# Learning Outcomes based Curriculum Framework (LOCF)
# for
# M.Sc. Microbiology
# (One/Two Year Program)

## Syllabus (2025 Onwards)

## (NEP-NCrF)

**DEPARTMENT OF MICROBIOLOGY**
**SCHOOL OF INTERDISCIPLINARY AND APPLIED SCIENCES**
**CENTRAL UNIVERSITY OF HARYANA**

## 1. Background

### 1.1 Introduction to the Microbiology and the Department

The M.Sc. Microbiology programme provides a platform to inculcate the basic understanding of microbes and to develop skills related to different areas of Microbiology. Microbiology is a core subject of life sciences and is required as a platform course in all the areas of biological sciences. Public private sector entities look for skilled microbiology workforce preferably at post graduate level. Keeping that in mind this M.Sc. Microbiology scheme and syllabi is designed to provide thorough and updated knowledge of the subject, to enable easy entry for the students in public private sector workforce and to prepare researchers for carrying out research in cutting edge areas of Microbiology. In this course there are practicals in each semester to train the students with hands on laboratory skills. One core course on seminar presentation has been added which will help in developing public speaking skills and critical thinking in the students. For hands on training in different core areas of Microbiology, there is one full semester Research thesis work in this programme. In the Research thesis work student is given a research problem and experimental path seeking the solution to the selected problem. Student will be collecting data, analyse it and present it both orally and in writing. All these rigorous paths will produce a skilled human resource for the changing societal need.

The Department of Microbiology was established in June 2015 with the vision of bridging the gap between classical microbiology and applied aspects of microbiology with research on infectious diseases, Immunology, Food and agriculture, biofuels and bioenergy. The main objective of the Department is to impart quality education in the field of Microbiology and to create trained microbiologist to contribute to the fields of food production, pharmaceuticals, agrochemicals, environment, agriculture and public health research. The Department of Microbiology aims at using Microbial research as a tool for the benefit of mankind.

The Department offers M.Sc and Ph.D. program in Microbiology where the students are working in the areas of Immunology, Medical Microbiology, Molecular Biology, Food Microbiology Environmental Microbiology Soil & Agricultural Microbiology and Industrial Microbiology. The department also organizes various workshops, seminar, guest lectures in subject specific domains to enrich our students with recent developments in the field of Microbiology.

Research in the department seeks to meet challenges and provide information to us to eliminate pathogens, prevent newly emerging infectious diseases, and sustainable solutions of agricultural and environmental issues. The faculty members of the department are trained and have research expertise in different field of microbiology and are engaged in several research projects funded by various organizations such as UGC, DBT, DST, AISTDF and industry. The vision of our department is to become an internationally renowned and ideal department through highest teaching standards and performing quality research. The department houses several pieces of high end equipments. More than 100 papers have been published by the faculty of the Department in journals of National and International repute.

### 1.2 Introduction to the programme

The **M.Sc. Microbiology Programme** offered by Central University of Haryana is of two years duration and is divided into four semesters. The various courses of the programme are designed to include lectures, laboratory work, project training, viva, seminars, assignments and field trips. At the end of the programme, the student will be well-versed in basic as well as the advanced microbiology techniques and will gain hands-on experience in microbiology, including fermentation technology and molecular biology techniques.

**Four categories of courses** will be offered:

**Core Courses:** Include theoretical as well as practical courses

**Discipline-Specific Elective Courses (DSE):**

- In the 2nd and 3rd semesters, students will opt for any one of the discipline-specific elective courses offered by the department of the University.

**Multidisciplinary Elective Courses (MDC):**

- In 1st and 3rd semester, students will opt for any one of the multidisciplinary elective courses offered by other departments of the University.

**Skill Enhancement Courses:**

- Skills enhancement practical in each semester and a separate skill-based course that leads to a Research thesis/ Industrial Project of twenty credits will be offered to the students

**Value-added courses (VAC):**

- The Department May offer Value added courses to enhance a student's skills, employability, and knowledge in a specific domain. These courses go beyond the core curriculum and often align with industry demands.

### 1.3 Vision of the Department

The Department serves to be in the frontline of the field of Microbiology, aiming to be recognized as amongst the best for education and research in Microbiology.

### 1.4 Mission of the Department

- To equip the young minds with fundamental & applied knowledge in Microbiology
- To promoting all round personality development through multi-dimensional education
- To produce skilled human resource who can choose research areas or professional career as Microbiologists in industries and institutes.

