

Shree Warana Vibhag Shikshan Mandal's

**WARANA UNIVERSITY,  
WARANANAGAR**

(A State Public University established under Section 3 (6) of MPUA, 2016)

॥ विद्या सर्वस्य भूषणम् ॥



Warana University

Established: 2025

**Structure & Syllabus For  
Bachelor of Science (B. Sc.)  
Industrial Microbiology**

UNDER

**Faculty of Science & Technology**

**B. Sc. Part - II (Semester - III and IV)**

**(As Per National Education Policy – 2020)  
With Effect from Academic Year 2026-27 Onwards**

**1. Year of Implementation:** Revised Syllabus will be implemented from June 2026 onwards.

**2. Preamble:**

This syllabus is framed to give sound knowledge with understanding of Industrial Microbiology to undergraduate students at second year of three years of B.Sc. degree course. The goal of the syllabus is to make the study of Industrial Microbiology popular, interesting and encouraging to the students for higher studies including research. The new and updated syllabus is based on a basic and applied approach with vigor and depth. At the same time, precautions are taken to make the syllabus comparable to the syllabi of other universities and the needs of industries and research. The syllabus is prepared after discussion at length with number of faculty members of the subject and experts from industries and research fields. The units of the syllabus are well defined, taking into consideration the level and capacity of students.

**3. Program Learning Outcomes (PLOs):**

A candidate who wishes to graduate in B.Sc. (Industrial Microbiology Course) needs to have acquired/developed following competencies:

|   |                                                                                                                                                                                                                           |
|---|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Acquired knowledge and understanding of the industrial microbiology concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and others.                             |
| 2 | Demonstrate key practical skills/competencies in working with microbes for study and use in the laboratory as well as outside, including the use of good microbiological practices.                                       |
| 3 | Competent enough to use industrial microbiology knowledge and skills to analyze problems involving microbes, articulate these with peers/ team members/ other stake holders, and undertake remedial measures/studies etc. |
| 4 | Developed a broader perspective of the discipline of industrial microbiology to enable him to identify challenging societal problems and plan his professional career to develop innovative solutions for such problems.  |

#### 4. Course Outcomes (COs)

##### **Course V: INDUSTRIAL FERMENTED FOODS PRODUCTION, SPOILAGE AND ITS PRESERVATION**

|   |                                                                                                              |
|---|--------------------------------------------------------------------------------------------------------------|
| 1 | Understand the industrial production processes of fermented dairy products, alcoholic beverages, and pickles |
| 2 | Learn the types and causes of spoilage in fermented dairy products, alcoholic beverages, and pickles         |
| 3 | Identify spoilage organisms and their effects on product quality and safety                                  |
| 4 | Explore preservation methods used for dairy products, alcoholic beverages, and Pickles                       |

##### **Couse VI: QUALITY CONTROL AND ASSURANCE OF FOOD PRODUCTS**

|   |                                                                               |
|---|-------------------------------------------------------------------------------|
| 1 | Learn microbiological tests to check food quality and detect pathogens.       |
| 2 | Understand food quality regulations like PFA, FDA, FPO, ISO, BIS, and AGMARK. |
| 3 | Learn the basics of GMP, GLP, and HACCP for food safety.                      |
| 4 | Apply TQM and ICMSF guidelines in milk and food quality control               |

##### **Course VII: FERMENTATION TECHNOLOGY**

|   |                                                                                                          |
|---|----------------------------------------------------------------------------------------------------------|
| 1 | Understand the industrial production process of antibiotics and organic acids                            |
| 2 | Identify raw materials and microbes used in fermentation for pharmaceutical products                     |
| 3 | Learn the steps of recovery and applications of amino acids and enzymes                                  |
| 4 | Explore the role of fermentation in producing valuable bio-products like antibiotics, acids, and enzymes |

##### **Course VIII: INDUSTRIAL PRODUCTION OF BIOFERTILIZERS**

|   |                                                                                                                   |
|---|-------------------------------------------------------------------------------------------------------------------|
| 1 | Understand the role and need of nitrogen-fixing biofertilizers in organic farming                                 |
| 2 | Learn the characteristics, production, and application of Rhizobium, Azotobacter, and Azospirillum biofertilizers |
| 3 | Study the types, functions, and application methods of VAM and PSB biofertilizers                                 |
| 4 | Understand FCO guidelines for quality control, sampling, and standards of Biofertilizers                          |

| <b>5. Program Objectives (POs):</b> |                                                                                                                                                                                      |
|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1                                   | To create a center of Academic Excellence in the field of education in Industrial Microbiology.                                                                                      |
| 2                                   | To provide a sound academic background for overall development of personality for a successful career in Industrial Microbiology.                                                    |
| 3                                   | To provide an environment that fosters continuous improvement and innovation in the subject.                                                                                         |
| 4                                   | To instill in students the essential skills oriented towards self-development.                                                                                                       |
| 5                                   | To inculcate in students the need for the value of dignity of labour, the positive attitude and proper community orientation and civic responsibilities in their outlook.            |
| 6                                   | To cultivate a sense of social responsibility in students, encouraging them to be active citizens through an excellent academic program and participation in daily management tasks. |

**6. Duration of the Program:** The course shall be a full-time course.

**7. Medium of Instruction:** The medium of instruction shall be English.

**8. Eligibility for Admission:** The criterion for admission is as per the rules and regulations set from time to time by concerned departments, HEIs, university, government, and other relevant statutory authorities.

**9. Scheme of Teaching and Examination Pattern (Theory/Practical/Internal):**

The scheme of teaching and examination for a program of study as approved by the Academic Council / Board of Studies.

