>CO No.</b> | <b>Course Objectives</b>                                                            |
|---------------|-------------------------------------------------------------------------------------|
| <b>CO1</b>    | Recall principles of soil microbiology, plant pathology, and microbial diversity.   |
| <b>CO2</b>    | Explain plant–microbe interactions and nutrient cycling mechanisms.                 |
| <b>CO3</b>    | Apply microbial techniques in agriculture for soil fertility and crop productivity. |
| <b>CO4</b>    | Analyze plant diseases, epidemiology, and environmental influences                  |
| <b>CO5</b>    | Evaluate sustainable and integrated approaches in agricultural microbiology.        |

**Course Outcomes**

| <b>CO No.</b> | <b>Course Outcomes</b>                                    | <b>Bloom's Level</b> |
|---------------|-----------------------------------------------------------|----------------------|
| <b>CO1</b>    | Describe agricultural ecosystems and microbial diversity. | Remember             |
| <b>CO2</b>    | Explain plant–microbe relationships and nutrient cycles.  | Understand           |
| <b>CO3</b>    | Apply microbiological tools in agriculture.               | Apply                |
| <b>CO4</b>    | Analyze disease development and environmental impact.     | Analyze              |
| <b>CO5</b>    | Evaluate sustainable agricultural practices.              | Evaluate             |

## Syllabus

| Credits  | Topics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Lectures                                                    |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|
| Credit I | <b>Foundations of Agricultural Microbiology, Plant–Microbe Interactions, Plant Pathology and Epidemiology</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 15                                                          |
|          | <b>Unit I Fundamentals of Agricultural Microbiology</b> <ul style="list-style-type: none"> <li>a. Introduction to Agricultural Microbiology               <ul style="list-style-type: none"> <li>i. Scope, history, and importance</li> <li>ii. Role of microorganisms in agriculture</li> <li>iii. Concept of sustainable agriculture</li> </ul> </li> <li>b. Soil Microbiology               <ul style="list-style-type: none"> <li>i. Soil as a microbial habitat</li> <li>ii. Soil microbial diversity (bacteria, fungi, actinomycetes, algae, protozoa)</li> <li>iii. Factors affecting soil microflora</li> <li>iv. Soil enzymes and soil health indicators</li> </ul> </li> <li>c. Microbial Ecology               <ul style="list-style-type: none"> <li>i. Microbial interactions (symbiosis, parasitism, competition, antagonism, synergism, dysbiosis)</li> <li>ii. Biofilms and quorum sensing</li> <li>iii. Soil health and microbial indicators</li> </ul> </li> </ul> | 1<br><br><br><br><br><br><br>2<br><br><br><br><br><br><br>3 |
|          | <b>Unit II Plant–Microbe Interactions</b> <ul style="list-style-type: none"> <li>a. Rhizosphere Microbiology               <ul style="list-style-type: none"> <li>i. Rhizosphere concept and root exudates</li> <li>ii. Rhizosphere effect</li> </ul> </li> <li>b. Plant Growth Promoting Microorganisms (PGPM)               <ul style="list-style-type: none"> <li>i. PGPR mechanisms: nitrogen fixation, phytohormones, siderophores</li> <li>ii. Induced systemic resistance</li> </ul> </li> <li>c. Symbiotic Associations               <ul style="list-style-type: none"> <li>i. Rhizobium-legume symbiosis</li> <li>ii. Mycorrhiza (VAM, ectomycorrhiza)</li> <li>iii. Cyanobacterial associations</li> </ul> </li> </ul>                                                                                                                                                                                                                                                    | 2<br><br><br><br><br><br><br>2<br><br><br><br><br><br><br>1 |

| Credits                                   | Topics                                                                                                      | Lectures  |
|-------------------------------------------|-------------------------------------------------------------------------------------------------------------|-----------|
|                                           | <b>Unit III: Plant Pathology &amp; Epidemiology</b>                                                         |           |
|                                           | a. Plant Diseases and Development                                                                           |           |
|                                           | i. Disease cycle and stages                                                                                 | 1         |
|                                           | b. Plant Disease Epidemiology                                                                               |           |
|                                           | i. Disease triangle and tetrahedron                                                                         | 1         |
|                                           | ii. Monocyclic, polycyclic diseases                                                                         |           |
|                                           | c. Classification of Plant Diseases                                                                         | 2         |
|                                           | i. Symptom-based classification                                                                             |           |
|                                           | ii. Emerging plant diseases                                                                                 |           |
|                                           | d. Plant Disease Management                                                                                 |           |
| i. Chemical, biological, cultural control |                                                                                                             |           |
| ii. Integrated Pest Management (IPM)      |                                                                                                             |           |
| <b>Credit II</b>                          | <b>Emerging Trends in Agricultural Microbiology: Microbiomes, Biotechnology and Sustainable Agriculture</b> | <b>15</b> |
|                                           | <b>Unit I Modern Agricultural Microbiology</b>                                                              |           |
|                                           | a. Soil and Plant Microbiome                                                                                | 5         |
|                                           | i. Microbiome concept                                                                                       |           |
|                                           | ii. Metagenomics and NGS basics                                                                             |           |
|                                           | b. Agricultural Biotechnology                                                                               | 5         |
|                                           | i. GM crops (Bt, herbicide-resistant)                                                                       |           |
|                                           | ii. RNAi technology                                                                                         |           |
|                                           | iii. CRISPR basics                                                                                          |           |
|                                           | c. Climate Change and Sustainable Agriculture                                                               | 5         |
|                                           | i. Microbial role in climate resilience                                                                     |           |
| ii. Carbon sequestration                  |                                                                                                             |           |
| iii. Sustainable practices                |                                                                                                             |           |

### Reference Books & E-Resources

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1. Alexander M. – Introduction to Soil Microbiology
2. Agrios G.N. – Plant Pathology
3. Rangaswami G. – Diseases of Crop Plants in India
4. Mehrotra R.S. – Plant Pathology
5. Pepper I.L. – Environmental Microbiology
6. Kashyap P.L. – Plant Microbiome in Sustainable Agriculture
7. Stewart C.N. – Plant Biotechnology and Genetics

### E-Resources & Web Links

- ICAR: <https://icar.org.in>
- FAO: <https://www.fao.org>
- NCBI: <https://www.ncbi.nlm.nih.gov>
- PubMed: <https://pubmed.ncbi.nlm.nih.gov>
- NPTEL: <https://nptel.ac.in>
- SWAYAM: <https://swayam.gov.in>

**MB 312 MJ P– Practical Course MJ P -7**

|                             |                                |
|-----------------------------|--------------------------------|
| <b>Semester</b>             | <b>V</b>                       |
| <b>Course Code</b>          | <b>MB 312 MJ P</b>             |
| <b>Course Title</b>         | <b>Practical Course MJ P-7</b> |
| <b>Credits</b>              | <b>02</b>                      |
| <b>Total Teaching Hours</b> | <b>60</b>                      |

**Course Objectives**

| <b>CO No.</b> | <b>Course Objectives</b>                                                               |
|---------------|----------------------------------------------------------------------------------------|
| <b>CO1</b>    | To develop practical skills in microbiological and antimicrobial assays                |
| <b>CO2</b>    | To train students in pharmaceutical and food microbiology quality control techniques   |
| <b>CO3</b>    | To impart knowledge and hands-on experience in the analysis of fermentation products   |
| <b>CO4</b>    | To impart knowledge and hands-on experience in the analysis of fermentation products   |
| <b>CO5</b>    | To expose students to industrial fermentation practices and quality assurance systems. |

**Course Outcomes**

| <b>CO No.</b> | <b>Course Outcomes</b>                                                     | <b>Bloom's Level</b> |
|---------------|----------------------------------------------------------------------------|----------------------|
| <b>CO1</b>    | Perform microbiological assays and evaluate antimicrobial activity         | Apply                |
| <b>CO2</b>    | Apply pharmaceutical and food microbiology quality control techniques      | Apply                |
| <b>CO3</b>    | Quantify and analyze fermentation products                                 | Analyze              |
| <b>CO4</b>    | Demonstrate proficiency in downstream processing techniques                | Apply                |
| <b>CO5</b>    | Evaluate industrial fermentation processes and quality assurance practices | Evaluate             |

**Syllabus**

| Sr. No.   | Title of the practical                                                                                                                                                                                                                                         | No. of Practicals |
|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| <b>1</b>  | Determination of    1) Minimum Inhibitory Concentration (MIC)<br>2) Minimum Bactericidal Concentration (MBC)                                                                                                                                                   | <b>2</b>          |
| <b>2</b>  | a. Microbiological Assay of Antibiotics: Determination of antibiotic potency using suitable test microorganisms.<br>b. Microbiological Assay of Growth Factors: Estimation of growth factors (e.g., vitamins or amino acids) using specific microbial strains. | <b>2</b>          |
| <b>3</b>  | Bacterial endotoxin assay (Use Kit)                                                                                                                                                                                                                            | <b>1</b>          |
| <b>4</b>  | Bio burden test of medical liquid samples by membrane filtration method                                                                                                                                                                                        | <b>1</b>          |
| <b>5</b>  | Microbial limit test for presence of pathogens                                                                                                                                                                                                                 | <b>1</b>          |
| <b>6</b>  | Sterility testing of pharmaceutical products such as injectables/ surgicals by direct inoculation and Membrane Filtration method                                                                                                                               | <b>1</b>          |
| <b>7</b>  | Shelf-life testing of fermented food sample [ Physico-chemical & Microbiological Methods]                                                                                                                                                                      | <b>2</b>          |
| <b>8</b>  | Quantification of a fermentation product in broth by titration – eg. Citrate                                                                                                                                                                                   | <b>1</b>          |
| <b>9</b>  | Quantification of a fermentation product in broth by colorimetric method – eg. Alcohol by (Cerric Ammonium Nitrate) CAN method                                                                                                                                 | <b>1</b>          |
| <b>10</b> | Detection of Vitamin B <sub>12</sub> from fermentation broth Using Thin-Layer Chromatography (TLC)                                                                                                                                                             | <b>1</b>          |
| <b>11</b> | Liquid-Liquid extraction of microbial pigments.                                                                                                                                                                                                                | <b>1</b>          |
| <b>12</b> | Visit to a fermentation Industry with emphasis on quality control tests of the fermentation product                                                                                                                                                            | <b>1</b>          |
|           | <b>TOTAL</b>                                                                                                                                                                                                                                                   | <b>15</b>         |

## Reference Books & E-Resources

1. Aiba S., Humphrey A. E. and Millis N.F. (1977). Biochemical Engineering. Academic Press, New York,
2. British Pharmacopoeia. (2021). The Stationery Office Ltd (TSO), PO Box 29, Norwich, NR3 1PD. <https://www.pharmacopoeia.com/Catalogue/Products>
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12. European Pharmacopoeia (Ph. Eur.) - General Chapter 2.7.2: Microbiological assay of antibiotics.
13. USP (United States Pharmacopoeia) - General Chapter <81>: Antibiotics—Microbial Assays.
14. Japanese Pharmacopoeia (JP) - General Tests: Microbial Assay for Antibiotics
15. Hewitt, W. (1977). *Microbiological Assay*: New York, Academic Press.
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19. General Methods for Vitamin Assay (1947): L. Atkin et al.

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21. EUCAST Definitive Document (2000/2003)
22. Balows, A., et al. (Eds.) - "Manual of Clinical Microbiology":
23. The Minimum Inhibitory Concentration of Antibiotics - PMC: A comprehensive review [PMC7913839]
24. CLSI Standards (Clinical and Laboratory Standards Institute): M07-A11 (Methods for Dilution Antimicrobial Susceptibility Tests)
25. The Minimum Inhibitory Concentration of Antibiotics - [PMC – NIH PubMed Central \(PMC\) \(.gov\)](https://pubmed.ncbi.nlm.nih.gov/articles/PMC7913839/) <https://pubmed.ncbi.nlm.nih.gov/articles/PMC7913839/> by B Kowalska-Krochmal · 2021
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29. Novitsky, T.J., & Roslansky, P.F. (1985): Quantification of Endotoxin Inhibition in Serum and Plasma Using a Turbidimetric Limulus Amebocyte Lysate Assay.
30. Rietschel, E.T. et al. (1994): *Bacterial endotoxin: molecular relationships of structure to activity and function* (FASEB J).
31. FDA Guidance for Industry (2012): *Pyrogen and Endotoxins Testing: Questions and Answers*.
32. **ISO 11737-1: Sterilization of medical devices - Microbiological methods - Part 1: Estimation of population of microorganisms on products.**

**MB 313 MJ P– Practical Course MJ P-8**

|                             |                                |
|-----------------------------|--------------------------------|
| <b>Semester</b>             | <b>V</b>                       |
| <b>Course Code</b>          | <b>MB 313 MJ P</b>             |
| <b>Course Title</b>         | <b>Practical course MJ P-8</b> |
| <b>Credits</b>              | <b>02</b>                      |
| <b>Total Teaching Hours</b> | <b>60</b>                      |

**Course Objectives**

| <b>CO No.</b> | <b>Course Objectives</b>                                                                                                                                                              |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>CO1</b>    | To develop skills in soil sampling, physicochemical analysis, and assessment of soil microbial quality.                                                                               |
| <b>CO2</b>    | To isolate, identify, and characterize agriculturally important microorganisms, including phosphate-solubilizing bacteria, PGPR, and nitrogen-fixing microorganisms.                  |
| <b>CO3</b>    | To study plant diseases through symptom-based identification and isolation of fungal and bacterial plant pathogens from infected plant materials.                                     |
| <b>CO4</b>    | To provide hands-on training in the preparation, evaluation, and application of biofertilizers and biocontrol agents for sustainable agriculture.                                     |
| <b>CO5</b>    | To expose students to agricultural microbiology practices through laboratory experiments, field-based activities, and visits to agricultural farms or biofertilizer production units. |

**Course Outcomes**

| <b>CO No.</b> | <b>Course Outcome</b>                                                                                     | <b>Bloom's Level</b> |
|---------------|-----------------------------------------------------------------------------------------------------------|----------------------|
| <b>CO1</b>    | Perform soil sampling and physicochemical analysis for assessment of soil quality.                        | Apply                |
| <b>CO2</b>    | Isolate, enumerate, and identify agriculturally important microorganisms from soil and plant samples.     | Apply                |
| <b>CO3</b>    | Analyse plant disease symptoms and identify microbial plant pathogens.                                    | Analyze              |
| <b>CO4</b>    | Evaluate the plant growth-promoting and biocontrol potential of beneficial microorganisms.                | Evaluate             |
| <b>CO5</b>    | Apply biofertilizer technologies and agricultural microbiology practices for sustainable crop production. | Apply                |

