

Shree Warana Vibhag Shikshan Mandal's

**WARANA UNIVERSITY,  
WARANANAGAR**

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



Established: 2025

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

UNDER

**Faculty of Science & Technology**

**B. Sc. Part - I (Semester - I and II)**

**(As Per National Education Policy – 2020)**

**With Effect from Academic Year 2025-26 Onwards**

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**Abbreviations:**

|      |                              |
|------|------------------------------|
| POs  | Program Outcomes             |
| PSOs | Program Specific Outcomes    |
| COs  | Course Outcomes              |
| DSC  | Discipline Specific Core     |
| DSE  | Discipline Specific Elective |
| GE   | Generic Elective             |
| OE   | Open Elective                |
| VSC  | Vocational Skill Course      |
| SEC  | Skill Enhancement Course     |
| IKS  | Indian Knowledge System      |
| AEC  | Ability Enhancement Course   |
| VEC  | Value Education Course       |
| OJT  | On Job Training (Internship) |
| FP   | Field project                |
| CEP  | Community engagement project |
| CC   | Co-curricular Courses        |
| RM   | Research Methodology         |
| RP   | Research Project             |
| MJ   | Major Course                 |
| MN   | Minor Course                 |
|      |                              |

## **PREAMBLE**

Industrial Microbiology is one of the most dynamic and applied branches of microbiology that directly contributes to human welfare and industrial progress. It deals with the use of microorganisms in large-scale production of valuable products such as antibiotics, enzymes, organic acids, fermented foods, beverages, biofuels, and bioplastics. The subject bridges the gap between basic microbiological knowledge and its translation into sustainable industrial applications.

The course is designed in line with the objectives of the National Education Policy (NEP-2020), which emphasizes skill-based, flexible, and interdisciplinary learning. Industrial microbiology not only provides students with fundamental insights into microbial physiology, genetics, and metabolism, but also trains them in bioprocess technology, fermentation engineering, and downstream processing.

This subject enables undergraduate students to:

- Understand the principles and methods of industrial production using microorganisms.
- Gain knowledge of fermentation processes, microbial strain improvement, and quality control.
- Develop practical skills in laboratory and pilot-scale techniques relevant to biotechnology and allied industries.
- Appreciate the importance of microbes in sectors like pharmaceuticals, agriculture, food, energy, and environmental management.
- Prepare for higher studies, research, and employment opportunities in microbiology, biotechnology, and industrial sectors.

The inclusion of Industrial Microbiology in the undergraduate curriculum is aimed at equipping students with hands-on experience and analytical skills to meet the demands of industry and society. The preamble highlights its role in fostering entrepreneurship, innovation, and sustainable development, thereby making learners industry-ready while nurturing their scientific curiosity.

## **GENERAL OBJECTIVES OF THE COURSE**

The undergraduate program in Industrial Microbiology is designed to provide students with a strong foundation in the principles and applications of microorganisms in industrial processes. Its objectives are to develop conceptual and practical knowledge of microbial physiology, genetics, and biochemistry relevant to industries such as pharmaceuticals, food, beverages, agriculture, and environmental management. The program aims to train students in modern laboratory techniques, fermentation technology, bioprocess engineering, and microbial product development while fostering critical thinking and problem-solving skills. It also emphasizes innovation, entrepreneurship, and ethical practices to prepare graduates for careers in research, industry, and higher education, thereby contributing to advancements in biotechnology and sustainable development.

## **PROGRAMME OUTCOMES (POs) – B.Sc.**

**PO-1:** - Students will gain fundamental knowledge of microbiology which will help them with PG Studies and Research

**PO-2:** - Students will be able to know good laboratory practices and lab safety.

**PO-3:** - To make the learner proficient in analytical skill during the course.

**PO-4:** - Students will be able to apply the fundamental knowledge to address crosscutting issues such as sustainable development

**PO-5:** - Students will be able to solve various problems by identifying the essential parts of a problem, formulating a strategy for solving the problem, applying appropriate techniques to arrive at a solution, testing the precision and accuracy of the solution and interpreting the results.

**PO-6:** - Students will be able to communicate effectively, i.e., articulate, comprehend and write effective reports, make effective presentations and documentation and express the subject through technical writing and oral presentation.

### **Program Specific Outcomes:**

PSO-1: - Learn, design and perform experiments in the labs to demonstrate the concepts, principles and theories learnt in the classroom.

PSO-2: - Develop the ability to apply the knowledge acquired in classroom and laboratories to specific problems in theoretical and experimental Biochemistry.

PSO-3: - Identify the area of interest in academic research and development.

PSO-4: - Perform job in various fields like food, pharmaceutical, agriculture, health care, public services and business etc.

PSO-5: - Be an entrepreneur with precision, analytical mind, innovative thinking, and clarity of thought, expression and systematic approach.

### **ELIGIBILITY FOR ADMISSION**

As per guidelines obtained from Warana University, Warananagar by following rules and regarding reservations by Govt. of Maharashtra

### **DURATION**

The course shall be a fulltime course. One Year, Semester I and II.

**MEDIUM OF INSTRUCTION** The medium of instruction shall be English

**MEME Instructions:** In alignment with the National Education Policy (NEP) 2020, the Bachelor of Science (B.Sc.) program adopts the Multiple Entry and Multiple Exit (ME-ME) framework. This flexible structure is designed to provide students with academic mobility, skill development, and lifelong learning opportunities. Through ME-ME framework, the program enables students to enter and exit at different stages with appropriate certifications. Information regarding different entry and exit options available to students and respective mandatory number of credits to be earned by the students are

| Year | Stage of exit                             | Type of Award                        | Mandatory Credits to be earned | Minimum credits to be earned |
|------|-------------------------------------------|--------------------------------------|--------------------------------|------------------------------|
| 1    | After successful completion of One Year   | Undergraduate Certificate in Science | 44                             | 40                           |
| 2    | After successful completion of Two Year   | Undergraduate Diploma in Science     | 88                             | 80                           |
| 3    | After successful completion of Three Year | Bachelor of Science Degree           | 132                            | 120                          |

provided in the table below.