Each theory course is of 2 credits and require 30 hours of teaching. There shall be two lectures per theory course per week. Each practical course is of 2 credits and require 60 hours of teaching.

The pattern of examination will be Semester End Examination with Internal Assessment/Evaluation. Note: Separate passing is mandatory for both, Semester End Examination and Internal Assessment/ Evaluation.

**10. Equivalence of the papers:**

Two additional chances shall be provided for the repeater students of old three-year B.Sc. immediate after their Semester VI or VIII. After that the students concerned shall have to appear for the Examination as per this revised pattern. Equivalence of papers shall be provided as per revised syllabus for the pattern in accordance with NEP.

## 11. Programme Structure

| <b>WARANA UNIVERSITY, WARANANAGAR</b><br><b>NEP-2020 (2.0): Credit Framework for UG (B. Sc. II) Programme under Faculty of Science and Technology</b> |                                                   |                                                   |                   |                                                      |                                                                     |                      |                  |                                                                         |
|-------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|---------------------------------------------------|-------------------|------------------------------------------------------|---------------------------------------------------------------------|----------------------|------------------|-------------------------------------------------------------------------|
| SEM<br>(Level)                                                                                                                                        | COURSES                                           |                                                   | OE                | VSC/SEC                                              | AEC/VEC/IKS                                                         | OJT/FP/CEP<br>/CC/RP | Total<br>Credits | Degree/Cum. Cr.<br>MEME                                                 |
|                                                                                                                                                       | MAJOR                                             | MINOR                                             |                   |                                                      |                                                                     |                      |                  |                                                                         |
| <b>SEMIII<br/>(5.0)</b>                                                                                                                               | Major V (2)<br>Major VI (2)<br>Major P III (2)    | Minor V (2)<br>Minor VI (2)<br>Minor P III (2)    | OE-3(2) (T/P)     | VSC I (2) (P)<br>(Major specific)<br>SEC I (2) (T/P) | AEC I (2)<br>(English)                                              | CC-I (2)             | 22               | UG Diploma<br>88                                                        |
| <b>SEMIV<br/>(5.0)</b>                                                                                                                                | Major VII (2)<br>Major VIII (2)<br>Major P IV (2) | Minor VII (2)<br>Minor VIII (2)<br>Minor P IV (2) | OE-4(2) (T/P)     | SEC-II (2) (T/P)                                     | AEC-II (2)<br>(English)<br>VEC-II (2)<br>(Environmental<br>studies) | CEP-I (2)            | 22               |                                                                         |
| <b>Credits</b>                                                                                                                                        | <b>8(T)+4(P)=12</b>                               | <b>8(T)+4(P)=12</b>                               | <b>2+2=4(T/P)</b> | <b>4(T/P) +2(P)=6</b>                                | <b>2+4=6</b>                                                        | <b>2+2=4</b>         | <b>44</b>        | <b>Exit Option:4<br/>credits<br/>NSQF/Internship/<br/>Skill courses</b> |

T : Theory

P: Practical

OE: Generic/Open Elective

VSC: Vocational Skill course

SEC: Skill Enhancement Courses

AEC: Ability Enhancement Course (English)

DSC: Discipline Specific Course

DSE: Discipline Specific Elective Course

VEC: Value Education Courses (Environmental  
Science)

IKS: Indian Knowledge System

OJT: On Job Training

FP: Field Projects

CEP: Community Engagement Practice

CC: Co-Curricular Courses

RP: Research Project

IDC: Interdisciplinary Course

## 12. Standard of Passing and Determination of SGPA/CGPA, Grading and Declaration of Results:

The Standard of passing shall be 35%. For B. Sc. (all Semesters) the student shall have to score as per this standard of passing shown in the following table:

| Maximum Marks                      | 100 | 80 | 50 | 40 | 20 | 10 |
|------------------------------------|-----|----|----|----|----|----|
| Minimum Marks required for passing | 35  | 28 | 18 | 14 | 7  | 4  |

There shall be a separate head of passing in Theory and Internal Examination. However, ATKT rules shall be made applicable in respect of Theory courses (University examination) only. For Environmental Studies (Semester IV, Examination) the student shall have to score marks 13 marks out of 35 in theory course and 5 marks out of 15 for project work.

### Gradation Chart:

| Marks Obtained | Numerical Grade (Grade Point) |  | CGPA        | Letter Grade       |
|----------------|-------------------------------|--|-------------|--------------------|
| Absent         | 0 (zero)                      |  | -           | -                  |
| 0 – 34         | 0 to 4                        |  | 0.0 – 4.99  | F (Fail)           |
| 35 – 44        | 5                             |  | 5.00 – 5.49 | C                  |
| 45 – 54        | 6                             |  | 5.50 – 6.49 | B                  |
| 55 – 64        | 7                             |  | 6.50 – 7.49 | B+                 |
| 65 – 74        | 8                             |  | 7.50 – 8.49 | A                  |
| 75 – 84        | 9                             |  | 8.50 – 9.49 | A+                 |
| 85 – 100       | 10                            |  | 9.50 – 10.0 | O<br>(Outstanding) |

### Note:

1. Marks obtained  $\geq 0.5$  shall be rounded off to next higher digit.
2. The SGPA & CGPA shall be rounded off to 2 decimal points.