## 2. PROGRAMME EDUCATIONAL OBJECTIVES (PEOS)

**PEO-1** To inculcate scientific knowledge and professional ethics for the overall development of students

**PEO-2** To equip the students with advanced microbiological analytical skills

**PEO-3** To impart the students with entrepreneurial skills in microbiology to make them ready to contribute to society as responsible individuals

## 3. PROGRAMME OUTCOMES (PO):

- **Basic and applied knowledge:** Interdisciplinary knowledge to find solution for the complex biological problems

- **Problem analysis:** Ability to analyse society related/ applied research problem, design and execute experiments to find relevant solutions

- **Advanced Usage of Technology**: Apply advanced instrumentation tools, online resources with an understanding of the troubleshooting and limitations

- **Ethics:** Commitment towards professional ethics and responsibilities as a social endeavor to bring harmony with nature

- **Lifelong learning:** Scientific skills for industrial applications and entrepreneurship

## 4. PROGRAMME SPECIFIC OUTCOMES (PSOS)

**PSO-1** Comprehensive theoretical and advanced knowledge on importance of microbes in diverse sphere of life

**PSO-2**: Familiarized with advanced tools and techniques of microbiological sciences.

**PSO-3**: Capacity to develop, employ and integrate technical and professional skills as a member of team withholding the essence of collaboration, cooperation and integrity

**PSO-4** Entrepreneurial skill development through critical analysis of problems and hands on training for providing their sustainable solutions

**PSO-5** Analysis of scientific or societal issues across the spectrum of related discipline.

**PSO-6** Ability to upgrade knowledge independently and act upon means of improvement for lifelong learning.

**PSO-7** Uphold the responsibility as a global citizen maintaining professional and ethical values

## 5. About Post Graduate attributes

The Masters course is designed to develop the current skills and abilities in the students in basic as well as advanced areas of Microbiology. A special emphasis is laid on the practical aspects of different areas of Microbiology as well as skill development. A course on Scientific communication skill development and seminar presentations will enhance of communication skills, socialistic approach and leadership qualities in the students. The course will provide highly skilled and knowledgeable manpower for different industrial sectors such as agriculture, food and dairy, medical and paramedical field as well as pursuing higher studies in reputed research institutes. A major component of the course is a skill enhancement elective course comprising complete semester for a research project. The student is guided throughout the semester for executing experiments related to a research problem and presenting the results in the form of an oral presentation as well

as a thesis. The research work is evaluated through oral presentation alongwith a viva-voce. This activity will foster self-confidence and self-reliance in the student as he/she learns to work and think independently.

## Course mapping with PSOs/Pos & Sustainable Development Goal

| Course Code | Course Title | Type | Credit | Level | POs/PSOs | SDG |
|---|---|---|---|---|---|---|
| MIB 401 DM 40 | Cell Biology# | Core | 4 | 400 | PSO1, PSO2 | SDG3,4 |
| MIB 403 DM 30 | Principles of Biochemistry | Core | 3 | 400 | PSO1, PSO2, PSO3, | SDG3,12 |
| MIB 405 DM 30 | Essentials of Microbiology | Core | 3 | 400 | PSO1, PSO2, PSO6 | SDG3,6 |
| MIB 407 DM 30 | Molecular Biology | Core | 3 | 400 | PSO1, PSO2, PSO4, | SDG2,4 |
| MIB 409 DM 30 | Microbial Systematics | Core | 3 | 400 | PSO1, PSO2, PSO5 | SDG3,4 |
| MIB 411 SE 40 | Practical-I | Core | 4 | 400 | PSO2, PSO3, PSO6 | SDG3,6,11 |
| | **Multidisciplinary Elective Courses** (to be opted from other Department) | MDC | 4 | 400 | PSO5, PSO6 | SDG3,4,15 |
| MIB 402 DM 40 | Advanced Analytical Techniques# | Core | 4 | 500 | PSO2, PSO3 | SDG6,9 |
| MIB 404 DM 40 | Microbial Genetics | Core | 4 | 500 | PSO1, PSO2, PSO3 | SDG3,15 |
| MIB 406 DM 40 | Microbial Physiology and Metabolism | Core | 4 | 500 | PSO2, PSO3 PSO4 | SDG3,12 |
| MIB 408 SE 40 | Practical-II | Core | 4 | 500 | PSO2, PSO3, PSO6 | SDG3,6,11 |
| MIB 410 DS 40 | Agricultural Microbiology * | DSE | 4 | 500 | PSO1, PSO2, PSO4 | SDG3,13,15 |