**Re-entry provision:** Students leaving after a undergraduate certificate or undergraduate diploma may re-enter the program within 5 years by earning required credits through Academic Bank of Credits.

**SCHEME OF TEACHING AND EXAMINATION:** [The scheme of teaching and examination should be given as applicable to the course/paper concerned.]

| B.Sc. Program Structure for Level 4.5 of B.Sc.-I Semester I |                             |                 |           |       |         |                                            |     |     |                              |     |     |                                             |     |     |
|-------------------------------------------------------------|-----------------------------|-----------------|-----------|-------|---------|--------------------------------------------|-----|-----|------------------------------|-----|-----|---------------------------------------------|-----|-----|
| Teaching Scheme                                             |                             |                 |           |       |         | Examination Scheme                         |     |     |                              |     |     |                                             |     |     |
| Sr. No.                                                     | Theory (TH) & Practical (P) |                 |           |       |         | Semester-end Examination (SEE)             |     |     | Internal Assessment (IA)     |     |     | Practical                                   |     |     |
|                                                             | Course Type                 | No. of Lectures | Practical | Hours | Credits | Paper Hours                                | Max | Min | Internal                     | Max | Min | Paper Hours                                 | Max | Min |
| 1.                                                          | DSC-I                       | 4               | 1         | 4+4   | 6       | 1                                          | 30  | 12  | Assignment                   | 20  | 8   | 2                                           | 50  | 20  |
| 2.                                                          | DSC-I                       | 4               | 1         | 4+4   | 6       | 1                                          | 30  | 12  |                              | 20  | 8   | 2                                           | 50  | 20  |
| 3.                                                          | DSC-I                       | 4               | 1         | 4+4   | 6       | 1                                          | 30  | 12  |                              | 20  | 8   | 2                                           | 50  | 20  |
| 4.                                                          | OE -I                       | -               | 1         | 4     | 2       | -                                          | -   | -   |                              | -   | -   | 2                                           | 50  | 20  |
| 5.                                                          | VEC                         | -               | -         | -     | -       | -                                          | -   | -   |                              | -   | -   | -                                           | -   | -   |
| 6.                                                          | IKS (Generic)               | 2               | -         | 2     | 2       | 2                                          | 50  | 20  |                              | -   | -   | -                                           | -   | -   |
| Total                                                       |                             |                 |           |       | 22      | [DSC (60 X 3) + IKS 50]<br>Total SEE = 230 |     |     | DSC (40X3)<br>Total IA = 120 |     |     | Practical. = 50X4<br>Total Practical. = 200 |     |     |
| Total Semester –I = 550                                     |                             |                 |           |       |         |                                            |     |     |                              |     |     |                                             |     |     |

| B.Sc. Program Structure for Level 4.5 of B.Sc.-I Semester II |                             |                 |           |       |         |                                            |     |     |                              |     |     |                                             |     |     |
|--------------------------------------------------------------|-----------------------------|-----------------|-----------|-------|---------|--------------------------------------------|-----|-----|------------------------------|-----|-----|---------------------------------------------|-----|-----|
| Teaching Scheme                                              |                             |                 |           |       |         | Examination Scheme                         |     |     |                              |     |     |                                             |     |     |
| Sr. No.                                                      | Theory (TH) & Practical (P) |                 |           |       |         | Semester-end Examination (SEE)             |     |     | Internal Assessment (IA)     |     |     | Practical                                   |     |     |
|                                                              | Course Type                 | No. of Lectures | Practical | Hours | Credits | Paper Hours                                | Max | Min | Internal                     | Max | Min | Paper Hours                                 | Max | Min |
| 1.                                                           | DSC-II                      | 4               | 1         | 4+4   | 6       | 1                                          | 30  | 12  | Assignment                   | 20  | 8   | 2                                           | 50  | 20  |
| 2.                                                           | DSC-II                      | 4               | 1         | 4+4   | 6       | 1                                          | 30  | 12  |                              | 20  | 8   | 2                                           | 50  | 20  |
| 3.                                                           | DSC-II                      | 4               | 1         | 4+4   | 6       | 1                                          | 30  | 12  |                              | 20  | 8   | 2                                           | 50  | 20  |
| 4.                                                           | OE -II                      | -               | 1         | 4     | 2       | -                                          | -   | -   |                              | -   | -   | 2                                           | 50  | 20  |
| 5.                                                           | VEC -I                      | 2               | -         | 2     | 2       | 2                                          | 50  | 20  |                              | -   | -   | -                                           | -   | -   |
| 6.                                                           | IKS (Generic)               | -               | -         | -     | -       | -                                          | -   | -   |                              | -   | -   | -                                           | -   | -   |
| Total                                                        |                             |                 |           |       | 22      | [DSC (60 X 3) + IKS 50]<br>Total SEE = 230 |     |     | DSC (40X3)<br>Total IA = 120 |     |     | Practical. = 50X4<br>Total Practical. = 200 |     |     |
| Total Semester –I = 550                                      |                             |                 |           |       |         |                                            |     |     |                              |     |     |                                             |     |     |

### **General Guidelines for the selection of subjects**

1. In first year, student has to choose three DSC subjects from the basket for faculty of Science. (The DSC Basket for faculty of Science includes Mathematics, Physics, Chemistry, Biochemistry, Zoology, Biochemistry, Industrial Microbiology and Computer Science)
2. At the start of second year, out of these 3 DSC subjects, he/she has to opt one subject as Major subject and one as Minor subject. The remaining DSC subject will be dropped.
3. Student cannot select a subject as major or minor other than the subjects taken in first year.
4. OE is to be chosen compulsorily from faculty other than that of the major. (B.Sc. students needs to select OE from faculty of Arts or Faculty of Commerce)
5. VSC is to be selected from the basket of Skill courses approved by the university.
6. IKS (Generic) will be provided by the university separately.