### Calculation of SGPA & CGPA:

#### 1.Semester Grade Point Average (SGPA)

$$SGPA = \frac{\sum(\text{Course credits} \times \text{Grade point obtained}) \text{ of a semester}}{\sum(\text{Course credits}) \text{ of a respective semester}}$$

## 2. Cumulative Grade Point Average (CGPA)

CGPA

$$= \frac{\sum(\text{Total credits of a semester} \times \text{SGPA of respective semester}) \text{ of all semester}}{\sum(\text{Total course credits}) \text{ of all semesters}}$$

### 13. Nature of Question Paper, Duration and Scheme of Marking:

#### A) Theory Examinations

- a) Maximum Marks : 30
- b) Duration : 1 hr 30 min
- c) Nature of the Theory Examination Question Paper and Scheme of Marking

| Question No. | Nature/Type of Question                                             | Marks                                   |
|--------------|---------------------------------------------------------------------|-----------------------------------------|
| 1            | Multiple Choice Questions (MCQs)<br>(6 Questions)                   | 6 Marks<br>(1 Mark for Each Question)   |
| 2            | Broad Answer/Descriptive Type Questions<br>(Attempt Any 2 Out of 3) | 12 Marks<br>(6 Marks for Each Question) |
| 3            | Short Note Type Questions<br>(Attempt Any 3 Out of 5)               | 12 Marks<br>(4 Marks for Each Question) |
|              | <b>Total Marks</b>                                                  | <b>40</b>                               |

#### B) Practical Examinations

- a) The practical examination will be conducted on two consecutive days for six hours per day per batch.
- b) Each candidate must produce a certificate from the Head of the Department in his/ her college, stating that he/she has completed in a satisfactory manner the practical course on lines laid down from time to time by Academic Council on the recommendations of Board of Studies and that the journal has been properly maintained. Every candidate must have recorded his/her observations in the laboratory journal and have written a report on each exercise performed. Every journal is to be checked and signed periodically by a member of teaching staff and certified by the Head of the Department at the end of the semester. Candidates must produce their journals at the time of practical examinations.

- c) Candidates have to visit at least one place of microbiological interest (pharmaceutical / industry/dairy/research institute etc.) and submit the report of their visit.

### Nature of the Practical Examination Question Paper and Distribution of Marks

- Semester III**

| Question No.       | Nature/Type of Question                                                                                     | Marks     |
|--------------------|-------------------------------------------------------------------------------------------------------------|-----------|
| 1                  | SPC of given food sample                                                                                    | 10        |
| 2                  | Isolation of bacteria from spoiled food                                                                     | 10        |
| 3                  | Detection of presence of <i>E. coli</i> / <i>Staphylococcus</i> / <i>Pseudomonas</i> from given food sample | 10        |
| 4                  | Spotting                                                                                                    | 10        |
| 5                  | Journal                                                                                                     | 10        |
| <b>Total Marks</b> |                                                                                                             | <b>50</b> |

- Semester IV**

| Question No.       | Nature/Type of Question                                            | Marks     |
|--------------------|--------------------------------------------------------------------|-----------|
| 1                  | Isolation of <i>Azotobacter</i> / <i>Rhizobium</i> / PSB from Soil | 10        |
| 2                  | Bioassay of Streptomycin / Tetracycline                            | 10        |
| 3                  | Assay of Amylase / Protease                                        | 10        |
| 4                  | Tour report                                                        | 10        |
| 5                  | Journal                                                            | 10        |
| <b>Total Marks</b> |                                                                    | <b>50</b> |

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Warana University

Established: 2025

**Structure and Syllabus in Accordance with  
National Education Policy - 2020 (NEP 2.0)  
with Multiple Entry and Multiple Exit**

**Syllabus For**

**B.Sc. Part II**

**INDUSTRIAL MICROBIOLOGY**

**(MAJOR COURSE)**

**(Faculty of Science and Technology)**

**SEMESTER III AND IV**

**(To Be Implemented from Academic Year 2026-27)**

## B.Sc. Part II (NEP 2.0) Semester- III

| <b>COURSE- V: INDUSTRIAL FERMENTED FOODS<br/>PRODUCTION, SPOILAGE, AND ITS PRESERVATION<br/>(MAJOR COURSE)<br/>[CREDITS - 02; LECTURES - 30 Hours; LEC/WEEK – 02]</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                         |                         |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------|-------------------------|
| <b>Learning Objectives</b> <ol style="list-style-type: none"> <li>1. To understand the industrial production processes of fermented dairy products, alcoholic beverages, and pickles</li> <li>2. To learn the types and causes of spoilage in fermented dairy products, alcoholic beverages, and pickles</li> <li>3. To identify spoilage organisms and their effects on product quality and safety</li> <li>4. To explore preservation methods used for dairy products, alcoholic beverages, and pickles</li> </ol>                                                                                                                                        |                                                         |                         |
| <b>Module I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>INDUSTRIAL PRODUCTION OF FERMENTED FOODS</b>         | <b>No. of hours: 15</b> |
| <b>A) Dairy Product</b> <ol style="list-style-type: none"> <li>1. Cheese</li> <li>2. Yoghurt</li> <li>3. Curd</li> <li>4. Butter</li> </ol> <b>B) Alcoholic Beverages</b> <ol style="list-style-type: none"> <li>1. Wine: - Industrial production of -               <ol style="list-style-type: none"> <li>a) Red Table Wine</li> <li>b) Sparkling Wine-Champagne</li> </ol> </li> <li>2. Beer: - Industrial production of -               <ol style="list-style-type: none"> <li>a) Ale</li> <li>b) Lager</li> </ol> </li> </ol> <b>C) Pickles</b> <ol style="list-style-type: none"> <li>1. Sauerkraut</li> <li>2. Cucumber</li> <li>3. Olive</li> </ol> |                                                         |                         |
| <b>Module II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>SPOILAGE OF FERMENTED FOODS AND ITS PRESERVATION</b> | <b>No. of hours: 15</b> |
| <b>A) Spoilage of Dairy Product:</b> <ol style="list-style-type: none"> <li>1. Cheese</li> <li>2. Yoghurt</li> <li>3. Curd</li> <li>4. Butter</li> </ol> <b>B) Spoilage of Alcoholic Beverages:</b> <ol style="list-style-type: none"> <li>1. Wine</li> <li>2. Beer</li> </ol> <b>C) Spoilage of Pickles:</b> <ol style="list-style-type: none"> <li>1. Sauerkraut</li> <li>2. Cucumber</li> <li>3. Olive</li> </ol> <b>D) Preservation of :</b> <ol style="list-style-type: none"> <li>1. Dairy Product</li> <li>2. Alcoholic Beverages</li> <li>3. Pickles</li> </ol>                                                                                     |                                                         |                         |