**Syllabus**

| Sr. No.  | Title of the practical                                                                                                                                                                                                                                                      | No. of Practical |
|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| <b>1</b> | <b>Soil Sampling and Physico-chemical Analysis</b><br>i. SOPs Collection of soil samples<br>ii. Determination of pH, moisture content & electrical conductivity                                                                                                             | <b>1</b>         |
| <b>2</b> | <b>Isolation of Soil Microorganisms</b><br>Serial dilution and spread plate technique for bacteria & Fungi                                                                                                                                                                  | <b>1</b>         |
| <b>3</b> | <b>Enumeration of Soil Microflora</b><br>Testing microbial quality of soil with respect to<br>i. Phosphate solubilizing Bacteria<br>ii. Nitrogen Fixing Bacteria ( Free living)                                                                                             | <b>2</b>         |
| <b>4</b> | <b>Phosphate Solubilizing bacteria</b><br>• Isolation & Identification of P-solubilizing microorganisms                                                                                                                                                                     | <b>1</b>         |
| <b>5</b> | <b>Isolation of PGPR from Rhizosphere</b><br>i. Screening & detection of PGPR traits qualitatively ( Zinc, potash & Silica solubilization),<br>ii. ( IAA production, siderophore, Nitrate reduction- Any one )                                                              | <b>2</b>         |
| <b>6</b> | <b>Study Free living &amp; symbiotic Nitrogen fixers</b><br>i. Isolation & Identification of <i>Rhizobium</i> spp. from legume root nodules<br>ii. Isolation & Identification of <i>Azotobacter</i> , <i>Bacillus</i> , and <i>Pseudomonas</i> spp. from soil               | <b>2</b>         |
| <b>7</b> | <b>Identification of Plant Diseases</b><br>Study of diseased plant specimens ( identification of diseases) ,Symptom-based classification 5 plant specimens ( fungal, viral, Bacterial diseases) collection and documentation.( e- herbarium preparation) – [Activity based] | <b>1</b>         |

|           |                                                                                                                                                                                                                                                                                                                                          |           |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>8</b>  | <b>Isolation of Plant Pathogens</b><br>i. Fungal pathogen isolation from infected plant parts Tikka disease of groundnut / wilts/ smuts/ argots/ mildews etc. (any one).<br>ii. Bacterial pathogen isolation from infected plant parts <i>Xanthomoas citri</i> / <i>Erwinia</i> spp. ( any one)                                          | <b>2</b>  |
| <b>9</b>  | <b>Biofertilizer Study and Characterization</b><br>i. Preparation & lab testing of Bacterial / algal Biofertilizer – liquid formulation ( any one)<br>ii. Validation of commercial formulations of bioinoculants based on BIS standards, Pot studies to check effect of bioinoculants on plant growth, Testing of Seed germination index | <b>1</b>  |
| <b>10</b> | <b>Biocontrol Activity Assay</b><br>Antagonistic activity of <i>Trichoderma</i> spp. or <i>Pseudomonas</i> spp. (dual culture method – demo experiment) (any one)                                                                                                                                                                        | <b>1</b>  |
| <b>11</b> | <b>Field visit</b> to agricultural farm / biofertilizer unit                                                                                                                                                                                                                                                                             | <b>1</b>  |
|           | <b>TOTAL</b>                                                                                                                                                                                                                                                                                                                             | <b>15</b> |

## Reference Books & E-Resources

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### Books

1. Rangaswami, G. & Bagyaraj, D.J. Agricultural Microbiology.
2. Subba Rao, N.S. Agricultural Microbiology.
3. Pareek, R.P. & Pareek, N. Agricultural Microbiology.
4. Agrios, G.N. Plant Pathology.
5. Singh, R.S. Introduction to Plant Pathology.
6. Sylvia, D.M. et al. Principles and Applications of Soil Microbiology.
7. Paul, E.A. Soil Microbiology, Ecology and Biochemistry.
8. Kumar, A. Techniques in Agricultural Microbiology.
9. Cappuccino & Sherman – *Microbiology: A Laboratory Manual*
10. Aneja K.R. – *Experiments in Microbiology*

### E-Resources

- ICAR – Protocols and manuals
- FAO – Soil and agriculture resources
- NCBI – Molecular techniques
- NPTEL – Video demonstrations
- SWAYAM – Online courses

**MB 321 VSC – Waste Water Treatment and Management**

|                             |                                             |
|-----------------------------|---------------------------------------------|
| <b>Semester</b>             | <b>V</b>                                    |
| <b>Course Code</b>          | <b>MB 321 VSC</b>                           |
| <b>Course Title</b>         | <b>Waste Water Treatment and Management</b> |
| <b>Credits</b>              | <b>02</b>                                   |
| <b>Total Teaching Hours</b> | <b>30 Hours</b>                             |

**Course Objectives**

| <b>CO No.</b> | <b>Course Objectives</b>                                                         |
|---------------|----------------------------------------------------------------------------------|
| <b>CO1</b>    | To make students learn methods for treatment of waste water.                     |
| <b>CO2</b>    | To acquaint students with physico-chemical composition of effluents.             |
| <b>CO3</b>    | To understand design and operation of wastewater treatment plants.               |
| <b>CO4</b>    | To analyze water quality and design treatment units for sustainable water reuse. |
| <b>CO5</b>    | To create awareness about public health importance.                              |

**Course Outcomes**

| <b>CO No.</b> | <b>Course Outcomes</b>                                                                | <b>Bloom's Level</b> |
|---------------|---------------------------------------------------------------------------------------|----------------------|
| <b>CO1</b>    | Analyze wastewater and set standards for its disposal.                                | Understand           |
| <b>CO2</b>    | Select appropriate treatment method based on physico-chemical composition.            | Understand           |
| <b>CO3</b>    | Purify wastewater by designing a treatment plant.                                     | Apply                |
| <b>CO4</b>    | Design, operate, and manage treatment systems.                                        | Analyze              |
| <b>CO5</b>    | Protect public health and environment by removing pollutants to regulatory standards. | Evaluate             |

## Syllabus

| Credit          | Topic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Lectures                  |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| <b>Credit I</b> | <b>Fundamentals of Wastewater Treatment</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>15</b>                 |
|                 | <b>Unit I Introduction to Wastewater Treatment</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>(8)</b>                |
|                 | <ul style="list-style-type: none"> <li>a. Definition and sources of Wastewater (domestic, industrial, agricultural), concept of sewage and effluent</li> <li>b. The need for treatment of wastewater</li> <li>c. Composition of wastewater <ul style="list-style-type: none"> <li>General characteristics of waste water - pH, Color Turbidity, Odour, Electrical conductivity, COD, BOD, Solids (Total Solids, Total Dissolved Solids, Total Suspended Solids, Total Volatile Solids), Chlorides, Sulphates, Oil and Grease.</li> </ul> </li> <li>d. Microorganisms present in Wastewater</li> <li>e. Standards of drinking water as per Bureau of Indian Standards and permissible limits for disposal of wastewater</li> </ul> | 2<br>1<br>3<br><br>1<br>1 |
|                 | <b>Unit II Collection system and Primary Wastewater Treatment</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>(7)</b>                |
|                 | <ul style="list-style-type: none"> <li>a. Design of wastewater treatment plant</li> <li>b. Collection system <ul style="list-style-type: none"> <li>i. Methods of collection,</li> <li>ii. Conservation systems</li> <li>iii. Water carriage system, sewerage system.</li> </ul> </li> <li>c. Primary Wastewater Treatment <ul style="list-style-type: none"> <li>i. Screening</li> <li>ii. Grit removal</li> <li>iii. Oil and grease removal</li> <li>iv. Coagulation and Flocculation</li> <li>v. Equalization</li> <li>vi. Sedimentation</li> <li>vii. Floatation</li> </ul> </li> </ul>                                                                                                                                       | 1<br>2<br><br>4           |

| Credit           | Topic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Lectures                                 |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|
| <b>Credit II</b> | <b>Secondary and Tertiary Wastewater Treatments</b>                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>15</b>                                |
|                  | <b>Unit I Secondary Wastewater Treatment</b><br>a. Role of microorganisms in wastewater treatment<br>b. Removal of pathogenic microbes, indicator microbes,<br>c. aerobic and anaerobic, suspended and attached growth processes<br>d. Aerobic -attached / anchored and suspended growth models- Activated sludge process, Trickling filter<br>e. Anaerobic digestion models- Upflow Anaerobic Sludge Blanket (UASB) reactor<br>f. Advantages of biological process to treat wastewater | <b>(9)</b><br>1<br>1<br>2<br>2<br>2<br>1 |
|                  | <b>Unit II Tertiary Wastewater Treatment</b><br>(Working Principle, Process and advantages-disadvantages of following methods)<br>a. Chlorination<br>b. UV radiation<br>c. Ozonation<br>d. Reverse Osmosis<br>e. Membrane filters- ultra and micro<br>f. Nutrient removal- Nitrogen and Phosphorous<br>g. Adsorption- activated charcoal treatment, Biosorption<br>h. Ion Exchange<br>i. Effluent disposal, control and recycling.                                                      | <b>(6)</b><br>4<br>2                     |

### Reference Books & E-Resources

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1. Chandrappa R. and Das D. B. (2012). Solid Waste Management-Principles and Practice. In Environmental Science and Engineering. Springer (Firm).
2. Dutta S., Neela Priya D., Chakradhar B. and Sasi Jyothsna T.S. (2019) Value Added Byproducts Recovery from Municipal Solid Waste in Waste Valorisation and Recycling. Springer, Singapore.
3. G.L. Karia and R.A Christian Wastewater Treatment: Concepts and Design Approach
4. Kanwaljit Kaur. Handbook of water and wastewater analysis
5. Mackenzie L. Davis, Water and Wastewater Engineering- Design Principles and Practice
6. Masters G. M. (1994). Introduction to Environmental Engineering and Science. Prentice Hall of India (Private) Ltd., New Delhi.
7. Metcalf and Eddy (Eds.) 2003. Wastewater Engineering – Treatment and Reuse. 4th Edition. Tata Mac Graw Hill Publishing Co. Ltd. New Delhi.
8. Srivastava Anamika. Wastewater Treatment and Water Management - Water Treatment and Management

**MB 331 FP – Field Project**

|                             |                      |
|-----------------------------|----------------------|
| <b>Semester</b>             | <b>V</b>             |
| <b>Course Code</b>          | <b>MB 331 FP</b>     |
| <b>Course Title</b>         | <b>Field Project</b> |
| <b>Credits</b>              | <b>02</b>            |
| <b>Total Teaching Hours</b> | <b>60 Hours</b>      |

**Course Objectives**

| <b>CO No.</b> | <b>Course Objectives</b>                                                                       |
|---------------|------------------------------------------------------------------------------------------------|
| <b>CO1</b>    | To understand the principles of research methodology and microbiological techniques.           |
| <b>CO2</b>    | To develop skills in research problem formulation, literature review, and experimental design. |
| <b>CO3</b>    | To apply microbiological techniques in scientific investigations.                              |
| <b>CO4</b>    | To analyze and interpret experimental data using appropriate methods.                          |
| <b>CO5</b>    | To design, execute, and communicate scientific research effectively.                           |

**Course Outcomes**

| <b>CO No.</b> | <b>Course Outcome</b>                                                          | <b>Bloom's Level</b> |
|---------------|--------------------------------------------------------------------------------|----------------------|
| <b>CO1</b>    | Explain the principles of research methodology and microbiological techniques. | Understand           |
| <b>CO2</b>    | Formulate research problems and design appropriate experimental strategies.    | Apply                |
| <b>CO3</b>    | Apply microbiological techniques to conduct scientific investigations.         | Apply                |
| <b>CO4</b>    | Analyze and interpret experimental data using appropriate tools and methods.   | Analyze              |

## Research Planning, Execution and Scientific Reporting



**Savitribai Phule  
Pune University**  
(Formerly University of Pune)

As per NEP 2020  
& SPPU Pattern 2024

Effective from A.Y. 2026–27

# FIELD PROJECT

## RESEARCH PLANNING, EXECUTION & SCIENTIFIC REPORTING

PLAN • EXECUTE • ANALYZE • REPORT • IMPACT

A structured approach to develop research skills, scientific temper and professional competence through hands-on project work and effective scientific communication.



### COURSE STRUCTURE

| Units    | Title                                            | Topics                                                                                                                 | No. of hrs. |
|----------|--------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|-------------|
| Unit I   | <b>Research Planning &amp; Literature Review</b> | Research methodology, problem identification, literature survey (PubMed, Google Scholar), hypothesis, proposal writing | 12          |
| Unit II  | <b>Experimental Design &amp; Methodology</b>     | Materials & methods, microbiological techniques, sampling, controls, biosafety                                         | 12          |
| Unit III | <b>Execution of Project Work</b>                 | Experimentation, data collection, documentation, troubleshooting                                                       | 20          |
| Unit IV  | <b>Data Analysis &amp; Interpretation</b>        | Tabulation, graphs, statistical analysis (mean, SD), interpretation                                                    | 8           |
| Unit V   | <b>Scientific Writing &amp; Presentation</b>     | Report writing, referencing styles, PPT/poster, plagiarism, ethics                                                     | 8           |

### LEARNING OUTCOMES

|                                           |                                                   |                                               |                                               |                                      |
|-------------------------------------------|---------------------------------------------------|-----------------------------------------------|-----------------------------------------------|--------------------------------------|
| <br>Identify and define research problems | <br>Design and execute experiments systematically | <br>Analyze and interpret data scientifically | <br>Prepare scientific reports with integrity | <br>Communicate research effectively |
|-------------------------------------------|---------------------------------------------------|-----------------------------------------------|-----------------------------------------------|--------------------------------------|

### DEVELOPS ESSENTIAL SKILLS

|                       |                   |                       |                              |                        |                     |
|-----------------------|-------------------|-----------------------|------------------------------|------------------------|---------------------|
| <br>Research Aptitude | <br>Data Analysis | <br>Critical Thinking | <br>Scientific Communication | <br>Ethics & Integrity | <br>Problem Solving |
|-----------------------|-------------------|-----------------------|------------------------------|------------------------|---------------------|