**Credit Distribution Structure for B.Sc.-I in Biochemistry with Multiple Entry and Multiple Exit Options:**

| <b>COURSE CATEGORY</b> | <b>ABBREVIATION (Only 2 Letters)</b> | <b>DESCRIPTION</b>                | <b>Sem.-I Credit</b> | <b>Sem.-II Credit</b> |
|------------------------|--------------------------------------|-----------------------------------|----------------------|-----------------------|
| DSC                    | DSC (DS)                             | Discipline Specific Course        | 6x3=18               | 6x3=18                |
| OE                     | OE(OE)                               | Open Elective                     | 2x1=02               | 2x1=02                |
| SEC                    | SEC (SE)                             | Skill Enhancement Course          | -                    | -                     |
| AEC/IKS/VEC            | AEC(AE)                              | Ability Enhancement Course        | -                    | -                     |
|                        | IKS(IK)                              | Indian Knowledge System (Generic) | 2x1=02               | -                     |
|                        | VEC(VE)                              | Value Education Course            | -                    | 2x1=02                |
| CC/CEP                 | CC (CC)                              | Co-curricular Course              | -                    | -                     |
|                        | CEP(CE)                              | Community Engagement Project      | -                    | -                     |
|                        |                                      |                                   | 22                   | 22                    |
|                        |                                      |                                   | Total 44             |                       |

**Warana University, Warananagar**  
**Bachelor of Science**  
**Credit Framework**  
**First-Year (B. Sc. I-Industrial Microbiology)**

| Level                                                                                                                                                   | Sem.           | Subject-1<br>(Chemistry)                                                   | Subject-2          | Subject-3          | IDC/MDC/OE/GE                                                                          | SEC | AEC, VEC, IKS |                                                               |                                              | OJT, FP, CEP, CC, RP |        |                 | Total Credits |
|---------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|----------------------------------------------------------------------------|--------------------|--------------------|----------------------------------------------------------------------------------------|-----|---------------|---------------------------------------------------------------|----------------------------------------------|----------------------|--------|-----------------|---------------|
|                                                                                                                                                         |                | DSC                                                                        | DSC                | DSC                | OE                                                                                     | SEC | AEC           | VEC                                                           | IKS                                          | CC                   | FP/OJT | RP/<br>Dissert. |               |
| 4.5                                                                                                                                                     | I              | IIM-101<br>Paper-I Introduction<br>to Industrial<br>Microbiology (2 Cr)    | DSC-I<br>(2 Cr)    | DSC-I (2 Cr)       | IMOEP-101<br>Practical Paper-I<br>Food and Dairy<br>Microbiology<br>(2 Cr)             | --  | --            | --                                                            | IKS-I<br>(2 Cr)<br>Introduction<br>on to IKS | --                   | --     | --              | --            |
|                                                                                                                                                         |                | BoF-102<br>Paper-II Basics of<br>Fermentation (2 Cr)                       | DSC-II<br>(2 Cr)   | DSC-II (2 Cr)      |                                                                                        |     |               |                                                               |                                              |                      |        |                 |               |
|                                                                                                                                                         |                | PRIM-103 Practical<br>Paper-I (2 Cr)                                       | DSC-P-I<br>(2 Cr)  | DSC-P-I (2 Cr)     |                                                                                        |     |               |                                                               |                                              |                      |        |                 |               |
|                                                                                                                                                         | <b>Credits</b> | <b>4(T)+2(P)=6</b>                                                         | <b>4(T)+2(P)=6</b> | <b>4(T)+2(P)=6</b> | <b>2 (P)=2</b>                                                                         | --  | --            | --                                                            | <b>2(T)</b>                                  | --                   | --     | --              | <b>22</b>     |
|                                                                                                                                                         | II             | IFT -201<br>Paper-III Introduction<br>to Fermentation<br>Technology (2 Cr) | DSC-III<br>(2 Cr)  | DSC-I (2 Cr)       | IMOEP-201<br>Practical Paper-II<br>Industrial and<br>Medical<br>Microbiology<br>(2 Cr) | --  | --            | VEC-I<br>(2 Cr)<br>Democracy,<br>Election and<br>Constitution | --                                           | --                   | --     | --              | --            |
|                                                                                                                                                         |                | MFA-202<br>Paper-IV Microbial<br>Fermentation and<br>Assay (2 Cr)          | DSC-IV<br>(2 Cr)   | DSC-II (2 Cr)      |                                                                                        |     |               |                                                               |                                              |                      |        |                 |               |
|                                                                                                                                                         |                | PRIM-203 Practical<br>Paper-II (2 Cr)                                      | DSC-P-II<br>(2 Cr) | DSC-P-II (2 Cr)    |                                                                                        |     |               |                                                               |                                              |                      |        |                 |               |
|                                                                                                                                                         | <b>Credits</b> | <b>4(T)+2(P)=6</b>                                                         | <b>4(T)+2(P)=6</b> | <b>4(T)+2(P)=6</b> | <b>2 (P)=2</b>                                                                         | --  | --            | <b>2(T)</b>                                                   | --                                           | --                   | --     | --              | <b>22</b>     |
| <b>Total Credits</b>                                                                                                                                    |                | <b>12</b>                                                                  | <b>12</b>          | <b>12</b>          | <b>4</b>                                                                               | --  | --            | <b>2</b>                                                      | <b>2</b>                                     | --                   | --     | --              | <b>44</b>     |
| <b>Exit Option: Award of UG Certificate in Major with 44 Credits and an additional 4 credits core NSQF course/ Internship/Skill Courses OR Continue</b> |                |                                                                            |                    |                    |                                                                                        |     |               |                                                               |                                              |                      |        |                 |               |