## COURSE VI: QUALITY CONTROL AND ASSURANCE OF FOOD PRODUCTS

(MAJOR COURSE)

[CREDITS - 02; LECTURES - 30 hours; LEC/WEEK – 02]

### Learning Objectives

1. To learn microbiological tests to check food quality and detect pathogens
2. To understand food quality regulations like PFA, FDA, FPO, ISO, BIS, and AGMARK
3. To learn the basics of GMP, GLP, and HACCP for food safety
4. To apply TQM and ICMSF guidelines in milk and food quality control

| Module I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | QUALITY CONTROL OF FOOD PRODUCTS                   | No. of hours: 15 |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|------------------|
| <b>A) Need of Microbiological quality control of food</b><br><b>B) Microbiological analysis of food products</b> <ol style="list-style-type: none"> <li>1. SPC</li> <li>2. Detection for the presence of               <ol style="list-style-type: none"> <li>I) Pathogenic bacteria                   <ol style="list-style-type: none"> <li>a. <i>E. coli</i></li> <li>b. <i>Staph. aureus</i></li> <li>c. <i>Shigella</i></li> <li>d. <i>Pseudomonas</i></li> <li>e. <i>Salmonella</i></li> </ol> </li> <li>II) Yeast and mold</li> </ol> </li> </ol>                                                                                                                                                                                                                                                                                                                                                          |                                                    |                  |
| Module II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | INTRODUCTION TO QUALITY ASSURANCE OF FOOD PRODUCTS | No. of hours: 15 |
| <b>A) Basic concepts of: -</b> <ol style="list-style-type: none"> <li>1. Regulation as per PFA, FDA &amp; FPO.</li> <li>2. Standards &amp; Norms as per ISO, BIS, AGMARK</li> </ol> <b>B) Introduction of GMP &amp; GLP</b><br><b>C) Introduction to HACCP (Hazard Analysis Critical Control Points)</b><br><b>D) TQMS (Total Quality Management System) of milk and milk products-</b> <ol style="list-style-type: none"> <li>1. Raw material acceptance</li> <li>2. Process control</li> <li>3. Packaging</li> <li>4. Finished product storage</li> <li>5. Transport and Distribution</li> </ol> <b>E) ICMSF (International Commission on the Microbiological Specification of Foods)</b> <ol style="list-style-type: none"> <li>1. Introduction</li> <li>2. ICMSF–Sampling plans               <ol style="list-style-type: none"> <li>a. The two class plan</li> <li>b. The three class</li> </ol> </li> </ol> |                                                    |                  |

| <b>PRACTICAL COURSE III</b><br><b>(MAJOR COURSE)</b><br><b>[CREDITS -02, TOTAL HOURS- 60, PRACTICALS /WEEK - 04]</b>                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                         |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| <b>Learning Objectives</b> <ol style="list-style-type: none"> <li>1. To produce sauerkraut and perform standard plate count (SPC) for fermented and dairy products</li> <li>2. To isolate and identify spoilage bacteria from milk, cheese, and wine</li> <li>3. To isolate and identify lactic acid bacteria from curd</li> <li>4. To detect common foodborne pathogens and spoilage microbes from various food samples</li> </ol> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                         |
| <b>Module I</b>                                                                                                                                                                                                                                                                                                                                                                                                                     | <ol style="list-style-type: none"> <li>1) Production of sauerkraut</li> <li>2) SPC of sauerkraut</li> <li>3) SPC of buttermilk &amp; cheese</li> <li>4) Isolation of bacteria from spoiled milk</li> <li>5) Isolation of bacteria from spoiled cheese</li> <li>6) Isolation of bacteria from spoiled wine</li> <li>7) Isolation and identification of Lactic acid bacteria from Curd</li> </ol>                                                                                                                | <b>No. of hours :30</b> |
| <b>Module II</b>                                                                                                                                                                                                                                                                                                                                                                                                                    | <ol style="list-style-type: none"> <li>1) Rapid detection of food pathogens – <i>E. coli</i> and <i>Staphylococcus</i> from given food sample</li> <li>2) Detection for the presence of <i>E. coli</i> &amp; <i>Staph. aureus</i> in butter</li> <li>3) Detection for the presence of <i>Pseudomonas</i> from given food sample</li> <li>4) Detection for the presence of <i>Salmonella</i> from given food sample</li> <li>5) Detection for the presence of Yeast and molds from given food sample</li> </ol> | <b>No. of hours :30</b> |