**Building Researchers.  
Creating Solutions.  
Impacting Society.**



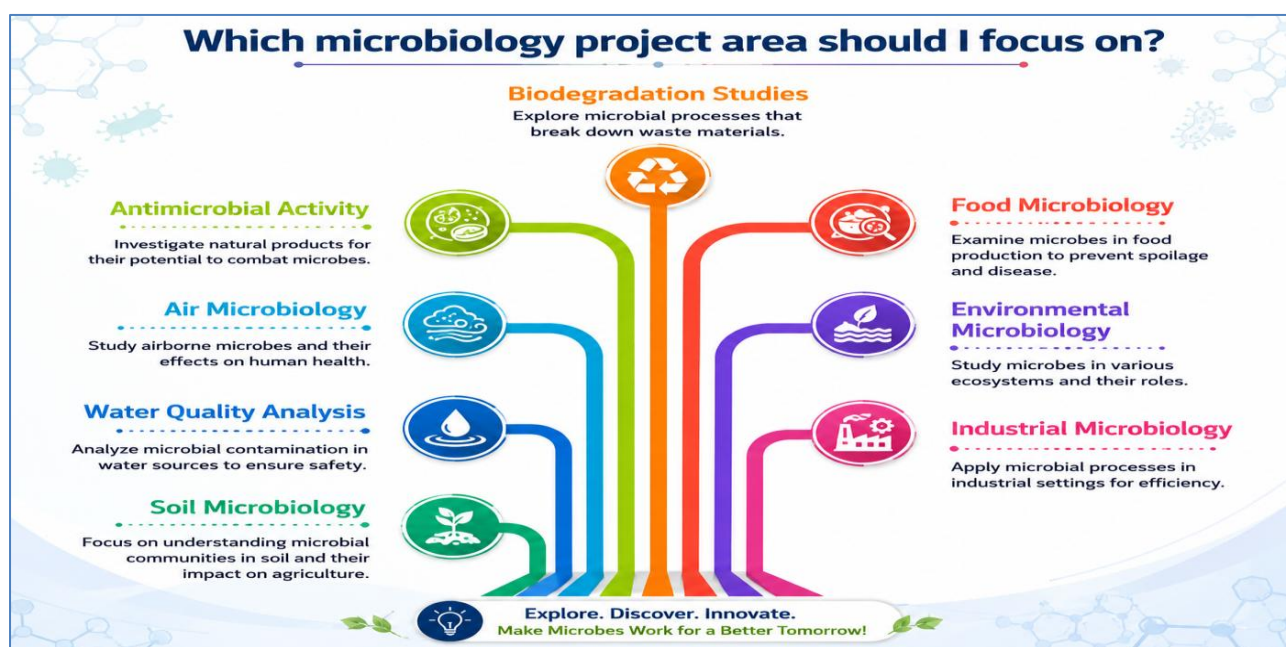
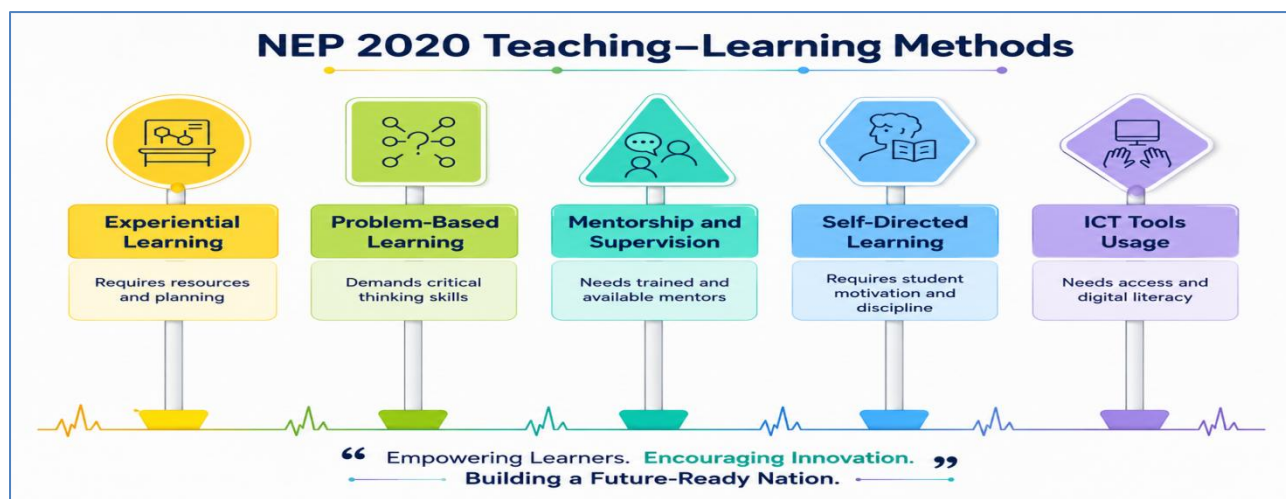
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Your Research Today,  
**A Better Tomorrow!**

**Assessment Pattern**

| Component                       | Marks           |
|---------------------------------|-----------------|
| Project Proposal & Review       | 05              |
| Experimental Work & Performance | 05              |
| Project Report                  | 10              |
| Presentation (PPT / Poster)     | 05              |
| Viva Voce                       | 05              |
| <b>Total</b>                    | <b>30 Marks</b> |

**Sample Project Areas****Teaching–Learning Methods (NEP 2020)**

### Reference Books & E-Resources

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1. Kothari C.R. – Research Methodology
2. Aneja K.R. – Experiments in Microbiology
3. Cappuccino & Sherman – Microbiology: A Laboratory Manual
4. PubMed <https://pubmed.ncbi.nlm.nih.gov>
5. Google Scholar : <https://scholar.google.com>
6. NCBI: <https://www.ncbi.nlm.nih.gov>
7. ICMR: <https://www.icmr.gov.in>
8. WHO: <https://www.who.int>
9. SWAYAM: <https://swayam.gov.in>

**MB 341 MN T – Applied Microbiology**

|                             |                             |
|-----------------------------|-----------------------------|
| <b>Semester</b>             | <b>V</b>                    |
| <b>Course Code</b>          | <b>MB 341 MN T</b>          |
| <b>Course Title</b>         | <b>Applied Microbiology</b> |
| <b>Credits</b>              | <b>02</b>                   |
| <b>Total Teaching Hours</b> | <b>30 Hours</b>             |

**Course Objectives**

| <b>CO No.</b> | <b>Course Objectives</b>                                                                                               |
|---------------|------------------------------------------------------------------------------------------------------------------------|
| <b>CO1</b>    | To provide knowledge of advanced applications of microorganisms in industry, environment, agriculture, and healthcare. |
| <b>CO2</b>    | To develop students' ability to analyze real-world microbiological processes.                                          |
| <b>CO3</b>    | To familiarize students with emerging microbial technologies such as biosensors, probiotics, and bioremediation.       |
| <b>CO4</b>    | To encourage students to solve environmental and industrial problems using microbial approaches.                       |
| <b>CO5</b>    | To create awareness about sustainable and eco-friendly microbial technologies.                                         |

**Course Outcomes**

| <b>CO No.</b> | <b>Course Outcomes</b>                                                             | <b>Bloom's Level</b> |
|---------------|------------------------------------------------------------------------------------|----------------------|
| <b>CO1</b>    | Explain industrial and environmental applications of microorganisms.               | Understand           |
| <b>CO2</b>    | Describe microbial processes involved in product development.                      | Describe             |
| <b>CO3</b>    | Apply microbiological concepts to real-life industrial and environmental problems. | Apply                |
| <b>CO4</b>    | Interpret case studies related to microbial biotechnology.                         | Analyze              |
| <b>CO5</b>    | Assess the importance of microbes in sustainable development.                      | Evaluate             |

## Syllabus

| Credits          | Topics                                                                                                                                                                                                                                                                                              | Lectures   |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>Credit I</b>  | <b>Industrial Microbiology and Fermentation Technology</b>                                                                                                                                                                                                                                          | <b>15</b>  |
|                  | <b>Unit I Industrial Microbiology, Fermentation Technology and Microbial Products</b>                                                                                                                                                                                                               | <b>(9)</b> |
|                  | a. Scope and importance of applied microbiology <ul style="list-style-type: none"> <li>i. Introduction to fermentation process</li> <li>ii. Bioreactors and its types</li> <li>iii. Types of fermentation processes (Solid and liquid state fermentation, comparative account, examples)</li> </ul> | 4          |
|                  | b. Industrially important microorganisms–<br>List of industrially important microbes and their products.<br>Introduction and industrial significance of <i>Lactobacillus</i> , <i>Saccharomyces</i> and <i>Streptomyces</i>                                                                         | 2          |
|                  | c. Industrial production of microbial products: [ Flow sheets] <ul style="list-style-type: none"> <li>i. Mushrooms (Solid state fermentation)</li> <li>ii. Spirulina</li> <li>iii. Organic acid (Citric acid)</li> </ul>                                                                            | 3          |
|                  | <b>Unit II Applied Food and Dairy Microbiology</b>                                                                                                                                                                                                                                                  | <b>(6)</b> |
|                  | a. Microbial fermentation in food industry <ul style="list-style-type: none"> <li>i. Introduction to fermented foods</li> <li>ii. Types of fermented food</li> </ul>                                                                                                                                | 02         |
|                  | b. Dairy microbiology and starter cultures used in dairy products                                                                                                                                                                                                                                   | 01         |
|                  | c. Probiotics and their role in gut health – Definition, Classification, examples and significance                                                                                                                                                                                                  | 03         |
| <b>Credit II</b> | <b>Environmental and Sustainable Microbiology</b>                                                                                                                                                                                                                                                   | <b>15</b>  |
|                  | <b>Unit I Microbes in Environmental Sustainability –</b>                                                                                                                                                                                                                                            | <b>(6)</b> |
|                  | a. Environmental sustainability and its significance,                                                                                                                                                                                                                                               | 02         |

| Credits | Topics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Lectures                                     |
|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|
|         | <p>b. Use of microbial systems with examples,</p> <p>c. Definitions with one example of –</p> <ul style="list-style-type: none"> <li>i. Biostimulation</li> <li>ii. Bioattenuation</li> <li>iii. Bioleaching</li> <li>iv. Biosorption</li> <li>v. Bioaccumulation</li> <li>vi. Bioventing</li> <li>vii. Biosparging</li> <li>viii. Biofiltration</li> <li>ix. Bioslurping</li> <li>x. Biopiles</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                              | 04                                           |
|         | <p><b>Unit II Modern Applications of Microbiology</b></p> <p>a. Recombinant Microbial products:</p> <p>Introduction and significance, outline of general production process and application – [ Flow sheets]</p> <ul style="list-style-type: none"> <li>i. Biopharmaceuticals (hormones-any one example)</li> <li>ii. Vaccines: Recombinant vaccines (any one example)</li> <li>iii. Industrial enzymes: Amylase and lipases</li> <li>iv. Antibodies: Recombinant antibodies</li> </ul> <p>b. Microorganisms in bioenergy:</p> <ul style="list-style-type: none"> <li>i. Bioenergy And Its Significance,</li> <li>ii. Introduction To Bioethanol,</li> <li>iii. Biodiesel,</li> <li>iv. Biohydrogen And Biogas,</li> <li>v. Microbial Fuel Cells (Concept And Overview Of Production Using Microbial System</li> </ul> | <p><b>(9)</b></p> <p>2</p> <p>4</p> <p>3</p> |

### Reference Books & E-Resources

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**MB 351 MJ T – Medical Microbiology – II**

|                             |                                  |
|-----------------------------|----------------------------------|
| <b>Semester</b>             | <b>VI</b>                        |
| <b>Course Code</b>          | <b>MB 351 MJ T</b>               |
| <b>Course Title</b>         | <b>Medical Microbiology – II</b> |
| <b>Credits</b>              | <b>02</b>                        |
| <b>Total Teaching Hours</b> | <b>30 Hours</b>                  |

**Course Objectives**

| <b>CO No.</b> | <b>Course Objectives</b>                                                                                                           |
|---------------|------------------------------------------------------------------------------------------------------------------------------------|
| <b>CO1</b>    | To provide fundamental and advanced knowledge of antimicrobial agents, viral, parasitic, and fungal pathogens.                     |
| <b>CO2</b>    | To develop understanding of mechanisms of action of antimicrobial agents and analytical/diagnostic skills for infectious diseases. |
| <b>CO3</b>    | To familiarize students with pathogenesis, host–pathogen interaction, chemotherapy, and antimicrobial resistance.                  |
| <b>CO4</b>    | To encourage critical thinking related to emerging infectious diseases and hospital-acquired infections.                           |
| <b>CO5</b>    | To create awareness about public health aspects including infection control, vaccination, and disease prevention.                  |

**Course Outcomes**

| <b>CO No.</b> | <b>Course Outcome</b>                                                                                                            | <b>Bloom's Level</b> |
|---------------|----------------------------------------------------------------------------------------------------------------------------------|----------------------|
| <b>CO1</b>    | Explain classification, structure and pathogenic mechanisms of clinically important microorganisms.                              | Understand           |
| <b>CO2</b>    | Describe aetiology, pathogenesis, clinical manifestations and epidemiology of major infectious diseases.                         | Understand           |
| <b>CO3</b>    | Apply knowledge of antimicrobial agents and laboratory diagnostic techniques for identification of pathogens.                    | Apply                |
| <b>CO4</b>    | Interpret clinical and laboratory data including microbiological reports, antimicrobial sensitivity, and immunological findings. | Analyze              |
| <b>CO5</b>    | Assess antimicrobial resistance mechanisms and evaluate effectiveness of infection control and vaccination strategies.           | Evaluate             |

## Syllabus

| Credit           | Topic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Lectures                                                                           |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| <b>Credit I</b>  | <b>Chemotherapy and Mechanisms of Drug Resistance</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>15</b>                                                                          |
|                  | <b>Unit I Chemotherapy</b><br>a. Definition of chemotherapy, Desirable parameters of chemotherapeutic agent (Selective toxicity, Bioavailability of Drug, LD-50 value), routes of drug administration, MIC, MBC<br>b. Routes of drug administration.<br>c. Mode of action of antimicrobial agents on:<br>1. Bacteria:<br>i. Cell wall: Beta lactam (Generations of B Lactam)<br>ii. Cell membrane: Polymyxin<br>iii. Protein synthesis: Streptomycin, Tetracycline<br>iv. Nucleic acids: Rifamycin, Ciprofloxacin<br>v. Enzyme inhibitors: Trimethoprim, Sulfamethoxazole<br>2. Fungi: Griseofulvin, Amphotericin B.<br>3. Viruses: Acyclovir, Aceltamivir.<br>4. Protozoa: Metronidazole, Chloroquine | <b>(10)</b><br><br><br>2<br><br>1<br><br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1 |
|                  | <b>Unit II Resistance to Antibiotics</b><br>a. Development of antibiotic resistance (ESBL, VRE, MRSA)<br>b. Reasons and mechanism of drug resistance<br>c. Antibiotic misuse                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>(5)</b><br>2<br>2<br>1                                                          |
| <b>Credit II</b> | <b>Medical Virology, Parasitology, and Mycology</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>15</b>                                                                          |
|                  | <b>Unit I Medical Virology</b><br>a. Introduction to the cultivation of viruses.<br>b. Study of the following groups of viral pathogens:<br>Human viruses (with respect to – Virion morphology, Characteristics, Viability characteristics, Pathogenicity, Pathogenesis, Symptoms, Laboratory diagnosis including serological diagnosis, Epidemiology, Prophylaxis and                                                                                                                                                                                                                                                                                                                                 | <b>(10)</b><br>1<br>9                                                              |

| Credit | Topic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Lectures            |
|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
|        | <p>Chemotherapy):</p> <ol style="list-style-type: none"> <li>Respiratory Viruses: Influenza Virus (H1N1)</li> <li>Arthropod-borne Virus: Dengue</li> <li>Hepatic Virus: Hepatitis A &amp; B Virus</li> <li>Gastrointestinal Virus: Rotavirus</li> <li>Cutaneous Viruses: Human papillomavirus</li> <li>Neurological Viruses: Japanese Encephalitis Virus</li> <li>Human Immunodeficiency Virus: (HIV)</li> <li>Animal Viruses: FMD Virus, Lumpy skin disease.(LSD)</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                     |
|        | <p><b>Unit II Parasitology, and Mycology</b></p> <ol style="list-style-type: none"> <li>Study of following groups of parasites (with respect to Classification, Lifecycle, Morphological characteristics, Viability characteristics, Pathogenicity, Pathogenesis, Symptoms, Laboratory diagnosis (Serological diagnosis wherever applicable), Epidemiology, Prophylaxis and Chemotherapy): .             <ol style="list-style-type: none"> <li><i>Giardia lamblia</i></li> <li><i>Toxoplasma gondii</i></li> </ol> </li> <li>Study of following groups of yeast and fungal pathogens (With respect to – Morphological and cultural characteristics, Classification, Pathogenicity, Pathogenesis, Symptoms, Laboratory diagnosis, Epidemiology, Prophylaxis and Chemotherapy) .             <ol style="list-style-type: none"> <li>Dermatophytes :                 <ol style="list-style-type: none"> <li><i>Microsporum audouinii</i></li> <li><i>Epidermophyton floccosum</i></li> <li><i>Trichophyton rubrum</i></li> </ol> </li> <li><i>Cryptococcus neoformans</i></li> <li><i>Histoplasma Capsulatum</i></li> </ol> </li> </ol> | <p>(5)</p> <p>5</p> |