**Note on OE courses:** - The students of science should select the open elective subject from the OE basket provided by faculty of Arts and Humanities or faculty of Commerce and Management. The details of OE courses available are provided in the prospectus and posted on Institutional Website.

**B. Sc. I (NEP-2.0) Semester I, PAPER-I**

**IIM -1-101- Introduction to Industrial Microbiology**

**(Theory Credits-02, 30 hours. Marks- 50)**

| Expected Course outcomes                                                                                                |
|-------------------------------------------------------------------------------------------------------------------------|
| To get acquainted with the contribution made by prominent scientists in the field of industrial microbiology.           |
| To study the characteristics and industrial importance of microorganisms.                                               |
| To understand the basic concept of fermentation and technique used for isolation of industrially useful microorganisms. |
| To study the characteristics and industrial importance of microorganisms.                                               |

| Module                                                                         | Sub-module                                                            | Syllabus Content                                                                                                                                                                                                                                                                                          | Hrs.     |
|--------------------------------------------------------------------------------|-----------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| <b>I<br/>History and<br/>Basic Concepts<br/>of Industrial<br/>Microbiology</b> | <b>Historical<br/>developments of<br/>industrial<br/>microbiology</b> | 1. Definition and scope of Industrial Microbiology.<br>2. Contributions of various scientists to Industrial Microbiology.<br>a) Louis Pasteur<br>b) Antony Van Leeuwenhoek<br>c) Alexander Fleming<br>d) Selman Waksman<br>e) Edward Jenner                                                               | <b>3</b> |
|                                                                                | <b>Introduction to<br/>Industrially<br/>important<br/>products</b>    | a) pharmaceutical products–<br>i) Vitamins– Vit B12<br>ii) Antibiotics–Penicillin<br>iii) Vaccine–Types with examples<br>b) <b>Agricultural products</b> –<br>i) Biofertilizers– Azotobacter<br>ii) Biopesticides–Bacillus thuringiensis.<br>c) Food products–<br>i) Fermented milk products–Curd, Yogurt | <b>6</b> |

|                                                                          |                                                           |                                                                                                                                                                                                                                                                                                                |          |
|--------------------------------------------------------------------------|-----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
|                                                                          |                                                           | ii) Pickles– Sauerkraut                                                                                                                                                                                                                                                                                        |          |
|                                                                          | <b>Concepts of Fermentation</b>                           | 1. Fermentation–Definition<br>2. Primary and secondary metabolites<br>3. Types of fermentation-<br>a) Batch and continuous fermentations<br>b) Dual and multiple fermentation<br>c) Solid state and liquid state fermentation                                                                                  | <b>6</b> |
| <b>II Isolation &amp; Study of industrially important microorganisms</b> | <b>Screening of industrially important microorganisms</b> | 1. Primary Screening of-<br>a) Antibiotic producers<br>b) Organic acid producers<br>c) Amylase producers<br>d) Amino acid producers<br>e) Secondary screening-<br>i) Detail information of microorganism used.<br>ii) Detail information of products produced.<br>Qualitative & quantitative study of products | <b>7</b> |
|                                                                          | <b>Study of Industrially Important Microorganisms</b>     | General characteristics and industrial importance of:<br>a) Bacteria including actinomycetes.<br>b) Fungi (yeasts and molds)                                                                                                                                                                                   | <b>8</b> |

#### Reference Books:

1. General Microbiology–R.Y. Stanier and others. Macmillan Press Ltd.
2. Principles of Fermentation Technology –Stanbury and Whitaker. Pergamon Press.
3. Industrial Microbiology–L. E. Casida Jr. John Wiley and Sons.
4. Microbial Technology, Volumes I&II– H.J. Peppler. Academic Press
5. Microbiology by Pelczar, Reid & Chan
6. Isolation Methods for Microbiologists, Volumes I&II–Gibbs and Shapton. Academic Press  
Quantitative Bioassay–D. Hancroft, T. Hector and F. Rowell. John Wiley & Sons

**B.Sc. Part I (NEP-2.0) SEMESTER-I, PAPER-II****BoF-2-102- Basics of Fermentation****(Theory Credits: 02, 30 hours)**

| Expected Course outcomes                           |
|----------------------------------------------------|
| Capable of media preparation                       |
| Understand the knowledge of different ingredients. |
| Acquainted with sterilization of equipment's       |
| Capable of validation of sterilization processes   |

| Module                                                                          | Sub-module                                          | Syllabus Content                                                                                                                                                                                                                                                                                     | Hrs.      |
|---------------------------------------------------------------------------------|-----------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>I<br/>Fermentation<br/>media and<br/>Waste as<br/>fermentation<br/>media</b> | <b>Components<br/>of<br/>Fermentation<br/>media</b> | 1. Basic components<br>a) water,<br>b) Sources of carbon, nitrogen, minerals<br>2. Special ingredients–<br>a) Growth factors<br>b) buffers<br>c) precursors, inhibitors, inducers,<br>d) anti-foam agents<br>e) redox potential<br>3. Types of media used<br>a) synthetic, semisynthetic<br>b) crude | <b>08</b> |
|                                                                                 |                                                     | 1. Concept of Pretreatment and addition of supplements.<br>2. a) Industrial waste-<br>i) Molasses<br>ii) Corn steep liquor<br>iii) SWL                                                                                                                                                               | <b>07</b> |