## B.Sc. Part II (NEP 2.0) Semester-IV

| <b>COURSE VII: FERMENTATION TECHNOLOGY</b><br><b>(MAJOR COURSE)</b><br><b>[CREDITS - 02; LECTURES - 30 hours; LEC/WEEK – 02]</b>                                                                                                                                                                                                                                                                                                                                                |                                                  |                         |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|-------------------------|
| <b>Learning Objectives:</b> <ol style="list-style-type: none"><li>1. To understand the industrial production process of antibiotics and organic acids</li><li>2. To identify raw materials and microbes used in fermentation for pharmaceutical products</li><li>3. To learn the steps of recovery and applications of amino acids and enzymes</li><li>4. To explore the role of fermentation in producing valuable bio-products like antibiotics, acids, and enzymes</li></ol> |                                                  |                         |
| <b>Module I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Fermentation of Pharmaceutical products</b>   | <b>No. of hours: 15</b> |
| <b>Industrial production: -</b><br>Raw materials, Microorganisms, production process, Recovery and Applications:<br><b>A) Antibiotics</b> <ol style="list-style-type: none"><li>1. Streptomycin</li><li>2. Tetracycline</li><li>3. Rifampicin</li></ol> <b>B) Organic Acids</b> <ol style="list-style-type: none"><li>1. Lactic Acid</li><li>2. Citric Acid</li></ol>                                                                                                           |                                                  |                         |
| <b>Module II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Fermentation of Amino acids &amp; Enzymes</b> | <b>No. of hours: 15</b> |
| <b>Industrial production: -</b><br>Raw materials, Microorganisms, production process, Recovery and Applications:<br><b>A) Amino acids</b> <ol style="list-style-type: none"><li>1. Lysine</li><li>2. Glutamic Acid</li></ol> <b>B) Enzymes</b> <ol style="list-style-type: none"><li>1. Amylases</li><li>2. Lipase</li><li>3. Proteases</li></ol>                                                                                                                               |                                                  |                         |

| <b>COURSE VIII: INDUSTRIAL PRODUCTION OF BIOFERTILIZERS</b><br><b>(MAJOR COURSE)</b><br><b>[CREDITS - 02; LECTURES - 30 hours; LEC/WEEK – 02]</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                               |                         |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|-------------------------|
| <b>Learning Objectives:</b> <ol style="list-style-type: none"> <li>1. To understand the role and need of nitrogen-fixing biofertilizers in organic farming</li> <li>2. To learn the characteristics, production, and application of Rhizobium, Azotobacter, and Azospirillum biofertilizers</li> <li>3. To study the types, functions, and application methods of VAM and PSB biofertilizers</li> <li>4. To understand FCO guidelines for quality control, sampling, and standards of biofertilizers</li> </ol>                                                                                                                                                                                                                                                                        |                                               |                         |
| <b>Module I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Nitrogen fixing Bio-fertilizers</b>        | <b>No. of hours: 15</b> |
| <p><b>A) Concept &amp; its need in organic farming</b></p> <p><b>a) <i>Rhizobium</i> Biofertilizer</b></p> <ol style="list-style-type: none"> <li>1. Characteristics</li> <li>2. Host-Rhizobium interaction</li> <li>3. N<sub>2</sub>-fixation in root-nodules</li> <li>4. Production</li> <li>5. Methods of application:</li> </ol> <p><b>b) <i>Azotobacter</i> Biofertilizer</b></p> <ol style="list-style-type: none"> <li>1. Characteristics</li> <li>2. N<sub>2</sub>-fixation process</li> <li>3. Production</li> <li>4. Methods of application</li> </ol> <p><b>c) <i>Azospirillum</i> Biofertilizer</b></p> <ol style="list-style-type: none"> <li>1. Characteristics</li> <li>2. Association with plants</li> <li>3. Production</li> <li>4. Methods of application</li> </ol> |                                               |                         |
| <b>Module II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>Phosphate Solubilizing Bio-fertilizers</b> | <b>No. of hours: 15</b> |
| <p><b>A) VAM Biofertilizer</b></p> <ol style="list-style-type: none"> <li>1. Characteristics &amp; types of association</li> <li>2. Production</li> <li>3. Methods of application</li> </ol> <p><b>B) PSB Biofertilizer (Phosphate Solubilizing Bacteria)</b></p> <ol style="list-style-type: none"> <li>1. Mechanism of phosphate solubilization</li> <li>2. Production</li> <li>3. Methods of application</li> </ol> <p><b>C) Quality control of Biofertilizers as per FCO (Fertilizer Control Order)</b></p> <ol style="list-style-type: none"> <li>1. Introduction of FCO specifications for biofertilizers</li> <li>2. Sampling procedure</li> <li>3. Method of analysis</li> <li>4. Standards of biofertilizers</li> <li>5. Biostability of product biofertilizer</li> </ol>     |                                               |                         |

| <b>PRACTICAL COURSE IV</b><br><b>(MAJOR COURSE)</b><br><b>[CREDITS -02, TOTAL HOURS- 60, PRACTICALS /WEEK - 04]</b>                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                         |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| <b>Learning Objectives:</b> <ol style="list-style-type: none"> <li>1. To isolate and identify industrial and agricultural microorganisms</li> <li>2. To produce and purify citric acid, enzymes, and antibiotics using fermentation methods</li> <li>3. To estimate fermentation products using standard assay techniques</li> <li>4. To apply enzyme immobilization and perform microbial limit tests for quality control</li> </ol> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                         |
| <b>Module I</b>                                                                                                                                                                                                                                                                                                                                                                                                                       | <ol style="list-style-type: none"> <li>1) Isolation of lipolytic &amp; proteolytic producing microorganisms from suitable source</li> <li>2) Production, extraction, purification of Citric acid</li> <li>3) Production of amylase by a Surface culture method</li> <li>4) Production of protease by Submerged culture method</li> <li>5) Estimation of following fermentation products by suitable assay method               <ol style="list-style-type: none"> <li>a) Antibiotics–Streptomycin &amp; Tetracycline (Diffusion assay method)</li> <li>b) Organic Acids–Lactic acid &amp; Citric acid by titration method</li> <li>c) Enzymes–Amylase (DNSA method)</li> </ol> </li> <li>6) Immobilization of Amylase by using Sodium Alginate method</li> <li>7) Assay of protease (Folin Ciocalteu method)</li> </ol> | <b>No. of hours: 30</b> |
| <b>Module II</b>                                                                                                                                                                                                                                                                                                                                                                                                                      | <ol style="list-style-type: none"> <li>1) Isolation of <i>Azotobacter</i> from soil</li> <li>2) Isolation of <i>Azospirillum</i> from soil</li> <li>3) Isolation of <i>Rhizobium</i> from root-nodules</li> <li>4) Isolation of Phosphate solubilizing bacteria from soil</li> <li>5) Determination of heterocyst frequency of blue-green bacteria</li> <li>6) Microbial limit test for PSB market fertilizer product</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                        | <b>No. of hours: 30</b> |