## Reference Books & E-Resources

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13. Mayers D. L., Sobel J.D., Ouellette M., Kaye K.S. and Marchaim D. (Eds.) (2017). Antimicrobial
14. Drug Resistance: Mechanisms of Drug Resistance. Volume 1. Edition 2. Springer. ISBN 978-3-319-46718-4.
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#### Links:

<https://www.who.int/travel-advice/disease-information> 43 CBCS: 2022 pattern

#### E-Learning Resources

1. <http://www.who.ch>- World Health Organization
2. <http://www.ncbi.nlm.nih.gov/PubMed>- PubMed -Medline on the Web.
3. <http://www.cdc.gov>- US Centers for Disease Control (Atlanta)
4. <http://www.who.int/emc/>-WHO Communicable Disease Surveillance and Response
5. Microbiology Virtual Learning Platforms – MicrobeNotes / OpenStax

**MB 352 MJ T – Immunology – II**

|                             |                        |
|-----------------------------|------------------------|
| <b>Semester</b>             | <b>VI</b>              |
| <b>Course Code</b>          | <b>MB 352 MJ T</b>     |
| <b>Course Title</b>         | <b>Immunology – II</b> |
| <b>Credits</b>              | <b>02</b>              |
| <b>Total Teaching Hours</b> | <b>30 Hours</b>        |

**Course Objectives**

| <b>CO No.</b> | <b>Course Objectives</b>                                                                                         |
|---------------|------------------------------------------------------------------------------------------------------------------|
| <b>CO1</b>    | To provide comprehensive knowledge of the organization and functions of the immune system.                       |
| <b>CO2</b>    | To develop understanding of acquired (adaptive) immunity, including humoral and cell-mediated responses.         |
| <b>CO3</b>    | To explain mechanisms, diagnosis, and treatment of hypersensitivity, autoimmunity, and immunohematology.         |
| <b>CO4</b>    | To promote conceptual understanding of immune dysfunction and its impact on human health.                        |
| <b>CO5</b>    | To enable evaluation of clinical applications of immunology including vaccination and immunological diagnostics. |

**Course Outcomes**

| <b>CO No.</b> | <b>Course Outcomes</b>                                                                            | <b>Bloom's Level</b> |
|---------------|---------------------------------------------------------------------------------------------------|----------------------|
| <b>CO1</b>    | Explain the structure and functional components of the immune system.                             | Understand           |
| <b>CO2</b>    | Describe mechanisms of acquired immunity, including humoral and cell-mediated responses.          | Understand           |
| <b>CO3</b>    | Apply knowledge of primary and secondary immune responses to understand vaccination strategies.   | Apply                |
| <b>CO4</b>    | Analyze the mechanisms of cell-mediated immune responses in health and disease.                   | Analyze              |
| <b>CO5</b>    | Evaluate immune dysfunctions such as hypersensitivity, autoimmune diseases, and immunohematology. | Evaluate             |

## Syllabus

| Credit           | Topic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Lectures                                                    |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|
| <b>Credit I</b>  | <b>Cytokines, Adaptive / Acquired Immunity, Cell Mediated Immune response</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>15</b>                                                   |
|                  | <b>Unit I Cytokines:</b><br>a. Definition of Cytokines, Types (monokines, interleukins, chemokines, interferons and tumor necrosis factor with examples).<br>b. General characters (Properties, Action and attributes) and role in immune response                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>(2)</b><br>1<br>1                                        |
|                  | <b>Unit II Adaptive / Acquired Immunity (Third line of defense):</b><br>a. Humoral Immune Response<br>i. Primary and secondary Immune response<br>ii. Antigen processing and presentation (Major Histocompatibility class I (Endocytic) and class II(cytosolic) restriction pathways), cell adhesion molecules, response to super-antigens,<br>iii. B cell activation, proliferation and differentiation.<br>b. Cell Mediated Immune Response<br>i. Activation and differentiation of T cells<br>ii. Mechanism of Cytotoxic T lymphocytes (CTL) mediated cytotoxicity (Granzyme -perforin pathway and Fas ligand pathway), Antibody-dependent cellular cytotoxicity (ADCC)<br>iii. Significance of Cell Mediated Immune Response (CMI)<br>c. Vaccines: Criteria for Ideal vaccine, Types of vaccines, new vaccine strategies | <b>(6)</b><br>1<br>2<br>3<br><b>(7)</b><br>2<br>2<br>1<br>2 |
| <b>Credit II</b> | <b>Hypersensitivity, Autoimmunity and Autoimmune diseases and Immunohematology</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>15</b>                                                   |
|                  | <b>Unit II Autoimmunity and Autoimmune diseases:</b><br>a. Immunological tolerance<br>b. Types of autoimmune diseases<br>c. Mechanism, Diagnosis, and treatment of autoimmune diseases:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>(6)</b><br>1<br>2<br>4                                   |

[illegible]

## Reference Books & E-Resources

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1. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne. *Kuby Immunology*, 6th Edition, 2007, W. H. Freeman and Company, New York.
2. James D. Barrett. *Textbook of Immunology*, 4th Edition, 1983, C. V. Mosby & Co., London.
3. C. C. Chatterjee. *Human Physiology*, Vol. 1, Special Reprint Edition, 2002, Medical Allied Agency, Kolkata.
4. Abul K. Abbas, Andrew H. Lichtman. *Basic Immunology: Functions and Disorders of the Immune System*, 2nd Edition, 2004, Saunders (Elsevier), Philadelphia, USA.
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9. Charles A. Janeway Jr., Paul Travers, Mark Walport. *Immunobiology: The Immune System in Health and Disease*, 5th Edition, Garland Science, New York.
10. Ananthanarayan and Panicker's Textbook of Microbiology, 10th Edition, 2017, Universities Press.
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12. Sharon Ann Hunt. *Essentials of Blood Banking*, 1st Edition, 2013, Jones & Bartlett Learning.
13. Frank C. Hay, Olwyn M. R. Westwood. *Practical Immunology*, 4th Edition, 2002, Blackwell Science.
14. Owen, J. A., Jones, P. P., Kuby, J., Punt, J., & Stranford, S. A. (2013). *Kuby immunology* (7th Ed.). New York: W.H. Freeman.

## E-Learning Resources

- Immunopaedia – Free Immunology Education Immunopaedia- [immunopaedia.org.za](http://immunopaedia.org.za)
- NCBI PubMed Database – <https://pubmed.ncbi.nlm.nih.gov>
- Microbiology Virtual Learning Platforms – MicrobeNotes / OpenStax

**MB 353 MJ T – Molecular Biology – II**

|                             |                               |
|-----------------------------|-------------------------------|
| <b>Semester</b>             | <b>VI</b>                     |
| <b>Course Code</b>          | <b>MB 353 MJ T</b>            |
| <b>Course Title</b>         | <b>Molecular Biology – II</b> |
| <b>Credits</b>              | <b>02</b>                     |
| <b>Total Teaching Hours</b> | <b>30 Hours</b>               |

**Course Objectives**

| <b>CO No.</b> | <b>Course Objectives</b>                                                                                                       |
|---------------|--------------------------------------------------------------------------------------------------------------------------------|
| <b>CO1</b>    | To introduce the principles of eukaryotic genetics, gene mapping, and their biological applications.                           |
| <b>CO2</b>    | To provide an understanding of phage genetics, genetic recombination, and mapping techniques.                                  |
| <b>CO3</b>    | To familiarize students with the tools, methodologies, and applications of recombinant DNA technology and genetic engineering. |
| <b>CO4</b>    | To develop knowledge of fundamental molecular biology techniques and their applications in biological research.                |
| <b>CO5</b>    | To introduce the concepts and applications of omics technologies for studying complex biological systems.                      |

**Course Outcomes**

| <b>CO No.</b> | <b>Course Outcomes</b>                                                                                                       | <b>Bloom's Level</b> |
|---------------|------------------------------------------------------------------------------------------------------------------------------|----------------------|
| <b>CO1</b>    | Explain the principles of eukaryotic genetics, gene mapping, phage genetics, and genetic recombination.                      | Understand           |
| <b>CO2</b>    | Describe the mechanisms of DNA damage, DNA repair, mutation, and horizontal gene transfer in microorganisms.                 | Understand           |
| <b>CO3</b>    | Apply molecular biology techniques and recombinant DNA technology tools in genetic analysis and manipulation.                | Apply                |
| <b>CO4</b>    | Analyze the role of genetic engineering, antibiotic resistance, and gene transfer mechanisms in microbial systems.           | Analyze              |
| <b>CO5</b>    | Evaluate the applications of omics technologies and modern molecular approaches in understanding complex biological systems. | Evaluate             |

## Syllabus

| Credits          | Topics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Lectures   |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>Credit I</b>  | <b>Genetic Recombination and Bacteriophage Genetics</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>15</b>  |
|                  | <b>Unit 1 Gene linkage and Mapping</b> <ol style="list-style-type: none"> <li>Mendel's Laws of Inheritance</li> <li>Eukaryotic chromosome organization: Histone proteins, Structure of nucleosome, Chromatin-euchromatin and heterochromatin, 10nm and 30nm fibre nucleosome</li> <li>Eukaryotic Cell cycle: Mitosis and Meiosis</li> <li>Holliday model for Homologous recombination, Role of RecA and Ruv proteins.</li> <li>Gene linkage and cross over</li> <li>Chromosome mapping, Recombination frequency, Map unit</li> <li>Parasexual Cycle of <i>Neurospora crassa</i></li> <li>Genetic mapping by Tetrad analysis in <i>N. crassa</i> (Numerical Calculations using PD, TT and NPD)</li> </ol> | 8          |
|                  | <b>Unit II Bacteriophage Genetics</b> <ol style="list-style-type: none"> <li>Structure and life cycle of bacteriophage (Lytic, Lysogenic and Chronic)</li> <li>Regulation between lytic and Lysogeny cycles with special reference to CRO and CII genes</li> <li>Genetic recombination in Phages: Recombination during coinfection, fine structure mapping (Benzer's experiment), Concept of cistron, recon, muton</li> <li>Bacteriophage mutants (Plaque morphology mutants and conditional lethal mutants)</li> </ol>                                                                                                                                                                                  | 3<br><br>4 |
| <b>Credit II</b> | <b>Recombinant DNA technology and Introduction to Omics</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>15</b>  |
|                  | <b>Unit I Recombinant DNA Technology</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 7          |

| Credits | Topics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Lectures |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
|         | <ul style="list-style-type: none"> <li>a. Concept of restriction Modification system in <i>E. coli</i></li> <li>b. Enzymes in molecular biology: cutting and joining of DNA</li> <li>c. Exonuclease, restriction endonucleases types (Type II - Nomenclature, example), Significance of II restriction endonucleases are in recombinant DNA technology, 3DNA Ligase, Alkaline phosphatase, Terminal transferases, Phosphatases</li> <li>d. Use of linkers, double linkers, adapters, homopolymer tails</li> <li>e. Cloning vectors: Plasmid, pBR322 plasmid vector, Phasmid, Cosmid, Phage, M13, YAC, BAC, PAC, Expression vector, Shuttle vector,</li> <li>f. Methods of gene transfer (physical, Chemical, Biological)</li> <li>g. Methods for screening the recombinant: Antibiotic resistance selection, blue-white screening, colony hybridization, PCR screening)</li> <li>h. Concept of Genomic and cDNA libraries</li> <li>i. Transgenic plant (Ti plasmid mediated), transgenic animal/mice (virus mediated), genetically modified bacterium (<i>E. coli</i> with special reference to insulin gene)</li> </ul> |          |
|         | <b>Unit II Molecular techniques</b> <ul style="list-style-type: none"> <li>a. Isolation and purification of genomic DNA</li> <li>b. Principle and methodology of Agarose gel electrophoresis and its applications</li> <li>c. PCR Technique-Concept, methodology and applications</li> <li>d. Concept, Methodology and applications of Southern, Northern and Western blotting</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 3        |
|         | <b>Unit III DNA Damage and Repair</b> <ul style="list-style-type: none"> <li>a. DNA damage due to hydrolysis and reactive oxygen species</li> <li>b. DNA direct repair by photoreactivation</li> <li>c. DNA repair by Mismatch repair</li> <li>d. DNA damage by Excision repair mechanisms (BER/NER)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 3        |

| Credits | Topics                                                                                                                                                                                                       | Lectures |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
|         | <b>Unit IV - Introduction to Omics</b> <ul style="list-style-type: none"> <li>Definitions and Applications of Genomics, Transcriptomics, Epigenomics, Proteomics, Metabolomics, Pharmacogenomics.</li> </ul> | 2        |

#### Reference Books & E-Resources

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7. Hartwell L., Goldberg M., Fischer J. and Hood L. (2018). Genetics: from genes to genomes. McGraw-Hill. ISBN13: 9781259700903
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9. Klug W. S., Cummings M. R., Spencer C. A., Michael A. and Palladino M. (2019). Genetics. Pearson Publisher. ISBN 13: 978-0-134-60471-8
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15. Stanier R. Y. (1999). General Microbiology. 5th Edition. Palgrave Macmillan
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17. Tamarin R. H. (2002). Principles of Genetics. Publisher: McGraw-Hill Education (India) Pvt Limited. ISBN:9780070486676
18. Watson J.D., Baker, T.A., Bell, S.P., Gann A., Levine M. and Losick R. (2014).
19. Molecular Biology of the gene. 7th edition. Pearson. ISBN: 9780321762436

#### Reference-Links:

1. Potential biohazards of recombinant DNA molecules:  
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC388511/?page=1>
2. National Academies Press: Introduction of Recombinant DNA-Engineered Organisms into the Environment: Key Issues: <https://www.nap.edu/download/18907#>
3. Guidelines and Handbook for Institutional Biosafety Committees (DBT, Govt. of India and BCIL) :  
<https://thsti.res.in/pdf/IBG.pdf>
4. University of North Carolina's Biosafety Guidelines (Principles, Risk assessment, Biosafety levels, Guidelines): <https://ehs.unca.edu/laboratory-safety/biological-safety>

**MB 354 MJ T – Metabolism**

|                      |             |
|----------------------|-------------|
| Semester             | VI          |
| Course Code          | MB 354 MJ T |
| Course Title         | Metabolism  |
| Credits              | 02          |
| Total Teaching Hours | 30 Hours    |

**Course Objectives**

| CO No. | Course Objectives                                                                                                                                        |
|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO1    | To introduce the structure and function of biological membranes and mechanisms of membrane transport in microorganisms.                                  |
| CO2    | To develop an understanding of bioenergetics principles, thermodynamics, and energy generation through electron transport and oxidative phosphorylation. |
| CO3    | To familiarize students with the biosynthesis and degradation of major biological macromolecules.                                                        |
| CO4    | To explain the mechanisms of bacterial photosynthesis and carbon dioxide fixation pathways in autotrophic microorganisms.                                |
| CO5    | To provide knowledge of chemolithotrophic microorganisms and their role in microbial metabolism and biogeochemical cycles.                               |