|                                                                             |                                         |                                                                                                                                                                                                       |           |
|-----------------------------------------------------------------------------|-----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|                                                                             | <b>Types of Waste and Use of Wastes</b> | b) Agricultural waste <ul style="list-style-type: none"> <li>i. Wheat bran</li> <li>ii. Rice husk</li> </ul>                                                                                          |           |
| <b>II<br/>Sterilization<br/>Techniques in<br/>Fermentation<br/>Industry</b> | <b>Sterilization<br/>Technique:</b>     | 1. Principles of Sterilization<br>2. Sterilization of Equipment<br>3. Sterilization of production media with respect to Acid Alkali Buffer, Antifoam agent and precursors<br>4. Sterilization of air. | <b>15</b> |
|                                                                             |                                         | <b>Validation of sterilization processes</b>                                                                                                                                                          |           |

#### Reference Books:

1. Industrial Microbiology by A. H. Patel
2. Industrial Microbiology–Prescott & Dunn.
3. Industrial Microbiology–Agarwal & Parihar.
4. Principles & Techniques of Biochemistry and Molecular Biology–Wilson & Walker.
5. Industrial Microbiology–Prescott & Dunn.
6. Principles of Bacteriology –A. G. Salle
7. Biofertilizers–Arun Sharma.
8. Fundamentals of Microbiology–Frobisher et al.

**B. Sc. I Semester I, Practical Course  
PRIM-103-PRACTICAL PAPER-I  
(Credits-02, 60 hours)**

**Introduction to Industrial Microbial Techniques**

| <b>Expected Course outcomes</b> |                                                                                                                              |
|---------------------------------|------------------------------------------------------------------------------------------------------------------------------|
|                                 | Students will get detailed and comprehensive knowledge on the various practical aspects of basic microbiological techniques. |
|                                 | The students will be able to analyze different microbiological samples.                                                      |
|                                 | The students will get practical knowledge regarding preparation of media and its sterilization,                              |
|                                 | To understand methods the microbial screening in each sample by using standard analytical techniques.                        |

| <b>Sr No</b> | <b>Name of The Experiment</b>               |
|--------------|---------------------------------------------|
|              | <b>Biosafety in Microbiology Laboratory</b> |

|                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1                                                                      | a) Aseptic techniques: <ol style="list-style-type: none"> <li>Table disinfection</li> <li>Hand wash,</li> <li>Use of aprons</li> </ol> b) Proper disposal of used material<br>c) Cleaning and sterilization of glassware                                                                                                                                                                                                                                                                                             |
| 2.                                                                     | Studying parts of Light compound microscope and its use and care.                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 3.                                                                     | Study of the principle and applications of instruments used in the microbiology laboratory: <ol style="list-style-type: none"> <li>Biological safety cabinets</li> <li>Autoclave</li> <li>Incubator</li> <li>Hot air oven</li> <li>Seitz filter</li> <li>Centrifuge</li> <li>pH meter</li> <li>Spectrophotometer</li> <li>Distillation Unit</li> </ol>                                                                                                                                                               |
| <b>Preparation of Media and Study of Microorganism in Fermentation</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 4                                                                      | Preparation of media and isolation of Bacteria, Molds, Yeasts Preparation of-agar plates, slants and isolation of <ol style="list-style-type: none"> <li>Bacteria–               <ul style="list-style-type: none"> <li>Nutrient agar-Bacillus subtilis</li> <li>Soil extract agar-Actinomycetes</li> </ul> </li> <li>Molds–I. Potato Dextrose Agar-Aspergillus oryzae</li> <li>Yeasts–Sabouraud's Agar-Saccharomyces cerevisiae</li> <li>Actinomycetes–I. Glycerol Asparagine Agar- Streptomyces species</li> </ol> |
| 5.                                                                     | Sterilization of culture medium using Autoclave and assessment for sterility.                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 6.                                                                     | Sterilization of glassware using Hot Air Oven and assessment for sterility                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 7.                                                                     | Isolation and identification of Azotobacter chroococcum from soil                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 8.                                                                     | Primary Screening of- <ol style="list-style-type: none"> <li>Antibiotic producers</li> <li>Organic acid producers</li> <li>Amylase producer, / Amino acid producers</li> </ol>                                                                                                                                                                                                                                                                                                                                       |

### **Recommended Books for Practical**

1. Experimental Microbiology – R.J. Patel and K.R. Patel, Aditya Publishers, Ahmedabad
2. Laboratory Fundamentals of Microbiology –Alcamo I. E
3. Stains and Staining Procedures –Desai & Desai
4. Introduction to Practical Biochemistry –D. Plummer, J. Willey and sons
5. Introduction to Microbial Techniques –Gunasekaran.