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**Structure and Syllabus in Accordance with  
National Education Policy - 2020 (NEP 2.0)  
with Multiple Entry and Multiple Exit**

**Syllabus For**

**B.Sc. Part II**

**SKILL ENHACEMENT COURSE  
IN INDUSTRIAL MICROBIOLOGY**

**(Faculty of Science and Technology)**

**SEMESTER III AND IV**

**(To Be Implemented from Academic Year 2026-27)**

## B.Sc. Part II (NEP 2.0) Semester-III

### SKILL ENHANCEMENT COURSE-1 (SEC- 1):

#### Introduction to Artificial Intelligence-I

[CREDITS -02, TOTAL HOURS- 60, PRACTICALS /WEEK - 04]

#### Learning Objectives

1. To provide hands-on exposure to basic AI tools and applications.
2. To develop skills in scientific data handling and interpretation.
3. To familiarize students with AI-assisted scientific analysis.
4. To introduce simple machine learning activities without programming complexity.
5. To improve scientific problem-solving using AI platforms.

| Practical No. | Title of Experiment                                                                  |
|---------------|--------------------------------------------------------------------------------------|
| 1             | Introduction to Artificial Intelligence tools and applications.                      |
| 2             | Study of AI platforms such as ChatGPT, Google Gemini and Microsoft Copilot.          |
| 3             | Exercise on prompt writing and effective communication with AI systems.              |
| 4             | Identification and documentation of AI applications used in daily life.              |
| 5             | Collection and organization of scientific datasets using spreadsheet software.       |
| 6             | Preparation of graphical representations of data (bar graph, pie chart, line graph). |
| 7             | Demonstration of basic machine learning using Teachable Machine.                     |
| 8             | Image classification using AI tools.                                                 |
| 9             | Study of AI applications in Biological Sciences and Bioinformatics.                  |
| 10            | AI-assisted literature search using Google Scholar and PubMed.                       |

## B.Sc. Part II (NEP 2.0) Semester-IV

### SKILL ENHANCEMENT COURSE- 2 (SEC-2):

#### A.I APPLICATIONS IN INDUSTRIAL MICROBIOLOGY

[CREDITS -02, TOTAL HOURS- 60, PRACTICALS /WEEK - 04]

#### Learning Objectives

1. To introduce undergraduate students to basic applications of Artificial Intelligence in Industrial Microbiology.
2. To develop practical skills in AI-assisted data collection, analysis, and interpretation in microbiology experiments.
3. To familiarize students with simple AI tools useful in microbial studies, fermentation analysis, and scientific documentation.
4. To integrate AI-based learning with routine microbiology laboratory practices suitable for rural and basic laboratories.

| Practical No. | Title of Experiment                                                                                            |
|---------------|----------------------------------------------------------------------------------------------------------------|
| 1             | Use of ChatGPT for preparation of SOPs for microbiology laboratory practices.                                  |
| 2             | AI-assisted identification of laboratory instruments and microbiological equipment using image search tools.   |
| 3             | Preparation of microbial growth curves using spreadsheet software and AI-generated graph interpretation.       |
| 4             | Use of AI tools to predict optimum conditions for microbial growth (temperature, pH, incubation time).         |
| 5             | AI-assisted colony counting and comparison of microbial growth on agar plates.                                 |
| 6             | Study of fermentation in curd or yeast using AI-based data recording and analysis.                             |
| 7             | Use of AI chatbots for preparation of culture media compositions and calculation of media requirements.        |
| 8             | AI-assisted literature survey on industrially important microorganisms using Google Scholar and PubMed.        |
| 9             | Comparative analysis of microbial contamination in water or food samples using AI-generated tables and graphs. |
| 10            | Use of AI tools for preparation of laboratory reports, scientific summaries, and result interpretation         |

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**SEMESTER III AND IV**

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**VOCATIONAL SKILL COURSE  
IN INDUSTRIAL MICROBIOLOGY**

**(Faculty of Science and Technology)**

**SEMESTER III**

**(To Be Implemented from Academic Year 2026-27)**

## B.Sc. Part II (NEP 2.0) Semester-III

### **VOCATIONAL SKILL COURSE-1 (VSC- 1): MILK TESTING AND QUALITY CONTROL [CREDITS -02, TOTAL HOURS- 60, PRACTICALS /WEEK - 04]**