**Course Outcomes**

| CO No. | Course Outcomes                                                                                                                                   | Bloom's Level |
|--------|---------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| CO1    | Explain the structure and functions of biological membranes and the mechanisms of passive, active, and specialized transport systems.             | Understand    |
| CO2    | Interpret the principles of thermodynamics, bioenergetics, and ATP generation through electron transport and oxidative phosphorylation.           | Analyze       |
| CO3    | Apply knowledge of biosynthetic and degradative pathways of carbohydrates, lipids, and proteins to microbial metabolic processes.                 | Apply         |
| CO4    | Analyze the mechanisms of bacterial photosynthesis and compare different CO <sub>2</sub> fixation pathways and photosynthetic bacterial groups.   | Analyze       |
| CO5    | Evaluate the metabolic diversity and ecological significance of chemolithotrophic microorganisms in nutrient cycling and environmental processes. | Evaluate      |

## Syllabus

| Credits          | Topics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Lectures        |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| <b>Credit I</b>  | <b>Membrane transport and Bioenergetics</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>15</b>       |
|                  | <b>Unit I Biological membrane and Solute Transport</b> <ul style="list-style-type: none"> <li>a. Structure and function of biological membrane - Fluid Mosaic Model of Singer and Nicolson</li> <li>b. Membrane transport mechanisms:               <ul style="list-style-type: none"> <li>i. Passive transport - Diffusion, Osmosis, Facilitated transport</li> <li>ii. Active transport - Active transport systems in bacteria</li> <li>iii. Group translocation of sugars in bacteria</li> <li>iv. Ionophores: Mechanism and examples</li> <li>v. Ligand- gated ion channels, Voltage-gated ion channels</li> </ul> </li> </ul> | 5               |
|                  | <b>Unit II Bioenergetics</b> <ul style="list-style-type: none"> <li>a. Laws of thermodynamics- first and second law</li> <li>b. Concepts of free energy, entropy, enthalpy</li> <li>c. High energy compounds: Pyrophosphate, enolic phosphates, acyl phosphates, thioester compounds, and guanidinium compounds</li> <li>d. Mitochondrial electron transport chain: components, arrangement of different components in the inner membrane, structure and function of ATP synthetase, inhibitors and uncouplers of ETC and oxidative phosphorylation, energetics of mitochondrial electron transport chain</li> </ul>               | 1<br>3<br><br>6 |
| <b>Credit II</b> | <b>Metabolic pathways and Autotrophy</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>15</b>       |
|                  | <b>Unit I Biosynthesis and Degradation</b> <ul style="list-style-type: none"> <li>a. Chemistry, concept of polymerization of macromolecules:               <ul style="list-style-type: none"> <li>Polysaccharides. (Starch, and peptidoglycan) and Lipids (Fatty acids, triglycerides and phospholipids)</li> </ul> </li> <li>b. Degradation of macromolecules:               <ul style="list-style-type: none"> <li>Polysaccharides (starch), Lipids (fatty acids oxidation e.g. <math>\beta</math> oxidation),</li> </ul> </li> </ul>                                                                                            | 5<br><br>5      |

| Credits | Topics                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Lectures |
|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
|         | Proteins (urea cycle)                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |
|         | <b>Unit II Bacterial Photosynthesis</b> <ol style="list-style-type: none"> <li>a. Photosynthetic apparatus of bacteria, cyclic and noncyclic photophosphorylation, and CO<sub>2</sub> fixation pathways: Calvin cycle, reverse of TCA cycle</li> <li>b. Comparative study of all photosynthetic bacteria:               <ol style="list-style-type: none"> <li>i. Cyanobacteria,</li> <li>ii. Purple bacteria</li> <li>iii. Green bacteria</li> </ol> </li> </ol> | 3        |
|         | <b>Unit III Chemolithotrophy</b><br>Concept, utilizable substrates e.g. Iron oxidizing bacteria, Sulphur oxidizing bacteria, Nitrifying bacteria                                                                                                                                                                                                                                                                                                                  | 2        |

### Reference Books & E-Resources

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1. Berg J. M., Stryer L., Tymoczko J. and Gatto G. (2019). Biochemistry. 9th Edition. Palgrave Macmillan. ISBN-978-1319114657.
2. Conn E. E., Stumpf P. K., Bruening G. and Doi R. H. (1987). Outlines of Biochemistry. 5th Edition. John Wiley and Sons. ISBN-13: 9780471052883
3. Hall D. A. and Krishna Rao K. (1994). Photosynthesis (Studies in Biology). 6th Edition. Cambridge University Press, London. ISBN-13: 978-1-133-10629-6
4. Garrett R. H. and Grisham C. M. (2013). Biochemistry. 5th Edition. Brooks/Cole, Publishing Company, California. ISBN-13: 978-1-133-10629-6
5. Katoch R. (2011). Analytical Techniques in Biochemistry and Molecular Biology. Springer New York. ISBN 978-1-4419-9785-2.
6. Nelson D. L. and Cox M. M. (2021). Lehninger's Principles of Biochemistry. 8th Edition. Mac Millan Worth Pub. Co. New Delhi. ISBN:9781319228002
7. Segel I. H. (2010). Biochemical Calculations. 2nd Ed. Wiley India Pvt. Limited. ISBN: 9788126526437
8. Stanier R. Y., Adelberg E. A. and Ingraham J. L. (1985). General microbiology. 4th Edition. London: Macmillan.

**MB 355 MJ P– Practical Course MJ P-9**

|                             |                                |
|-----------------------------|--------------------------------|
| <b>Semester</b>             | <b>VI</b>                      |
| <b>Course Code</b>          | <b>MB 355 MJ P</b>             |
| <b>Course Title</b>         | <b>Practical Course MJ P-9</b> |
| <b>Credits</b>              | <b>02</b>                      |
| <b>Total Teaching Hours</b> | <b>60 hours</b>                |

**Course Objectives**

| <b>CO No.</b> | <b>Course Objectives</b>                                                                                                                     |
|---------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| <b>CO1</b>    | Provide fundamental knowledge of clinical microbiology, including specimen collection, processing, and diagnostic procedures.                |
| <b>CO2</b>    | Develop practical skills in microbiological, serological, and haematological laboratory techniques.                                          |
| <b>CO3</b>    | Familiarize students with laboratory equipment, culture media, and standard operating procedures used in clinical microbiology laboratories. |
| <b>CO4</b>    | Develop analytical skills for interpretation of laboratory results and identification of clinically significant microorganisms.              |
| <b>CO5</b>    | Promote awareness of biosafety, biomedical waste management, and the role of microbiology in public health and disease prevention.           |

**Course Outcomes**

| <b>CO No.</b> | <b>Course Outcome</b>                                                                                                       | <b>Bloom's Level</b> |
|---------------|-----------------------------------------------------------------------------------------------------------------------------|----------------------|
| <b>CO1</b>    | Explain the principles of clinical specimen collection, handling, transport, and diagnostic procedures.                     | Understand           |
| <b>CO2</b>    | Describe the characteristics and cultivation of clinically important microorganisms using selective and differential media. | Understand           |
| <b>CO3</b>    | Apply microbiological, serological, and haematological techniques for laboratory diagnosis.                                 | Apply                |
| <b>CO4</b>    | Analyze microbiological and clinical data for identification and interpretation of diagnostic results.                      | Analyze              |
| <b>CO5</b>    | Evaluate microbiological findings with respect to diagnosis, infection control, biosafety, and biomedical waste management. | Evaluate             |

## Syllabus

| Sr. No.      | Title of the practical                                                                                                                                                                                                                                                                                                                                          | No. of Practicals |
|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| 1.           | <b>Study of permanent slides of following microbial pathogens</b> <ol style="list-style-type: none"> <li><i>Giardia</i> spp.</li> <li><i>Mycobacterium</i> (tuberculosis and leprae)</li> <li><i>Epidermophyton</i> spp.</li> </ol>                                                                                                                             | 1                 |
| 2.           | <b>Hemogram</b> <ol style="list-style-type: none"> <li>Estimation of haemoglobin (Acid hematin and Cyan-methaemoglobin method)</li> <li>ESR and PCV determination,</li> <li>White blood cell differential count from peripheral blood</li> <li>Counting of Total RBCs and WBCs using counting chamber</li> <li>Calculation of haematological indices</li> </ol> | 5                 |
| 3.           | <b>Antibiotic Sensitivity Testing</b> of the Bacterial Pathogens (for Gram Negative and Gram Positive)                                                                                                                                                                                                                                                          | 1                 |
| 4.           | <b>Immuno-hematology</b> <ol style="list-style-type: none"> <li>Determination of Titre of Anti-A and Anti-B in Human Serum</li> <li>Coomb's Test (Direct and Indirect)</li> </ol>                                                                                                                                                                               | 2                 |
| 5.           | Qualitative detection of Rheumatoid factor (RA factor) and Streptolysin O using <b>Slide agglutination test</b> .                                                                                                                                                                                                                                               | 1                 |
| 6.           | <b>Determination of MIC and MBC</b> of antimicrobial agent                                                                                                                                                                                                                                                                                                      | 2                 |
| 7.           | <b>Demonstrations</b> <ol style="list-style-type: none"> <li>Egg inoculation technique</li> <li>Types of hemolysis on blood agar</li> </ol>                                                                                                                                                                                                                     | 2                 |
| 8.           | <b>Visit</b> to Blood Bank and preparation of visit report                                                                                                                                                                                                                                                                                                      | 1                 |
| <b>Total</b> |                                                                                                                                                                                                                                                                                                                                                                 | <b>15</b>         |

## Reference Books & E-Resources

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1. Abramson J. and Abramson Z. H. (2011). Research Methods in Community Medicine: Surveys, Epidemiological Research, Programme Evaluation, Clinical Trials. Sixth Edition. Wiley. ISBN: 978-0-470-98661-5
2. Baveja C. P. and Baveja V. (2019). Text and Practical Microbiology for MLT. 3<sup>rd</sup> Edition. Arya Publishing Company. ISBN-13: 9788178558387
3. Bergey's Manual of Systematic Bacteriology. (2005). Volume Two: The Proteobacteria, Part A: Introductory Essays. Garrity G. editor. Springer. ISBN 978-0-387-24143-2
4. Bergey's Manual of Systematic Bacteriology. (2005). Volume Two: The Proteobacteria, Part B: The Gammaproteobacteria. Garrity G. Brenner D. J., Krieg N. R., and Staley J. R. (Eds.). Springer. ISBN 978-0-387-24144-9
5. Bergey's Manual of Systematic Bacteriology. (2005). Volume Two: The Proteobacteria, Part C: The Proteobacteria. Garrity G. Brenner D. J., Krieg N. R., and Staley J. R. (Eds.). Springer. ISBN 978-0-387-24145-6
6. Bergey's Manual of Systematic Bacteriology. (2009). Volume Three: The Firmicutes. Part C: The Proteobacteria. Vos, P., Garrity, G., Jones, D., Krieg, N.R., Ludwig, W., Rainey, F.A., Schleifer, K.-H., Whitman, W. (Eds.). Springer. ISBN 978-0-387-95041-9
7. Godkar P. B. (2020). Textbook of Medical Laboratory Technology Volume 1 and 2. 3rd edition Bhalani Publishing House. ASIN: 9381496196. ISBN-13: 978- 9381496190
8. Greer D. L., Kane J., Summerbell R., Sigler L., Krajden S. and G. Land (Editors). (1999). Laboratory handbook of dermatophytes: a clinical guide and laboratory manual of dermatophytes and other filamentous fungi from skin, hair, and nails. Mycopathologia. 147: 113–114
9. Maheshwari N. (2017). Clinical Pathology Hematology and Blood Banking (For Dmlt Students). 3rd edition. Jaypee Brothers Medical Publishers. ISBN-13: 978- 9386261182
10. Mukherjee K. L. and Ghosh S. (2010). Medical Laboratory Technology, Volume I: Procedure Manual for Routine Diagnostic Tests. 2nd edition. McGraw Hill Education (India) Private Limited. ISBN-13: 978-1259061233
11. Mukherjee K. L. and Ghosh S. (2010). Medical Laboratory Technology, Volume II: Procedure

Manual for Routine Diagnostic Tests. 2nd edition. McGraw Hill Education (India) Private Limited. ISBN-13: 978-1259061240

12. Mukherjee K. L. and Ghosh S. (2010). Medical Laboratory Technology, Volume III: Procedure Manual for Routine Diagnostic Tests. 2nd edition. McGraw Hill Education (India) Private Limited. ISBN-13: 978-1259061257
13. Rosana Y., Matsuzawa T., Gono T. and Karuniawati A. (2014). Modified slide culture method for faster and easier identification of dermatophytes. Microbiology Indonesia. 8(3): 135-139 <https://doi.org/10.5454/mi.8.3.7>
14. Talib V. H. (2019). Handbook Medical Laboratory Technology. 2nd edition. CBS Publishers and Distributors Pvt. Ltd. ISBN-13: 978-8123906775

#### Links:

1. *Candida*: <https://www.slideshare.net/Sciblack/candidiasis-clinical-manifestations-and-lab-diagnosis-of-oral-candidiasis>
2. *Cryptococcus neoformans*:
  - i) (<https://www.cdc.gov/fungal/diseases/cryptococcosis-neoformans/symptoms.html>)
  - ii) *Rev. Inst. Med. Trop. Sao Paulo*, 57(4):295-298, July-August, 2015, <http://dx.doi.org/10.1590/S0036-46652015000400004>, isolation of *cryptococcus neoformans* from environmental samples collected in southeastern Nigeria, emeka i. nweze(1), fred a. kechia(2,3), uju e. dibua(1), charles eze(4) and uwakwe s. onoja(5)
  - iii) <https://academic.oup.com/mmy/article/43/6/565/1008990>
3. *Histoplasma*: [https://www.slideshare.net/shahmanthan24/histoplasmosis-mycology-epidemiology-laboratory-diagnosis?from\\_action=save](https://www.slideshare.net/shahmanthan24/histoplasmosis-mycology-epidemiology-laboratory-diagnosis?from_action=save)

**MB 356 MJ P– Practical Course MJ P -10**

|                             |                                 |
|-----------------------------|---------------------------------|
| <b>Semester</b>             | <b>VI</b>                       |
| <b>Course Code</b>          | <b>MB 356 MJ P</b>              |
| <b>Course Title</b>         | <b>Practical Course MJ P-10</b> |
| <b>Credits</b>              | <b>02</b>                       |
| <b>Total Teaching Hours</b> | <b>60 hours</b>                 |

**Course Objectives**

| <b>CO No.</b> | <b>Course Objectives</b>                                                                                                                                               |
|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>CO1</b>    | To provide fundamental knowledge of biochemical, molecular biological, and analytical techniques used for the qualitative and quantitative estimation of biomolecules. |
| <b>CO2</b>    | To develop practical skills in biochemical assays, clinical biochemistry estimations, and molecular biology techniques.                                                |
| <b>CO3</b>    | To familiarize students with methods for enrichment, isolation, enumeration, and characterization of bacteriophages.                                                   |
| <b>CO4</b>    | To enhance understanding of metabolic pathways, enzyme activities, and molecular interactions through experimental investigations.                                     |
| <b>CO5</b>    | To promote awareness of laboratory safety, Good Laboratory Practices (GLP), and the applications of biochemical and molecular techniques in research and industry.     |