| | | | | | | |
|---|---|---|---|---|---|---|
| MIB 412 DS 40 | The Microbiome* | DSE | 4 | 500 | PSO1, PSO2, PSO3 | SDG3,12 |
| MIB 414 DS 40 | Food Microbiology * | DSE | 4 | 500 | PSO1, PSO3, PSO5 | SDG2,12 |
| MIB 501 DM 30 | Environmental Biotechnology# | Core | 3 | 500 | PSO1, PSO2, PSO5 | SDG3,6, 7 |
| MIB 503 DM 40 | Industrial Microbiology | Core | 4 | 500 | PSO3, PSO4, PSO5 | SDG3,9, 12 |
| MIB 505 DM 40 | Medical Microbiology and Immunology | Core | 4 | 500 | PSO1, PSO2, PSO3 | SDG3, 12 |
| MIB 507 SE 40 | Practical-III | Core | 4 | 500 | PSO2, PSO3 | SDG 6,9 |
| MIB 509 SE 20 | Seminar | Core | 2 | 500 | PSO3 | SDG 4,9 |
| MIB 511 DS 40 | Plant pathology* | DSE | 4 | 500 | PPSO2, PSO3, PSO4 PSO5 | SDG3,6, 13 |
| MIB 513 DS 40 | Biorefinery* | DSE | 4 | 500 | PPSO1, PSO3, PSO4 PSO5 | SDG 7,11, 13 |
| MIB 515 DS 40 | Biosafety, Bioethics and IPR* | DSE | 4 | 500 | PSO1, PSO2, PSO3 | SDG 4,11 |
| | **Multidisciplinary Elective Courses** (to be opted from other Department) | MDC | 4 | 500 | PSO5, PSO6 | SDG3,12 |
| MIB 550 SRP | Research thesis/ Industrial Project | Core | 20 | 500 | PSO4, PSO5, PSO6 | SDG4,9 |

**Alignment courses with Focus on employability/ entrepreneurship/ skill development, inclusion of IKS and alignment with SDGs**

| Course Title | Course Code | Whether introduced for the first time* (Yes or No) | Focus on Employability (Yes or No) | Focus on Entrepreneurship (Yes or No) | Focus on skill development (Yes or No) | SDGs addressed (Write number only) | Is IKS component present in course? (Yes or No) |
|---|---|---|---|---|---|---|---|
| Cell Biology | MIB 401 DM 40 | Yes | Yes | No | No | 3,4 | No |
| Principles of Biochemistry | MIB 403 DM 30 | No | Yes | No | No | 3,12 | No |
| Essentials of Microbiology | MIB 405 DM 30 | No | NO | No | No | 3,6 | No |
| Molecular Biology | MIB 407 DM 30 | Yes | Yes | No | No | 2,4 | No |
| Microbial Systematics | MIB 409 DM 30 | Yes | No | No | No | 3,4 | No |
| Practical-I | MIB 411 SE 40 | No | Yes | Yes | Yes | 3,6,11 | No |
| Multidisciplinary Elective Courses | | No | No | No | No | 3,4,15 | No |
| Advanced Analytical Techniques | MIB 402 DM 40 | No | Yes | Yes | Yes | 6,9 | No |
| Microbial Genetics | MIB 404 DM 40 | No | No | No | No | 3,15 | No |
| Microbial Physiology and Metabolism | MIB 406 DM 40 | No | Yes | No | No | 3,12 | No |
| Practical-II | MIB 408 SE 40 | No | Yes | Yes | Yes | 3,6,11 | No |
| Agricultural Microbiology | MIB 410 DS 40 | No | Yes | Yes | Yes | 3,13,15 | Yes |
| The Microbiome | MIB 412 DS 40 | No | No | No | No | 3,12 | No |
| Food Microbiology | MIB 414 DS 40 | No | Yes | No | No | 2,12 | Yes |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Environmental Biotechnology | MIB 501 DM 30 | Yes | Yes | Yes | No | 3,6 | No |
| Industrial Microbiology | MIB 503 DM 40 | No | Yes | Yes | Yes | 3,9, 12 | Yes |
| Medical Microbiology and Immunology | MIB 505 DM 40 | No | Yes | No | No | 3, 12 | No |
| Practical-III | MIB 507 SE 40 | No | Yes | Yes | Yes | 6,9 | No |
| Seminar | MIB 509 SE 20 | No | No | No | Yes | 4,9 | No |
| Plant pathology | MIB 511 DS 40 | No | Yes | Yes | No | 3,6, 13 | |
| Biorefinery | MIB 513 DS 40 | Yes | Yes | Yes | Yes | 7,11, 13 | No |
| Biosafety, Bioethics and IPR | MIB 515 DS 40 | No | Yes | Yes | No | 4,11 | Yes |
| Multidisciplinary Elective Courses | | | | | No | 3,12 | No |
| Research thesis/ Industrial Project | MIB 550 SRP | No | Yes | Yes | No | 4,9 | No |
| General Microbiology | MIB 101 MD 40 | Yes | No | No | No | 3,4 | Yes |
| Applied Microbiology | MIB 103 MD 40 | No | No | No | No | 3,4 | No |
| | | | | | | | |