#### **Learning Objectives**

1. To operate essential laboratory equipment used in milk testing and quality control
2. To perform accurate milk sampling, preservation, and physical analysis techniques
3. To apply the phosphatase test and other methods to ensure milk safety and pasteurization efficiency
4. To gain practical insights into industrial milk processing and quality assurance

| <b>Practical No.</b> | <b>Title of Experiment</b>                                                                                                                                                                                                                                                                                               |
|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1                    | Demonstration of laboratory equipment<br>Incubator, Hot air oven, Water bath, Laminar air flow, Gerber's centrifuge                                                                                                                                                                                                      |
| 2                    | Milk sampling techniques and preservation of milk samples for different tests                                                                                                                                                                                                                                            |
| 3                    | Physical analysis of milk<br>Organoleptic tests- Flavour, Colour, Taste                                                                                                                                                                                                                                                  |
| 4                    | Chemical analysis of milk <ol style="list-style-type: none"><li>a) Measurement of pH of Milk and Milk Products</li><li>b) Clot on Boiling</li><li>c) Alcohol Test for Milk</li><li>d) Inhibitor Test</li><li>e) Acidity Test</li><li>f) Detection of Adulterant- Soap, Common salt, SMP, Starch, Formalin, etc</li></ol> |
| 5                    | Microbiological analysis of milk <ol style="list-style-type: none"><li>a) Dye Reduction Test – MBRT</li><li>b) SPC for Milk</li><li>c) Direct Microscopic Count</li><li>d) Yeast or mold count</li><li>e) Test for Coliforms</li></ol>                                                                                   |
| 6                    | Phosphatase test                                                                                                                                                                                                                                                                                                         |

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Warana University

Established: 2025

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**B.A. Part II /B. Com. Part II**

**OPEN ELECTIVE COURSE**

**IN INDUSTRIAL MICROBIOLOGY**

**SEMESTER III AND IV**

**(To Be Implemented from Academic Year 2026-27)**

## **B. A. Part II / B. Com. Part II (NEP 2.0) Semester-III**

**OPEN ELECTIVE COURSE-3 (OE-3):  
MICROORGANISMS IN EVERYDAY LIFE  
[CREDITS -02, TOTAL HOURS- 60, PRACTICALS /WEEK - 04]**

### **Learning Objectives**

1. To identify and observe the presence of microflora in various environments
2. To understand the role of microorganisms in human health and their implications for hygiene practices
3. To analyze the factors influencing microbial presence and growth in different environments and discuss their health and ecological implications
4. To evaluate the effectiveness of hygiene methods in reducing microbial growth

| <b>Practical No.</b> | <b>Title of Experiment</b>                                  |
|----------------------|-------------------------------------------------------------|
| 1                    | Observation of the presence of microflora in air            |
| 2                    | Observation of the presence of microflora in water          |
| 3                    | Observation of the presence of microflora on the skin       |
| 4                    | Observation of the presence of microflora from nails        |
| 5                    | Observation of the presence of microflora from teeth        |
| 6                    | Proper hand washing technique                               |
| 7                    | Effect of soap and disinfectant on growth of microorganisms |
| 8                    | Effect of sanitizer on growth of microorganisms             |
| 9                    | Observation of the presence of microflora from soil         |
| 10                   | Observation of the presence of microflora on currency-coin  |

**OPEN ELECTIVE COURSE-3 (OE-3):****रोजच्या जीवनातील सूक्ष्मजीव****[CREDITS -02, TOTAL HOURS- 60, PRACTICALS /WEEK - 04]****शिकण्याची उशिष्टे**

1. विविध िातांरिणातील सक्ष्मजींिीसृष्टीची ओळख ि विरीक्षण करणे.
2. मांिीी आरोग्यात सक्ष्मजींिीांची भवूमका समजू घेणे आवण संच्छता पद्धतींरिल तयांचे पररणाम समजांिू घेणे.
3. िेगिगळ्या िातांरिणातील सक्ष्मजींिीांची उपवस्िती आवण िाढ यांरि पररणाम करणारे घटक विश्लेवित करणे आवण तयांच्या आरोग्य ि पयांरिणीय पररणामांरि चचा करणे.

4. सक्ष्मजींिीांच्या िांटीला आळा घालायासाठी संच्छता पद्धतींच्या पभांिीवेचे पल्लणांकि करणे

| अ. क्र. | प्रयोगाचे नाव                                                      |
|---------|--------------------------------------------------------------------|
| 1       | हितील सक्ष्मजींिीांच्या उपवस्ितीचे विरीक्षण करणे                   |
| 2       | पाण्यातील सक्ष्मजींिीांच्या उपवस्ितीचे विरीक्षण करणे               |
| 3       | तिचेरिल सक्ष्मजींिीांच्या उपवस्ितीचे विरीक्षण करणे                 |
| 4       | िखांरिल सक्ष्मजींिीांच्या उपवस्ितीचे विरीक्षण करणे                 |
| 5       | दातांरिल सक्ष्मजींिीांच्या उपवस्ितीचे विरीक्षण करणे                |
| 6       | हात धुण्याची योग्य पद्धत अभ्यासणे                                  |
| 7       | साबण आवण जांतुंिाशकाचा सक्ष्मजींिीांच्या िांटीरिल प्रभांि अभ्यासणे |
| 8       | सॅविटायझरचा सक्ष्मजींिीांच्या िांटीरिल प्रभांि अभ्यासणे            |
| 9       | मातीतील सक्ष्मजींिीांच्या उपवस्ितीचे विरीक्षण करणे                 |
| 10      | चलि- िाण्यारिल सक्ष्मजींिीांच्या उपवस्ितीचे विरीक्षण करणे          |