**Course Outcomes**

| <b>CO No.</b> | <b>Course Outcomes</b>                                                                                                                                               | <b>Bloom's Level</b> |
|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| <b>CO1</b>    | Explain biochemical, molecular biological, and analytical techniques used for qualitative and quantitative estimation of biomolecules.                               | Understand           |
| <b>CO2</b>    | Perform biochemical assays, clinical biochemistry estimations, and molecular biology techniques including preparation of competent cells and genetic transformation. | Apply                |
| <b>CO3</b>    | Demonstrate enrichment, isolation, and enumeration of bacteriophages and calculate phage titers.                                                                     | Apply                |
| <b>CO4</b>    | Analyze metabolic pathways, enzymatic reactions, and molecular interactions using experimental data.                                                                 | Analyze              |
| <b>CO5</b>    | Evaluate laboratory practices, safety measures, GLP requirements, and applications of biochemical and molecular techniques in research and industry.                 | Evaluate             |

## Syllabus

| Sr. No. | Title of the practical                                                                                                                                                                         | No. of Practicals |
|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| 1.      | <b>Qualitative analytical tests</b>                                                                                                                                                            |                   |
|         | i. Proteins (tests for aromatic amino acids, sulfur containing amino acids and different amino acids)                                                                                          | 1                 |
|         | ii. Carbohydrates (tests for monosaccharides, disaccharides, and polysaccharides)                                                                                                              | 1                 |
| 2.      | <b>Quantitative estimation of total carbohydrates /proteins.</b>                                                                                                                               |                   |
|         | i. Estimation of total carbohydrates from natural sources by Phenol sulphuric acid/Cole's method                                                                                               | 1                 |
|         | ii. Estimation of proteins from natural sources by Bradford's method                                                                                                                           | 1                 |
|         | iii. Study of Mitotic division by using Onion root tips                                                                                                                                        | 1                 |
| 3.      | <b>Clinical Biochemistry - Estimation of following by using readymade kits</b>                                                                                                                 |                   |
|         | i. Blood sugar                                                                                                                                                                                 | 4                 |
|         | ii. Blood urea                                                                                                                                                                                 |                   |
|         | iii. Serum cholesterol                                                                                                                                                                         |                   |
|         | iv. Serum proteins and albumin                                                                                                                                                                 |                   |
| 4.      | <b>Enrichment, Isolation, and Enumeration of Bacteriophages</b><br>Enrichment, Isolation and Enumeration of Bacteriophages (Principle , Methodology and Calculations of phage titer in PFU/ml) | 2                 |
| 5.      | <b>Chromosome Banding</b> by Giemsa Staining (G-Banding) for Cytogenetic Analysis                                                                                                              | 1                 |
| 6.      | <b>Preparation of Competent Escherichia coli Cells and Genetic Transformation</b>                                                                                                              | 2                 |
|         | i. Preparation of Competent <i>E.coli</i> cells<br>ii. Transformation of <i>E. coli</i> and selection of transformants                                                                         |                   |
| 7.      | <b>Study visit to research institute / industry</b>                                                                                                                                            | 1                 |
| Total   |                                                                                                                                                                                                | 15                |

## Reference Books & E-Resources

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1. Clokie, M. R. J., & Kropinski, A. M. (Eds.). *Bacteriophage: Methods and protocols. Volume 1: Isolation, characterization and interactions* (Series Vol. 501). Humana Press, New York.
2. Hyman, P., & Abedon, S. T. (2009). Practical methods for determining phage growth parameters. *Methods in Molecular Biology*, 501, 175–202. [https://doi.org/10.1007/978-1-60327-164-6\\_18](https://doi.org/10.1007/978-1-60327-164-6_18)
3. Jayaraman, J. (2011). *Laboratory manual in biochemistry*. New Age International.
4. Jørgensen, N. O. G., Sørensen, J., & Nybroe, O. (2010). *Microbiology 2010: Block 3: Manual of laboratory exercises*. University of Copenhagen.
5. Katoch, R. (2011). *Analytical techniques in biochemistry and molecular biology*. Springer.
6. Miller, H., Witherow, D. S., & Carson, S. (2012). *Molecular biology techniques: A classroom laboratory manual* (2nd ed.). Cold Spring Harbor Laboratory Press.
7. Plummer, D. T. (2001). *Introduction to practical biochemistry*. Tata McGraw Hill.
8. Sadashivam, S., & Manickam, A. (2018). *Biochemical methods* (3rd ed.). New Age International.
9. Wilson, K., & Walker, J. (Eds.). (2010). *Principles and techniques of biochemistry and molecular biology* (7th ed.). Cambridge University Press.

**MB 360 MJ T – Fermentation Technology – II**

|                             |                                     |
|-----------------------------|-------------------------------------|
| <b>Semester</b>             | <b>VI</b>                           |
| <b>Course Code</b>          | <b>MB 360 MJ T</b>                  |
| <b>Course Title</b>         | <b>Fermentation Technology – II</b> |
| <b>Credits</b>              | <b>02</b>                           |
| <b>Total Teaching Hours</b> | <b>30 Hours</b>                     |

**Course Objectives**

| <b>CO No.</b> | <b>Course Objectives</b>                                                     |
|---------------|------------------------------------------------------------------------------|
| <b>CO1</b>    | To provide knowledge of microbial fermentations.                             |
| <b>CO2</b>    | To develop the skill of large-scale production using laboratory study.       |
| <b>CO3</b>    | To familiarize students with all types of microbially synthesized products.  |
| <b>CO4</b>    | To encourage learning of industrial fermentation processes of various types. |
| <b>CO5</b>    | To evaluate quality of fermentation products.                                |

**Course Outcomes**

| <b>CO No.</b> | <b>Course Outcome</b>                                                  | <b>Bloom's Level</b> |
|---------------|------------------------------------------------------------------------|----------------------|
| <b>CO1</b>    | Explain different types of microbial fermentations.                    | Understand           |
| <b>CO2</b>    | Describe process of large-scale production of microbial products.      | Understand           |
| <b>CO3</b>    | Apply the knowledge of use of microorganism for synthesis of products. | Apply                |
| <b>CO4</b>    | Design flow diagram of microbial fermentation process.                 | Create               |
| <b>CO5</b>    | Assess the percent yield of fermentation.                              | Evaluate             |

## Syllabus

| Credit           | Topic                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Lectures    |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| <b>Credit I</b>  | <b>Solid state and Submerged state fermentations and large-scale fermentations</b>                                                                                                                                                                                                                                                                                                                                                                                                | <b>15</b>   |
|                  | <b>Unit I Introduction to Solid State Fermentation and Submerged Fermentation</b><br>Process, production strains, media, fermenter design, fermentation conditions, applications, merits and demerits.                                                                                                                                                                                                                                                                            | 2           |
|                  | <b>Unit II Large scale production of Primary Metabolites</b><br>Process with flow sheet, nature of the product, production pathway, applications, production strains, media, fermentation process, parameters, product recovery of<br>Primary Metabolites<br><ul style="list-style-type: none"> <li>a. Vitamins B12 and K2</li> <li>b. Amino acids - Glutamic acid</li> <li>c. Organic acids (Citric acid and Vinegar)</li> </ul>                                                 | 6           |
|                  | <b>Unit III Large scale production of Secondary metabolites</b><br><ul style="list-style-type: none"> <li>a. Bioethanol</li> <li>b. Alcoholic Beverages - <ul style="list-style-type: none"> <li>i. Beer (Types of beer, Lagering, Maturation,)</li> <li>ii. Wine (Aging, Malo-lactic acid fermentation, types of wine, wine defects, comparison of white and red wine)</li> </ul> </li> <li>c. Antibiotics [Penicillin (natural and semi synthetic) and Streptomycin]</li> </ul> | 7           |
| <b>Credit II</b> | <b>Large scale production of enzymes, steroids, biomass-based products, milk products, vaccines, immune sera and Modern trends in microbial production</b>                                                                                                                                                                                                                                                                                                                        | <b>(15)</b> |
|                  | <b>Unit I Large scale production of Enzymes</b><br><ul style="list-style-type: none"> <li>a. Amylase</li> <li>b. Proteases</li> </ul>                                                                                                                                                                                                                                                                                                                                             | 2           |
|                  | <b>Unit II Large scale production of Microbial transformation of steroids</b>                                                                                                                                                                                                                                                                                                                                                                                                     | 1           |
|                  | <b>Unit III Large scale production of Biomass based products</b>                                                                                                                                                                                                                                                                                                                                                                                                                  | 3           |

| Credit | Topic                                                                                                                                                                                                                                                                        | Lectures |
|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
|        | <ul style="list-style-type: none"> <li>a. Yeast: Baker's and Distiller's yeast</li> <li>b. Probiotics: <i>Lactobacillus sporogenes</i></li> </ul>                                                                                                                            |          |
|        | <b>Unit IV Large scale production of Food products</b> <ul style="list-style-type: none"> <li>a. Cheese (Processed, soft, semi-hard, hard ripened types- bacterial and mold)</li> <li>b. Soyasauce</li> </ul>                                                                | 2        |
|        | <b>Unit V Large scale production of Vaccines</b> <ul style="list-style-type: none"> <li>a. Polio – Inactivated Polio Vaccine, Oral Polio Vaccine</li> <li>b. Tetanus – Tetanus toxoid (TT)</li> <li>c. iii. Rabies – HDCC, Chick embryo cell line, Vero cell line</li> </ul> | 3        |
|        | <b>Unit VI Large scale production of Immune sera</b> <ul style="list-style-type: none"> <li>a. Anti tetanus serum (ATS)</li> <li>b. ii. Anti rabies serum (ARS)</li> </ul>                                                                                                   | 2        |
|        | <b>Unit VII Modern trends in microbial production</b><br>Biosurfactant and bioemulsifier                                                                                                                                                                                     | 2        |

## Reference Books & E-Resources

1. Aiba S., Humphrey A. E. and Millis N.F. (1977). Biochemical Engineering. Academic Press,
2. Arora D. K. (Editor). (2003). Fungal Biotechnology in Agriculture, Food and Environmental Applications (Mycology). CRC Press. ISBN 9780824747701.
3. Bailey J. A., Bailey J. E., Bailey J., Simpson R. J. and Ollis D. F. (1986). Biochemical Engineering Fundamentals. 2nd Edition. McGraw-Hill. Chemical Engineering Series. McGraw-Hill Publisher. ISBN: 0070032122, 9780070032125
4. BIOTOL (Project), Open Universiteit (Heerlen, & Thames Polytechnic. (1992). *Bioreactor design and product yield*. Butterworth-Heinemann.
5. Casida, L.E. (2005) Industrial Microbiology. New Age, New Delhi
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15. Patel. A. H. (2016). Industrial Microbiology. Trinity Press (Publisher). ISBN-13-9789385750267-5

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### E-Learning Resources

1. National Digital Library of India. *NDLI digital repository*. Available at: <https://www.ndl.gov.in>
2. INFLIBNET Centre. *Shodhganga: A reservoir of Indian theses*. Available at: <http://shodhganga.inflibnet.ac.in>
3. National Repository of Open Educational Resources. *NROER digital learning resources*. Available at: <http://nroer.gov.in>
4. Traditional Knowledge Digital Library. *TKDL database*. Available at: <http://www.tkdlib.res.in>
5. Stanbury, P. F., Whitaker, A., & Hall, S. J. *Principles of fermentation technology*. Available at: [https://biokamikazi.files.wordpress.com/2013/09/principles\\_of\\_fermentation\\_technology-stanburry\\_whittaker.pdf](https://biokamikazi.files.wordpress.com/2013/09/principles_of_fermentation_technology-stanburry_whittaker.pdf)
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**MB 361 MJ T – Food Microbiology**

|                             |                          |
|-----------------------------|--------------------------|
| <b>Semester</b>             | <b>VI</b>                |
| <b>Course Code</b>          | <b>MB 361 MJ T</b>       |
| <b>Course Title</b>         | <b>Food Microbiology</b> |
| <b>Credits</b>              | <b>02</b>                |
| <b>Total Teaching Hours</b> | <b>30 Hours</b>          |

**Course Objectives**

| <b>CO No.</b> | <b>Course Objectives</b>                                              |
|---------------|-----------------------------------------------------------------------|
| <b>CO1</b>    | To understand the role of microorganisms in food systems.             |
| <b>CO2</b>    | To integrate modern technologies in food microbiology.                |
| <b>CO3</b>    | To analyze food spoilage, preservation, and safety.                   |
| <b>CO4</b>    | To develop awareness of global food safety standards and innovations. |
| <b>CO5</b>    | To evaluate emerging trends in probiotics and in functional foods.    |

**Course Outcomes**

| <b>CO No.</b> | <b>Course Outcomes</b>                                                                              | <b>Bloom's Level</b> |
|---------------|-----------------------------------------------------------------------------------------------------|----------------------|
| <b>CO1</b>    | Classify foods, explain microbial ecology, and identify spoilage organisms and foodborne pathogens. | Understand           |
| <b>CO2</b>    | Understand food safety systems and regulatory frameworks.                                           | Understand           |
| <b>CO3</b>    | Apply preservation techniques including modern methods.                                             | Apply                |
| <b>CO4</b>    | Analyze factors affecting microbial growth in foods.                                                | Analyze              |
| <b>CO5</b>    | Evaluate emerging trends like probiotics, functional foods, and molecular detection.                | Evaluate             |

## Syllabus

| Credits         | Topics                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Lectures    |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| <b>Credit I</b> | <b>Fundamentals of Food Microbiology &amp; Food Spoilage</b>                                                                                                                                                                                                                                                                                                                                                                                              | <b>(15)</b> |
|                 | <b>Unit I Introduction to Food Microbiology</b> <ul style="list-style-type: none"> <li>a. Definition and scope</li> <li>b. Food as substrate for microbial growth</li> <li>c. Classification of foods (perishable, semi-perishable, non-perishable)</li> </ul>                                                                                                                                                                                            | 3           |
|                 | <b>Unit II Factors Affecting Microbial Growth in Food</b> <ul style="list-style-type: none"> <li>a. Intrinsic factors - pH, water activity, O-R potential, nutrient Content, biological structure of food, inhibitory substances in food.</li> <li>b. Extrinsic factors - (temperature of storage, Relative humidity, concentration of gases).</li> <li>c. Implicit factors: Microbial interactions in food (synergism, antagonism, dysbiosis)</li> </ul> | 5           |
|                 | <b>Unit III Microbiology of Food Spoilage</b> <ul style="list-style-type: none"> <li>a. Sources of spoilage microorganisms</li> <li>b. Spoilage of               <ul style="list-style-type: none"> <li>i. fruits &amp; vegetables</li> <li>ii. meat, seafood, poultry</li> <li>iii. canned foods</li> <li>iv. cereals</li> </ul> </li> <li>c. Indicators of spoilage (sensory &amp; biochemical changes)</li> </ul>                                      | 5           |
|                 | <b>Unit IV Beneficial Microorganisms in Food</b> <ul style="list-style-type: none"> <li>a. Starter cultures and fermentation- Types and significance</li> </ul>                                                                                                                                                                                                                                                                                           | 2           |

| Credits          | Topics                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Lectures    |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
|                  | <b>b. Traditional fermented foods (Indian context)- Overview</b>                                                                                                                                                                                                                                                                                                                                                                                           |             |
| <b>Credit II</b> | <b>Food Preservation and Safety</b>                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>(15)</b> |
|                  | <b>Unit I Principles of Food Preservation</b><br><br>Importance of <ul style="list-style-type: none"> <li>a. TDP, TDT, D, F &amp; Z values</li> <li>b. Low and high temperature preservation</li> <li>c. Chemicals and antibiotics</li> <li>d. Canning</li> <li>e. Dehydration</li> <li>f. Radiation</li> <li>g. Tetra pack technology</li> <li>h. Food-grade bio-preservatives</li> <li>i. Hurdle technology ( combined Preservation)</li> </ul>          | 5           |
|                  | <b>Unit II Microbial Food Poisoning and Food Infection:</b><br><br>Sources of contamination, mode of transmission, epidemiology, pathogenesis, symptoms, lab diagnosis, treatment and prophylaxis. <ul style="list-style-type: none"> <li>a. Food poisoning : <i>Clostridium botulinum</i>, <i>Staphylococcus aureus</i>, <i>Aspergillus flavus</i></li> <li>b. Food infection : <i>Salmonella typhimurium</i>, <i>Vibrio parahaemolyticus</i>)</li> </ul> | 3           |
|                  | <b>Unit III Food Safety Systems &amp; Regulations</b> <ul style="list-style-type: none"> <li>a. HACCP principles</li> <li>b. GMP, GHP</li> <li>c. Food safety authorities:               <ul style="list-style-type: none"> <li>i. Codex Alimentarius</li> </ul> </li> </ul>                                                                                                                                                                               | 2           |

| Credits | Topics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Lectures |
|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
|         | ii.FSSAI (India), FDA, WHO<br>iii. ISO standards                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |          |
|         | <b>Unit IV Functional Foods &amp; Health Aspects</b><br>a. Probiotics, Prebiotics, postbiotics & Synbiotics<br>b. Nutraceuticals<br>c. Health benefits and safety concerns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 2        |
|         | <b>Unit V Modern &amp; Emerging Trends in Food Microbiology</b><br>a. Rapid detection of food contaminants:<br>i. PCR, qPCR<br>ii. Biosensors<br>b. Immunological methods (ELISA)<br>c. Food microbiome & metagenomics<br>d. Bio-preservation (bacteriocins, bacteriophages)<br>e. Nanotechnology in food preservation<br>f. Smart packaging:<br>i. Time–Temperature Indicators (TTI),<br>ii. Gas Indicators,<br>iii. Freshness Indicators,<br>iv. RFID Tags, Biosensors<br>v. active packaging (Oxygen Scavengers, Moisture Absorbers, Antimicrobial Packaging, Ethylene Absorbers, CO <sub>2</sub> Emitters, Edible Coatings)<br>vi. AI & digital monitoring in food safety | 3        |