### **B. Sc. I Semester II Practical Course**

#### **IMOEP-203 Practical Paper-I**

**(Credits-02, 60 hours)**

#### **FOOD AND DAIRY MICROBIOLOGY**

| Expected Course Outcomes                                                                                                                          |
|---------------------------------------------------------------------------------------------------------------------------------------------------|
| Gain in-depth knowledge of the principles and technologies involved in processing milk, dairy products, fruits, vegetables, and other food items. |
| Understand the fundamental concepts of food chemistry, microbiology, nutrition, and engineering relevant to food processing                       |

|                                                                                                                              |
|------------------------------------------------------------------------------------------------------------------------------|
| Learn about various unit operations, such as heat transfer, dehydration, and other methods used in food and dairy production |
|------------------------------------------------------------------------------------------------------------------------------|

|                                                                                                                                           |
|-------------------------------------------------------------------------------------------------------------------------------------------|
| Develop the ability to innovate and create new food products, including functional foods and products catering to specific dietary needs. |
|-------------------------------------------------------------------------------------------------------------------------------------------|

1. Bacterial examination of drinking water by membrane filter technique.
2. Study of important microbes in the degradation of waste.
3. Determination of TDT.
4. Determination of TDP.
5. Detection and quantification of Aflatoxin B1.
6. Detection of food-borne bacteria by immunoassays.
7. Detection and enumeration of Microorganisms present in Utensils.
8. Isolation and identification of pathogenic microorganisms from canned food.
9. Enumeration of bacteria in raw and pasteurized milk by SPC method.
10. Determination of quality of a milk sample by MBRT.
11. Detection of number of bacteria in milk by breed-count method
12. Litmus milk test.
13. Microbial quality of milk products.
14. Microbiological examination of Ice-cream and Dairy products
15. Soil microbes' interaction In vitro by dual culture method
16. Isolation, identification and enumeration of Rhizosphere and Rhizoplane microorganism
17. Isolation of Rhizobium from roots of leguminous plant

### **B.Sc. Part I (NEP-2.0) SEMESTER-I, PAPER-III**

#### **IFT-201- INTRODUCTION TO FERMENTATION TECHNOLOGY**

**(Theory Credits: 02, 30 hours, Marks-50)**

| Expected Course Outcomes                                                              |
|---------------------------------------------------------------------------------------|
| To study fermenter design and to understand different types of fermenters.            |
| To study the temperature, pH, pressure and foam control systems and their importance. |
| To understand the concepts of inoculums preparation, strain improvement, stock        |

culture maintenance and culture collection centers.

To study the various factors affecting fermentation process.

| Module                                                                                          | Sub-module                           | Syllabus Content                                                                                                                                                                                                                                                                                        | Hrs.      |
|-------------------------------------------------------------------------------------------------|--------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>I<br/>Design of<br/>Fermenter &amp;<br/>working<br/>system</b>                               | <b>Basic Fermenter<br/>design:</b>   | 1. Parts and their functions of<br>Conventional Stirred tank<br>fermenter.<br>2. Types of Fermenters <ul style="list-style-type: none"> <li>a) Fermenter Types – Airlift<br/>Fermenter</li> <li>b) Fluidized bed fermenter</li> <li>c) Packed bed fermenter</li> <li>d) Bubble cap fermenter</li> </ul> | <b>15</b> |
|                                                                                                 | <b>Fermenter<br/>control system:</b> | 1. Introduction & Importance of<br>control systems.<br>2. Designs, principles and<br>working of systems for control<br>of– <ul style="list-style-type: none"> <li>a. temperature</li> <li>b. pressure</li> <li>c. foam</li> <li>d. pH.</li> <li>e. Contamination</li> </ul>                             |           |
| <b>II<br/>Production<br/>strains and<br/>Factors<br/>affecting<br/>fermentation<br/>process</b> | <b>Production<br/>strains</b>        | 1. Concept<br>2. Concept of strain improvement<br>3. Stock culture maintenance<br>4. Culture collection centers                                                                                                                                                                                         | <b>08</b> |
|                                                                                                 | <b>Preparation<br/>of inoculum</b>   |                                                                                                                                                                                                                                                                                                         |           |

|  |                                               |                                                                       |           |
|--|-----------------------------------------------|-----------------------------------------------------------------------|-----------|
|  | <b>Factors Affecting fermentation process</b> | 1. Temperature, pH, Aeration, Agitation, Foam<br>2. Media Composition | <b>07</b> |
|--|-----------------------------------------------|-----------------------------------------------------------------------|-----------|

### Reference Books:

1. General Microbiology–R.Y. Stanier and others. Macmillan Press Ltd.
2. Principles of Fermentation Technology –Stanbury and Whitaker. Pergamon Press.
3. Industrial Microbiology–L. E. Casida Jr. John Wiley and Sons.
4. Microbial Technology, Volumes I&II– H.J. Peppler. Academic Press
5. Microbiology by Pelczar, Reid & Chan
6. Isolation Methods for Microbiologists, Volumes I&II–Gibbs and Shapton. Academic Press
7. Quantitative Bioassay–D. Hancroft, T. Hector and F. Rowell. John Wiley & Sons

**B. Sc. I Semester II, Paper IV**  
**IMT-202- MICROBIAL FERMENTATION AND ASSAY**  
**(Theory Credits:02, Lectures-30 hours, Marks- 50)**

| Expected Course Outcomes                                                           |
|------------------------------------------------------------------------------------|
| To study industrial production of penicillin, semisynthetic penicillin and Vit B12 |
| To study microbiological assay of vitamins and antibiotics.                        |
| To understand various downstream processes.                                        |
| To study economic protection of fermentation product.                              |