## **B. A. Part II / B. Com. Part II (NEP 2.0) Semester-IV**

### **OPEN ELECTIVE COURSE- 4 (OE-4):**

### **THE ROLE OF MICROORGANISMS**

**[CREDITS -02, TOTAL HOURS- 60, PRACTICALS /WEEK - 04]**

#### **Learning Objectives**

1. To cultivate microorganisms on natural surfaces
2. To examine and observe microbial spoilage in various food and plant products
3. To learn the significance of root nodules in leguminous plants
4. To understand the preparation of beneficial microbial inoculants for plant applications
5. To study commonly used biofertilizers, biopesticides and bioinsecticides

| <b>Practical No.</b> | <b>Title of Experiment</b>                                                                                                                |
|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| 1                    | Cultivation of microorganisms on natural surfaces- Coconut and Orange fruit                                                               |
| 2                    | Collection and observation of spoiled food products- Bread and Milk                                                                       |
| 3                    | Collection and observation of spoiled fruits- Banana and Apple                                                                            |
| 4                    | Observation of common symptoms of plant diseases caused by microorganisms-Citrus canker, Black rust of wheat, and Whip-smut of sugar cane |
| 5                    | Microbial spoilage of paper and leather products                                                                                          |
| 6                    | Collection and importance of root nodules of leguminous plants                                                                            |
| 7                    | Preparation of beneficial microbial inoculants for plant applications                                                                     |
| 8                    | Study of commonly used biofertilizers                                                                                                     |
| 9                    | Study of commonly used biopesticides                                                                                                      |
| 10                   | Study of commonly used bioinsecticides                                                                                                    |

**OPEN ELECTIVE COURSE- 4 (OE-4):****सूक्ष्मजीवांची भूशमका****[CREDITS -02, TOTAL HOURS- 60, PRACTICALS /WEEK - 04]****शिकण्याची उशिष्टे**

1. िैसवगाक पृष्ठभागांर सक्ष्मजीांची िाढ करणे.
2. विविध अन्ि आवण ििस्पती उतपादांमध्ये सक्ष्मजीांमुळे होणाऱ्या खराबीचे विरीक्षण ि परीक्षण करणे.
3. डाळिगीय ििस्पतींमध्ये मुळांरिल गाठींचे महत्ि समजू घेणे.
4. ििस्पतींसाठी उपयुक्त सक्ष्मजीां सांिधािची तयारी समजू घेणे.
5. प्रचवलत जैविक खते आवण जैविक कीटकिशकांचे अध्ययि करणे.

| अ. क्र. | प्रयोगाचे नाव                                                                                                                |
|---------|------------------------------------------------------------------------------------------------------------------------------|
| 1       | िैसवगाक पृष्ठभागांर सक्ष्मजीांची िाढ करणे - िारळ आवण सांत्री फळ                                                              |
| 2       | खराब झालेल्या अन्िपदांांचे सांकलि आवण विरीक्षण करणे - ब्रेड आवण दधू                                                          |
| 3       | खराब झालेल्या फळांचे सांकलि आवण विरीक्षण करणे - केळे आवण सफरचांद                                                             |
| 4       | सक्ष्मजीांमुळे ििस्पतीा होणाऱ्या आजारांची सामान्य लक्षणे अभ्यासणे - वसट्स कांकर, गव्हांरिल काळी गांज, आवण ऊसांरिल व्हीप-स्मट |
| 5       | कागद आवण चामड्याच्या उतपादांर सक्ष्मजीांमुळे होणारे िुकसांि अभ्यासणे                                                         |
| 6       | डाळींबांधातील ििस्पतींच्या मुळांरिल गाठींचे सांकलि करणे आवण तयांचे महत्ि अभ्यासणे                                            |
| 7       | ििस्पतींसाठी उपयुक्त सक्ष्मजीांसांिधािची तयारी करणे                                                                          |
| 8       | प्रचवलत जैविक खतांचे अध्ययि करणे                                                                                             |
| 9       | प्रचवलत जैविक कीटकिशक - बायोपेस्टीसाइड्स यांचे अध्ययि करणे                                                                   |
| 10      | प्रचवलत जैविक कीटकिशक - बायोइन्सेक्टसाइड्स यांचे अध्ययि करणे                                                                 |

## **LIST OF REFERENCE BOOKS FOR THEORY & PRACTICAL**

1. Food Microbiology by Frazier.
2. Food Microbiology by H. A. Modi. (Vol. I&II)
3. Industrial Microbiology by A. H. Patel.
4. Industrial Microbiology by Prescott & Dunn.
5. Soil Microbiology by Subbarao.
6. Agriculture Microbiology by Rangaswamy.
7. Methods in Food and Dairy Microbiology by Harrigon.
8. Bio fertilizers –Vyas & Vyas (Ekta Publication).
9. Bacteriological Techniques- F.K. Baker
10. Milk & milk products–Winton & Winton
11. Pharmaceutical Microbiology–Hugo & Russell.
12. Citric acid Biotechnology–J. Achrekar.
13. Enzyme Biotechnology–G. Tripathi.
14. Bio fertilizers– Arun Sharma.
15. Industrial Microbiology–Agrawal / Parihar
16. Biotechnology–S. S. Purohit.
17. Agriculture Microbiology–G. Rangaswami & D. J. Bagyaraj
18. Text-book of Biotechnology–G. R. Chhatwal.
19. Pharmaceutical Biotechnology–Purohit / Kakrani / Saluja.
20. Practical Microbiology–R. C. Dubey and D. K. Maheshwari
21. Experimental Microbiology–Rakesh J. Patel & Kiran R. Patel. (Vol.I&II)
22. Fertilizer Control Order–1985 amended up to June, 2011
23. Practical Biochemistry by Plummer.

### **List of the minimum equipments for B.Sc. Part II Industrial Microbiology course**

All the equipments required for B.Sc. Part I Industrial Microbiology course