## Reference Books & E-Resources

1. Alias A K., Paliyath G. and Bhat R. (2012). Progress in Food Preservation. United Kingdom: Wiley. ISBN: 9780470655856
2. Banwart G. J. (1989). Basic Food Microbiology. 2nd edition. Chapman and Hall. International Thompson Publishing.
3. Bozoglu T. F. and Erkmen O. (2016). Food Microbiology. 2 Volume Set: Principles into Practice. United Kingdom: Wiley. ISBN: 9781119237761
4. Coles R. and Kirwan M. J. (2011). Food and Beverage Packaging Technology. Germany: Wiley. ISBN: 9781444392173
5. Early R. (2012). Guide to quality management for the food Industry. Blackie Academic and Professional. ISBN-13: 978-1461358879
6. Frazier W. C., Westhoff D. C. and Vanitha N. M. (2013). Food Microbiology. 5th edition. McGraw Hill education, India.
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10. Jay J. M. and Loessner M. J. (2005). Modern Food Microbiology. 7th edition. Springer. ISBN 978-0-387-23413-7
11. Mahindru S. N. (2010). Encyclopedia of Food Analysis. 3 Volumes. APH Publishing Corporation. ISBN-13: 9788131308806
12. Makun H. A. (2016). Significance, Prevention and Control of Food Related Diseases. Croatia: IntechOpen. ISBN: 9789535122777
13. Peñas. E., Frias J. and Villaluenga C. M. (2016). Fermented Foods in Health and Disease Prevention. Netherlands: Elsevier Science. 9780128025499
14. Preedy V. R. (2015). Probiotics, Prebiotics, and Synbiotics: Bioactive Foods in Health Promotion. Netherlands: Elsevier Science. ISBN: 9780128023716
15. Ray B. (2019). Food Biopreservatives of Microbial Origin. United States: CRC Press. ISBN: 9781351080514.
16. Nodali Ndraha, Hung-Yun Lin b, Chen-Yow Wang, Hsin-I Hsiao, Han-Jia Lin (2023) Rapid detection methods for foodborne pathogens based on nucleic acid amplification: Recent advances, remaining challenges, and possible opportunities. Food Chem (Oxf).;7:100183. doi: 10.1016/j.fochms.2023.100183

**MB 362 MJ P– Practical Course MJ P -11**

|                             |                                 |
|-----------------------------|---------------------------------|
| <b>Semester</b>             | <b>VI</b>                       |
| <b>Course Code</b>          | <b>MB 362 MJ P</b>              |
| <b>Course Title</b>         | <b>Practical Course MJ P-11</b> |
| <b>Credits</b>              | <b>02</b>                       |
| <b>Total Teaching Hours</b> | <b>60 hours</b>                 |

**Course Objectives**

| <b>CO No.</b> | <b>Course Objectives</b>                                                                                           |
|---------------|--------------------------------------------------------------------------------------------------------------------|
| <b>CO1</b>    | To provide fundamental knowledge of microbial fermentation processes and their industrial applications.            |
| <b>CO2</b>    | To develop skills in laboratory-scale fermentation and understand their scale-up for industrial production.        |
| <b>CO3</b>    | To familiarize students with industrially important microorganisms and their commercially valuable products.       |
| <b>CO4</b>    | To enhance understanding of the production processes involved in the industrial manufacture of microbial products. |
| <b>CO5</b>    | To impart knowledge of quality control and quality assurance practices in fermentation industries.                 |

**Course Outcomes**

| <b>CO No.</b> | <b>Course Outcomes</b>                                                                              | <b>Bloom's Level</b> |
|---------------|-----------------------------------------------------------------------------------------------------|----------------------|
| <b>CO1</b>    | Explain the principles and types of microbial fermentation processes used in industry.              | Understand           |
| <b>CO2</b>    | Describe the large-scale production processes of industrially important microbial products.         | Understand           |
| <b>CO3</b>    | Apply knowledge of industrial microorganisms for the production of commercially important products. | Apply                |
| <b>CO4</b>    | Analyze fermentation processes by designing flow diagrams and interpreting time-course studies.     | Analyze              |
| <b>CO5</b>    | Evaluate fermentation performance by determining product yield and quality parameters.              | Evaluate             |

## Syllabus

| Sr. No. | Title of the practical                                                                                                                                                                                                                                                                                                                                                   | No. of Practicals |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| 1.      | <b>Lab Scale production of Ethanol</b><br>a. Fermentation<br>b. Time course study (Biomass, sugar, ethanol)<br>c. Yield and % efficiency calculation                                                                                                                                                                                                                     | 3                 |
| 2.      | <b>Lab Scale production of citric acid</b><br>a. Fermentation<br>b. Time course study (Biomass, sugar, citric acid)<br>c. Yield and % efficiency calculation                                                                                                                                                                                                             | 3                 |
| 3.      | <b>Lab Scale production of wine from any fruit</b><br>I. Pre -fermentation estimation of<br>a. Determination of Total Soluble Solids (°Brix) using refractometer<br>b. pH measurement<br>c. Titratable acidity<br>II. post fermentation estimation of<br>a. Specific gravity (hydrometer)<br>b. Sugar consumption over time<br>c. Alcohol estimation (dichromate method) | 2                 |
| 4.      | <b>Solid state fermentation</b> for production of any one fermentation product and yield calculation. ( <i>Trichoderma sp.</i> / mushrooms / enzymes)                                                                                                                                                                                                                    | 1                 |
| 5.      | <b>Study of probiotic microorganism from curd</b><br>a. Isolation<br>b. Identification<br>c. Characterization by any one test (acid tolerance / bile tolerance/ pepsin tolerance /antimicrobial activity)                                                                                                                                                                | 3                 |
| 6.      | Screening and Isolation of Biosurfactant-Producing Organism and Assessment of Biosurfactant Production Ability                                                                                                                                                                                                                                                           | 1                 |
| 7.      | <b>HACCP guidelines</b> for cheese/curd industry (activity based)                                                                                                                                                                                                                                                                                                        | 1                 |

## Reference Books & E-Resources

### 1. Lab scale fermentations:

a. Casida L. E., Jr. (2019). Industrial Microbiology, New Age International Publishers, New Delhi. ISBN- 9788122438024

b. Patel A. H. (2016). Industrial Microbiology. Trinity Press (Publisher). ISBN-13- 9789385750267 <https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1541-4329.2005.tb00060.x>

### 2. Solid state fermentation:

Meshram S. U. and Shinde G. B. (2009). Applied Biotechnology. I.K. International Publishing House Pvt. Ltd., New Delhi.

<https://iopscience.iop.org/article/10.1088/1757-899X/612/2/022111/pdf>.

<https://www.scielo.br/j/babt/a/vDHdsFsciRYsW6jkRfKQCDM/?lang=en>.

### 3. Practical Manuals & Lab Protocols for wine

- Food and Agriculture Organization (FAO) : Manuals on fermentation and beverage analysis
- National Dairy Research Institute (NDRI) : Practical manuals (adaptable methods for acidity, pH, etc.)
- Central Food Technological Research Institute (CFTRI) : Indian protocols for food & beverage physicochemical analysis
- Handbook of Enology Volume 2 : Advanced methods for physicochemical and sensory analysis

### 4. Study of probiotic microorganism:

<https://www.frontiersin.org/articles/10.3389/fmicb.2019.01382/full>.

<https://www.hindawi.com/journals/ijmicro/2020/8865456/>.

Haghshenas, B., Kiani, A., Mansoori, S., Mohammadi-Noori, E., & Nami, Y. (2023). Probiotic properties and antimicrobial evaluation of silymarin-enriched Lactobacillus bacteria isolated from traditional curd. *Scientific Reports*, 13(1), 10916.

[Probiotic properties and antimicrobial evaluation of silymarin-enriched Lactobacillus bacteria isolated from traditional curd | Scientific Reports](#)

### 5. Screening of Biosurfactant producing organism

Al-Marri, S., Eldos, H. I., Ashfaq, M. Y., Saeed, S., Skariah, S., Varghese, L., ... & Raja, M. M. (2023). Isolation, identification, and screening of biosurfactant-producing and hydrocarbon-degrading bacteria from oil and gas industrial waste. *Biotechnology Reports*, 39, e00804.

<https://tinywebs.site/owbKLZ>

### 6. HACCP guidelines: [https://www.fsai.ie/food\\_businesses/haccp/principles\\_of\\_haccp.html](https://www.fsai.ie/food_businesses/haccp/principles_of_haccp.html).

**MB 363 MJ P– Practical Course MJ P -12**

|                             |                                 |
|-----------------------------|---------------------------------|
| <b>Semester</b>             | <b>VI</b>                       |
| <b>Course Code</b>          | <b>MB 363 MJ P</b>              |
| <b>Course Title</b>         | <b>Practical Course MJ P-12</b> |
| <b>Credits</b>              | <b>02</b>                       |
| <b>Total Teaching Hours</b> | <b>30 hours</b>                 |

**Course Objectives**

| <b>CO No.</b> | <b>Course Objectives</b>                                                                                                                |
|---------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| <b>CO1</b>    | To provide knowledge of microbiological methods used for the examination and quality assessment of food products.                       |
| <b>CO2</b>    | To develop practical skills in enumeration, isolation, and identification of foodborne microorganisms and spoilage organisms.           |
| <b>CO3</b>    | To familiarize students with food preservation techniques and microbial thermal death parameters used in food safety evaluation.        |
| <b>CO4</b>    | To impart knowledge of food quality assurance systems, HACCP principles, and rapid detection methods used in the food industry.         |
| <b>CO5</b>    | To expose students to industrial food processing practices and food safety management through industry visits and practical activities. |

**Course Outcomes**

| <b>CO No.</b> | <b>Course Outcomes</b>                                                                                                                   | <b>Bloom's Level</b> |
|---------------|------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| <b>CO1</b>    | Explain the principles of microbial enumeration, food spoilage, food preservation, and food safety assessment.                           | Understand           |
| <b>CO2</b>    | Perform microbiological analysis of food samples, including bacterial, fungal, and yeast counts, and sensory evaluation of food quality. | Apply                |
| <b>CO3</b>    | Apply standard methods for isolation and identification of foodborne pathogens and assessment of microbial load.                         | Apply                |
| <b>CO4</b>    | Analyze thermal death parameters (TDP, TDT, D-value, and TDR) and interpret their significance in food processing and preservation.      | Analyze              |
| <b>CO5</b>    | Evaluate food safety practices using HACCP principles and                                                                                | Evaluate             |

| CO No. | Course Outcomes                                                                                    | Bloom's Level |
|--------|----------------------------------------------------------------------------------------------------|---------------|
|        | assess the applications of rapid detection methods and industrial food quality management systems. |               |

### Syllabus

| Sr. No. | Title of the practical                                                                                                                                                                                              | No. of Practicals |
|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| 1.      | a. To determine the number of bacteria in a given food sample by standard plate count method.<br>b. Determination of fungal and yeast count in food sample                                                          | 2                 |
| 2.      | To check sensory evaluation tests of food samples (Four food samples) (Appearance, Aroma, Taste, Texture, Flavor) to determine food quality and prepare score sheets.                                               | 1                 |
| 3.      | Isolation and Identification of bacterial food pathogens/ spoilage causing bacteria from food product (Vegetables or Fruits).                                                                                       | 2                 |
| 4.      | To assess the microbial load of food before and after preservation techniques (like salting / freezing/ drying).                                                                                                    | 2                 |
| 5.      | Determination of TDP and TDT value                                                                                                                                                                                  | 2                 |
| 6.      | Determination of TDR and D value                                                                                                                                                                                    | 1                 |
| 7.      | HACCP guidelines for food industry (activity based)                                                                                                                                                                 | 2                 |
| 8.      | Rapid Detection Methods (Demonstration / Simulation-Based)<br>a. ELISA for food pathogens (demo/video-assisted)<br>b. PCR/qPCR principle (demo or virtual lab)<br>c. Biosensors in food detection (case study/demo) | 2                 |
| 9.      | Visit to any food industry                                                                                                                                                                                          | 1                 |
| Total   |                                                                                                                                                                                                                     | 15                |

## Reference Books & E-Resources

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1. Alias, A. K., Paliyath, G., & Bhat, R. (2012). *Progress in food preservation*. Wiley.
2. Banwart, G. J. (1989). *Basic food microbiology* (2nd ed.). Chapman & Hall.
3. Bozoglu, T. F., & Erkmen, O. (2016). *Food microbiology: Principles into practice* (Vols. 1–2). Wiley.
4. Coles, R., & Kirwan, M. J. (2011). *Food and beverage packaging technology*. Wiley.
5. Early, R. (2012). *Guide to quality management for the food industry*. Blackie Academic & Professional.
6. Frazier, W. C., Westhoff, D. C., & Vanitha, N. M. (2013). *Food microbiology* (5th ed.). McGraw Hill Education.
7. Garbutt, J. (1997). *Essentials of food microbiology*. Taylor & Francis.
8. Gupta, V. (2017). *The food safety and standards act* (9th ed.). Commercial Law Publishers (India).
9. Jay, J. M. (2012). *Modern food microbiology*. Springer.
10. Jay, J. M., & Loessner, M. J. (2005). *Modern food microbiology* (7th ed.). Springer.
11. Mahindru, S. N. (2010). *Encyclopedia of food analysis* (Vols. 1–3). APH Publishing Corporation.
12. Makun, H. A. (2016). *Significance, prevention and control of food related diseases*. IntechOpen.
13. Ndraha, N., Lin, H.-Y., Wang, C.-Y., Hsiao, H.-I., & Lin, H.-J. (2023). Rapid detection methods for foodborne pathogens based on nucleic acid amplification: Recent advances, remaining challenges, and possible opportunities. *Food Chemistry: Molecular Sciences*, 7, 100183. <https://doi.org/10.1016/j.fochms.2023.100183>
14. Peñas, E., Frias, J., & Villaluenga, C. M. (2016). *Fermented foods in health and disease prevention*. Elsevier.
15. Preedy, V. R. (2015). *Probiotics, prebiotics, and synbiotics: Bioactive foods in health promotion*. Elsevier.
16. Ray, B. (2019). *Food biopreservatives of microbial origin*. CRC Press.