| Module                                                             | Sub-module                         | Syllabus Content                                                                            | Hrs.      |
|--------------------------------------------------------------------|------------------------------------|---------------------------------------------------------------------------------------------|-----------|
| <b>I</b><br><br><b>Microbial fermentations and microbial assay</b> | <b>Antibiotics:</b>                | Production of antibiotics -:<br>Penicillin, Streptomycin                                    | <b>2</b>  |
|                                                                    | <b>Vitamin</b>                     | Production of Vitamin -:<br>Vitamin B12                                                     | <b>13</b> |
|                                                                    | <b>Amino acid</b>                  | Production of L-lysine                                                                      |           |
|                                                                    | <b>Other Industrial products</b>   | a) Enzymes–Amylase<br>b) Organic Acid-Citric acid                                           |           |
|                                                                    | <b>Fermented Soyabean Products</b> | miso, tofu, soy sauce<br>Probiotic food                                                     |           |
| <b>II</b><br><br><b>Purification and assay of fermentation</b>     | <b>Downstream Processes</b>        | 1. Cell harvesting<br>2. Precipitation, filtration and centrifugation<br>3. Cell disruption |           |

|                 |                                        |                                                                                                                                      |          |
|-----------------|----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|----------|
| <b>products</b> |                                        | 4. Liquid-liquid extraction<br>5. Chromatography-Adsorption, Ion exchange, Gel and Affinity<br>6. Distillation<br>7. Crystallization | <b>8</b> |
|                 | <b>Assay on fermentation Products.</b> | 1. Microbiological assay of Vitamins and Antibiotics.<br>2. Chemical assays of Penicillin.                                           | <b>7</b> |

### References

1. Industrial Microbiology by A. H. Patel
2. Industrial Microbiology–Prescott & Dunn.
3. Industrial Microbiology–Agarwal & Parihar.
4. Principles & Techniques of Biochemistry and Molecular Biology–Wilson & Walker.
5. Industrial Microbiology–Prescott & Dunn.
6. Principles of Bacteriology –A. G. Salle
7. Biofertilizers–Arun Sharma.
8. Fundamentals of Microbiology–Frobisher et al.

**B. Sc. I Semester II Practical Course**  
**PRIM-203 Practical Paper-II**  
**(Credits-02, 60 hours)**

| <b>Expected Course outcomes</b> |                                                                                                                              |
|---------------------------------|------------------------------------------------------------------------------------------------------------------------------|
|                                 | Students will get detailed and comprehensive knowledge on the various practical aspects of basic microbiological techniques. |
|                                 | The students will be able to analyze different microbiological samples.                                                      |
|                                 | The students will get practical knowledge regarding preparation of media and its sterilization,                              |
|                                 | To understand methods the microbial screening in each sample by using standard analytical techniques.                        |

| <b>Study of Industrially Important Microorganism</b> |                                                                                                                                                                                                                                                                                                                                             | <b>(30 Hrs)</b> |
|------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| 1.                                                   | <b>Isolation and study of microorganisms:</b>                                                                                                                                                                                                                                                                                               |                 |
|                                                      | a. Bacteria–Isolation, colony characters, Gram staining & motility of <i>Bacillus amyloliquefaciens</i> .<br>b. Fungi– <i>Aspergillus niger</i> and <i>Penicillium chrysogenum</i> mounting & identification.<br>c. Yeasts – <i>Candida albicans</i> , monochrome staining.<br>d. Actinomycetes –cultivation using cover slip technique and |                 |

|                                         |                                                                                                                 |
|-----------------------------------------|-----------------------------------------------------------------------------------------------------------------|
|                                         | direct microscopic observation of <i>Streptomyces griseus</i>                                                   |
| 2.                                      | Sub-culturing of Microorganism by using solid media                                                             |
| 3.                                      | Demonstration of antimicrobial activity of actinomycetes by the Giant Colony Technique.                         |
| 4.                                      | Bioassay of Penicillin<br>a. Production of Sauerkraut and estimation of Lactic acid by titrable acidity         |
| <b>Microbial Fermentations (30 Hrs)</b> |                                                                                                                 |
| 1.                                      | Chemical assay of Penicillin<br>Immobilization of baker's yeast cells by gel entrapment for invertase activity. |
| 2.                                      | Separation of amino acids by paper chromatography.                                                              |
| 3.                                      | Separation of sugars by paper chromatography.                                                                   |
| 4.                                      | Demonstration of Lab Fermenter                                                                                  |

### References-

1. Experimental Microbiology – R.J. Patel and K.R. Patel, Aditya Publishers, Ahmedabad
2. Laboratory Fundamentals of Microbiology – Alcamo I. E
3. Stains and Staining Procedures – Desai & Desai
4. Introduction to Practical Biochemistry – D. Plummer, J. Willey and sons
5. Introduction to Microbial Techniques – Gunsekaran.

**B. Sc. I Semester II Practical Course**  
**IMOEP-203 Practical Paper-I**  
**(Credits-02, 60 hours, Marks-50)**  
**FOOD AND DAIRY MICROBIOLOGY**

| Expected Course Outcomes                                                                                                                          |
|---------------------------------------------------------------------------------------------------------------------------------------------------|
| Gain in-depth knowledge of the principles and technologies involved in processing milk, dairy products, fruits, vegetables, and other food items. |
| Understand the fundamental concepts of food chemistry, microbiology, nutrition, and engineering relevant to food processing                       |
| Learn about various unit operations, such as heat transfer, dehydration, and other methods used in food and dairy production                      |
| Develop the ability to innovate and create new food products, including functional foods and products catering to specific dietary needs.         |

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13. Microbial quality of milk products.
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15. Soil microbes' interaction In vitro by dual culture method
16. Isolation, identification and enumeration of Rhizosphere and Rhizoplane microorganism
17. Isolation of Rhizobium from roots of leguminous plant

#### SCHEME OF EXAMINATION:

- The examination shall be conducted at the end of each term for semester pattern.
- The theory paper shall carry 30 marks.
- The evaluation of the performance of the students in theory papers shall be on the basis of Semester Examination of 30 marks.
- The internal evaluation for each paper shall carry 10 marks. (Semester I and II: Home assignment, class assignment, unit test a and midterm test)
- Question paper will be set in the view of the /in accordance with the entire syllabus and preferably covering each unit of syllabi.