**MB 371 VSC**

|                             |                                |
|-----------------------------|--------------------------------|
| <b>Semester</b>             | <b>VI</b>                      |
| <b>Course Code</b>          | <b>MB 371 VSC</b>              |
| <b>Course Title</b>         | <b>Vocational Skill Course</b> |
| <b>Credits</b>              | <b>02</b>                      |
| <b>Total Teaching Hours</b> | <b>60 hours</b>                |

**Course Objectives**

| <b>CO No.</b> | <b>Course Objectives</b>                                                                                                      |
|---------------|-------------------------------------------------------------------------------------------------------------------------------|
| <b>CO1</b>    | To provide knowledge of wastewater sampling, preservation, and analysis of physicochemical parameters.                        |
| <b>CO2</b>    | To develop practical skills in the determination of water quality parameters and assessment of wastewater characteristics.    |
| <b>CO3</b>    | To familiarize students with biological and physicochemical wastewater treatment processes.                                   |
| <b>CO4</b>    | To introduce modern wastewater treatment and pollution control technologies used in environmental management.                 |
| <b>CO5</b>    | To promote analytical and problem-solving skills through field studies, case analyses, and water quality assessment projects. |

**Course Outcomes**

| <b>CO No.</b> | <b>Course Outcomes</b>                                                                                                                                                             | <b>Bloom's Level</b> |
|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| <b>CO1</b>    | Explain the principles of wastewater sampling, preservation, and analysis of physicochemical parameters used in water quality assessment.                                          | Understand           |
| <b>CO2</b>    | Perform laboratory estimation of pH, dissolved oxygen, BOD, COD, TDS, TS, and TSS using standard methods.                                                                          | Apply                |
| <b>CO3</b>    | Analyze wastewater quality data to assess the degree of pollution and treatment efficiency.                                                                                        | Analyze              |
| <b>CO4</b>    | Evaluate the effectiveness of biological and modern wastewater treatment processes, including activated sludge, anaerobic digestion, phytoremediation, and membrane-based systems. | Evaluate             |
| <b>CO5</b>    | Assess environmental issues related to wastewater management through field visits, case studies, and comparative analysis of water samples.                                        | Evaluate             |

## Syllabus

| Sr. No. | Title of the practical                                                                                                                                                                                                                                                                | No. of Practicals |
|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| 1       | <b>Sampling and Preservation of Wastewater</b> <ul style="list-style-type: none"> <li>a. Collection techniques (grab and composite sampling)</li> <li>b. Preservation and storage methods</li> </ul>                                                                                  | 1                 |
| 2       | <b>Determination of Physical Parameters</b> <ul style="list-style-type: none"> <li>• Color, turbidity, temperature</li> </ul>                                                                                                                                                         | 1                 |
| 3       | <b>Determination of pH and Dissolved Oxygen (DO)</b> <ul style="list-style-type: none"> <li>a. pH meter usage</li> <li>b. Modified Winkler's Method using Azide (Iodometric Method) for Dissolved Oxygen Estimation</li> </ul>                                                        | 2                 |
| 4       | Determination of <b>Biological Oxygen Demand (BOD)</b> , (5-days BOD test)                                                                                                                                                                                                            | 2                 |
| 5       | Determination of <b>Chemical Oxygen Demand (COD)</b> by Dichromate method (demonstration experiment)                                                                                                                                                                                  | 1                 |
| 6       | Estimation of Total Dissolved Solids (TDS), TS and TSS                                                                                                                                                                                                                                | 1                 |
| 7       | Study of Activated Sludge Process (Lab-scale Model)<br>Aeration and microbial floc formation                                                                                                                                                                                          | 1                 |
| 8       | Anaerobic Digestion and Biogas Production (Demonstration) <ul style="list-style-type: none"> <li>• Setup and observation</li> </ul>                                                                                                                                                   | 2                 |
| 9       | Modern & Applied Techniques: Construction- Wetland / Phytoremediation Model <ul style="list-style-type: none"> <li>• Small-scale setup using aquatic plants<br/>OR</li> </ul> Alternative: Demonstration of membrane filtration / UV disinfection                                     | 2                 |
| 10      | <b>Skill-Based / Experiential Components</b> <ul style="list-style-type: none"> <li>a. Field visit to wastewater treatment plant (WWTP)</li> <li>b. Mini-project: Comparative analysis of water samples</li> <li>c. Case study: Pollution assessment of local water bodies</li> </ul> | 2                 |

## Reference Books & E-Resources

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### Books

- APHA – *Standard Methods for the Examination of Water and Wastewater*
- Metcalf & Eddy – *Wastewater Engineering*
- Pelczar et al. – *Microbiology*

### E-Resources & Web Links

- CPCB – Water quality standards & protocols
- WHO – Water safety guidelines
- EPA – Analytical methods
- NPTEL – Video lectures
- SWAYAM – Online learning

**MB 381 OJT – On Job Training**

|                      |                           |
|----------------------|---------------------------|
| Semester             | VI                        |
| Course Code          | MB 381 OJT                |
| Course Title         | On-the-Job Training (OJT) |
| Credits              | 04                        |
| Total Teaching Hours | 120 Hours                 |

**Course Objectives**

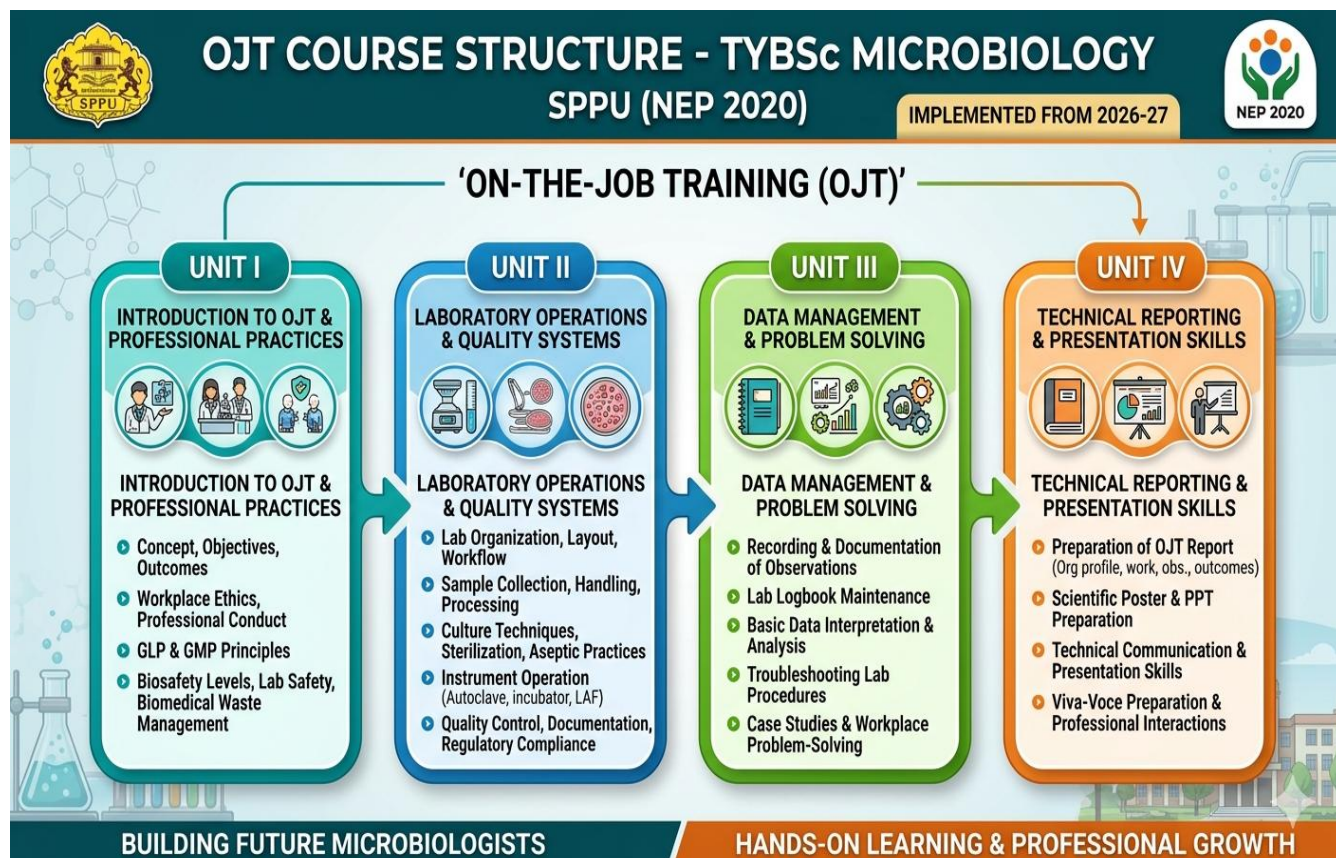
| CO No. | Course Objectives                                                                                                                                              |
|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO1    | To provide knowledge of microbiological techniques, laboratory practices, and procedures.                                                                      |
| CO2    | To familiarize students with laboratory and industrial workflows, documentation systems, and quality standards.                                                |
| CO3    | To develop practical skills required for microbiological work in laboratory and industrial environments.                                                       |
| CO4    | To enhance analytical abilities for interpreting observations, processes, and data generated during professional training.                                     |
| CO5    | To promote understanding of safety regulations, quality control practices, technical reporting, and continuous improvement in microbiology-related workplaces. |

**Course Outcomes**

| CO No. | Course Outcome                                                                                                                 | Bloom's Level |
|--------|--------------------------------------------------------------------------------------------------------------------------------|---------------|
| CO1    | Explain the functioning, workflow, and quality systems of microbiology-related laboratories and industries.                    | Understand    |
| CO2    | Apply microbiological techniques and laboratory skills in professional workplace settings.                                     | Apply         |
| CO3    | Demonstrate compliance with biosafety regulations, Good Laboratory Practices (GLP), and Good Manufacturing Practices (GMP).    | Apply         |
| CO4    | Analyze experimental observations, laboratory records, and operational data generated during training.                         | Analyze       |
| CO5    | Evaluate workplace practices and communicate findings effectively through technical reports, presentations, and documentation. | Evaluate      |

## Course Structure

| Unit No.                                                      | Content                                                                                                                                                                                                                                                                                                                                |
|---------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Unit I: Introduction to OJT and Professional Practices</b> | Concept, objectives, and expected outcomes of On-the-Job Training (OJT); workplace ethics and professional conduct; principles of Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP); biosafety levels, laboratory safety measures, and biomedical waste management.                                               |
| <b>Unit II: Laboratory Operations and Quality Systems</b>     | Laboratory organization, layout, and workflow; sample collection, handling, and processing; culture techniques, sterilization, and aseptic practices; operation and maintenance of laboratory instruments (autoclave, incubator, laminar airflow cabinet, etc.); quality control procedures, documentation, and regulatory compliance. |
| <b>Unit III: Data Management and Problem Solving</b>          | Recording and documentation of observations; laboratory logbook maintenance; basic data interpretation and analysis; troubleshooting laboratory procedures; case studies and workplace problem-solving approaches.                                                                                                                     |
| <b>Unit IV: Technical Reporting and Presentation Skills</b>   | Preparation of OJT report including organization profile, work carried out, observations, and outcomes; preparation of scientific posters and PowerPoint presentations; technical communication and presentation skills; viva-voce preparation and professional interactions.                                                          |



**Evaluation Scheme**

| Component                                      | Marks | Evaluator           |
|------------------------------------------------|-------|---------------------|
| Completion certificate+ PPT Presentation, oral | 60    | External + Internal |
| OJT Report + Viva                              | 40    | Internal            |

**Detailed Evaluation****1. Continuous Assessment (Internal –40 Marks)**

| Parameter                           | Marks |
|-------------------------------------|-------|
| Attendance & Regularity             | 5     |
| Daily Diary / Logbook               | 5     |
| OJT Report (Content + Presentation) | 20    |
| Seminar / Presentation              | 10    |

**2. (External – 60 Marks)**

| Parameter                           | Marks |
|-------------------------------------|-------|
| Punctuality & Discipline            | 10    |
| Technical Skills                    | 20    |
| Work Performance & Learning Ability | 20    |
| Teamwork & Communication            | 05    |
| Professional Ethics & Attitude      | 05    |

**Grading System**

| Marks (%) | Grade           |
|-----------|-----------------|
| ≥ 80      | O (Outstanding) |
| 70–79     | A               |
| 60–69     | B               |
| 50–59     | C               |
| 40–49     | D               |
| < 40      | F (Fail)        |

**Guidelines for Students**

- Maintain a Daily Training Diary / Logbook and Attendance Record.
- Follow safety norms, dress code, and confidentiality of industry data.
- Submit internship report and certificate within 15 days of completion.
- Participate in the seminar / presentation / viva.

**Suggested Training Sectors / Agencies**

- ICMR
- CSIR
- FSSAI
- CPCB
- DBT

**Suggested E-Resources**

- SWAYAM
- NPTEL
- WHO
- CDC

**Pre-Internship Requirements**

- Allocation of Faculty Mentor (Internal Guide)
- Identification of Industry Supervisor (External Mentor)
- Preparation of:
  - Learning objectives
  - Training plan / schedule
  - Orientation on: Biosafety & lab ethics
  - GMP, GLP, and workplace discipline

**Guidelines for Students**

- Maintain: Daily Training Diary / Logbook, Attendance Record
- Follow: Safety norms, discipline, and dress code, Confidentiality of industry data
- Submit within 15 days after completion: Internship report , Certificate from organization
- Participate in: Seminar / presentation / viva

**Guidelines for Faculty Mentor**

- Guide students in: Selection of training site .Defining learning outcomes
- Monitor progress through: Periodic review / interaction
- Evaluate: Report, presentation, and viva

**Guidelines for Industry Supervisor**

- Provide: Practical exposure and skill training
- Evaluate student based on: Punctuality, Work performance, Skill acquisition and Professional behavior accordingly give the certificate of OJT

**Internship Report Format**

- Introduction of organization
- Objectives of training
- Work carried out (day-wise / section-wise)
- Techniques learned (e.g., staining, culturing, QC tests)
- Results / observations
- Discussion (link with theory)
- Conclusion & learning outcomes
- References

**Key Features**

- Experiential learning & skill-based education
- Industry-academia integration
- Outcome-based assessment (OBE)
- Focus on employability & entrepreneurship
- Continuous + comprehensive evaluation





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(Formerly University of Pune)

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