**STANDARD OF PASSING:** As prescribed under rules and regulation for each degree.

#### SPECIAL INSTRUCTIONS, IF ANY

##### Determination of CZPA, Grading and Declaration of result

University has adopted 10-point Grading System as follows: **In each semester, marks obtained in each course (Paper) are converted to grade points:** If the total marks of course are 100 and passing criteria is 40%, then use the following Table for the conversion.

##### Gradation Chart:

**Table**

| Marks Obtained | Numerical Grade (Grade Point) | CGPA      | Letter Grade     |
|----------------|-------------------------------|-----------|------------------|
| Absent         | 0 (zero)                      | -         | Ab: Absent       |
| 0–39           | 0 to 4                        | 0.0– 4.99 | F: Fail          |
| 40– 49         | 5                             | 5.00–5.49 | C: Average       |
| 50– 54         | 6                             | 5.50–6.49 | B: Above Average |
| 55– 64         | 7                             | 6.50–7.49 | B+: Good         |

|         |    |           |                |
|---------|----|-----------|----------------|
| 65– 74  | 8  | 7.50–8.49 | A: VeryGood    |
| 75– 84  | 9  | 8.50–9.49 | A+: Excellent  |
| 85– 100 | 10 | 9.50–10.0 | O: 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.
3. Marks obtained in 50 marks or 200 marks paper shall be converted to 100 marks.

### **Calculation of SGPA & CGPA**

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

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

#### 2. Cumulative Grade Point Average (**CGPA**)

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

### **NATURE OF THEORY QUESTION PAPER AND SCHEME OF MARKING:**

Duration of question paper: As per University rule:

- |      |                                       |           |         |
|------|---------------------------------------|-----------|---------|
| i.   | Duration of Examination for           | 60 marks- | 2 Hours |
| ii.  | Duration of Examination for           | 30 marks- | 1 Hours |
| iii. | Duration of Practical Examination for | 50 marks- | 2 Hours |

#### **Assessment pattern**

For 4 Credits 60:40 (SSE : CIE)

For 2 Credits 30:20 (SSE : CIE)

**ESE Question paper pattern for theory**  
**(Biochemistry Paper-I, II, III and IV)**

**Duration: 1 Hr**

**Total Marks: 30**

Q. 1. Multiple choices questions (6-questions)

6 Marks

*(It may include Wh que., match the pairs, true/false, multiple correct options MCQ etc.)*

i)

ii)

iii)

iv)

v)

vi)

Q. 2. Attempt any two of the following

12 Marks

A. or B.

C. or D.

Q. 3. Short answer questions (any three) (out of five).

12 Marks

*(It may include short notes, label the diagram, compare between, distinguish between etc.)*

a.

b.

c.

d.

e.

Nature of Question Paper  
Program: B.Sc. (Part I) (Level 4.5) (Semester – I) (NEP-2020)  
**Semester I**

**Nature of Practical Exam**

**Semester-I Practical Paper-I**

**(30 Marks)**

|                                             |          |
|---------------------------------------------|----------|
| Q. 1 Microbiological Isolation-             | 10 Marks |
| Q. 2 Microbiological Demonstration Methods- | 10 Marks |
| Q. 3 Media Preparation -                    | 05 Marks |
| Q. 4 Spotting Spot A, B, C, D, E, -         | 05 Marks |

**Semester-II Practical Paper-II**

**(30 Marks)**

|                                             |          |
|---------------------------------------------|----------|
| Q. 1 Microbiological Isolation-             | 10 Marks |
| Q. 2 Microbiological Demonstration Methods- | 10 Marks |
| Q. 3 Media Preparation -                    | 05 Marks |
| Q. 4 Spotting Spot A, B, C, D, E, -         | 05 Marks |

**Internal Evaluation**

**(20)**

|                                   |   |
|-----------------------------------|---|
| Journal                           | 5 |
| Practical Note Book               | 5 |
| Oral based on practical           | 5 |
| Tour report / Project/ Model etc. | 5 |

## B. Sc. I Semester II OPEN ELECTIVE COURSE

### Nature of Practical Exam for OE for both Semester

|                         |           |
|-------------------------|-----------|
| Q.1. Major Experiment.  | 25 Marks. |
| Q.2. Minor Experiment.  | 15 Marks. |
| Q.3. Spotting (5 Spots) | 05 Marks. |
| Q.4. Certified Journal  | 05 Marks. |

**Course Title: Interdisciplinary course in Generic IKS**

**Course Code: 2502USBOIK101**

**SSE 30 Marks**

#### **Question paper pattern**

- Q. 1. Multiple choices questions (6-questions) 6 Marks  
*(It may include Wh que., match the pairs, true/false, multiple correct options MCQ etc.)*
- i)
  - ii)
  - iii)
  - iv)
  - v)
  - vi)
- Q. 2. Write short notes on (Any three) 12 Marks
- A.
  - B.
  - C.
  - D.
  - E.
- Q. 3. Answer the following (any two) 12 Marks
- a.
  - b.
  - c.

**Internal Assessment**

**20 Marks**

Nature of Question Paper  
**Course Title: Democracy, Election and Constitution**  
**Course Code: 2502USBOVE201**

**SSE 50 Marks**

**Question paper pattern**

Q. 1. Multiple choices questions (25questions)

50 Marks

25 MCQ questions each with 4 options

A)

B)

C)