## Two Year/Four Semester Master Degree Programme

## 6. Structure of Master Course

The Programme is contenting of four semesters and required achieve 89+/- credits are to be achieved through the various core, departmental electives, and multidisciplinary courses, demonstrated as below:

| **Master of Microbiology: 89 Credits** | | | | | |
|---|---|---|---|---|---|
| **Courses/Sem** | **1st Year** | | **2nd Year** | | |
| | | | **Coursework + Research** | | **Research Only** |
| | **Sem-1** | **Sem-2** | **Sem-3** | **Sem-4** | **Sem-3 + Sem-4** |
| | Credits | Credits | Credits | Credits | Credits |
| **Core** | 20 | 16 | 17 | 20 | 45 |
| **Discipline-Specific Elective Courses (DSE):** | 00 | 04 | 04 | 00 | 00 |
| **Multidisciplinary Elective Courses (MDC):** | 04 | 00 | 04 | 00 | 00 |
| **Total** | **24** | **20** | **25** | **20** | **45** |

## 6.1 Semester wise Course Curriculum and Credit distribution Total credits: 89

**Semester-I (Total credits - 24)**

| Course code | Course title | L | T | P | Credit |
|---|---|---|---|---|---|
| MIB 401 DM 40 | Cell Biology# | 4 | 0 | 0 | 4 |
| MIB 403 DM 30 | Principles of Biochemistry | 3 | 0 | 0 | 3 |
| MIB 405 DM 30 | Essentials of Microbiology | 3 | 0 | 0 | 3 |
| MIB 407 DM 30 | Molecular Biology | 3 | 0 | 0 | 3 |
| MIB 409 DM 30 | Microbial Systematics | 3 | 0 | 0 | 3 |
| MIB 411 SE 40 | Practical-I | 0 | 0 | 8 | 4 |
| | **Multidisciplinary Elective Courses** (to be opted from other Department) | 4 | 0 | 0 | 4 |

#Likely to be offered from Swayam

**Semester-II (Total credits - 20)**

| Course code | Course title | L | T | P | Credit |
|---|---|---|---|---|---|
| MIB 402 DM 40 | Advanced Analytical Techniques# | 4 | 0 | 0 | 4 |
| MIB 404 DM 40 | Microbial Genetics | 4 | 0 | 0 | 4 |
| MIB 406 DM 40 | Microbial Physiology and Metabolism | 4 | 0 | 0 | 4 |
| MIB 408 SE 40 | Practical-II | 0 | 0 | 8 | 4 |
| MIB 410 DS 40 | Agricultural Microbiology * | 4 | 0 | 0 | 4 |
| MIB 412 DS 40 | The Microbiome* | 4 | 0 | 0 | 4 |
| MIB 414 DS 40 | Food Microbiology * | 4 | 0 | 0 | 4 |

*One of the DSE course will be opted by the student.

# Likely to be offered from Swayam

**Semester-III (Total credits – 25)**

| Course Code | Course Title | L | T | P | Credit |
|---|---|---|---|---|---|
| MIB 501 DM 30 | Environmental Biotechnology# | 3 | 0 | 0 | 3 |
| MIB 503 DM 40 | Industrial Microbiology | 4 | 0 | 0 | 4 |
| MIB 505 DM 40 | Medical Microbiology and Immunology | 4 | 0 | 0 | 4 |
| MIB 507 SE 40 | Practical-III | 0 | 0 | 8 | 4 |
| MIB 509 SE 20 | Seminar | 0 | 4 | 0 | 2 |
| MIB 511 DS 40 | Plant pathology* | 4 | 0 | 0 | 4 |
| MIB 513 DS 40 | Biorefinery* | 4 | 0 | 0 | 4 |
| MIB 515 DS 40 | Biosafety, Bioethics and IPR* | 4 | 0 | 0 | 4 |
| | **Multidisciplinary Elective Courses** (to be opted from other Department) | 4 | 0 | 0 | 4 |

*One of the DSE course will be opted by the student.
# Likely to be offered from Swayam

**Semester-IV (Total credits - 20)**

Skill Enhancement Course

| Course Code | Course Title | Credit |
|---|---|---|
| MIB 550 SRP | Research thesis/ Industrial Project | 20 |
| | **Total credits of the Program** | **89** |

## Two Year/Four Semester Master Degree Programme (Research only)

**Semester-III + Semester-IV (Total credits - 45)**

| Course Code | Course Title | Credit |
|---|---|---|
| MIB 590 YRP | Research thesis | 45 |
| | **Total credits of the Program** | **89** |

**Multidisciplinary Elective Courses (MDC):** Offered by Department of Microbiology to students from other Departments of University.

| Semester | Core | Paper Code | Title of the Paper | Credit |
|---|---|---|---|---|
| **I** | MDC | MIB 101 MD 40 | General Microbiology | 4 |
| **III** | MDC | MIB 103 MD 40 | Applied Microbiology | 4 |

**Value Added Courses (VAC):** Offered by Department of Microbiology to students from other Departments of University.

| Semester | Core/ Elective | Paper Code | Title of the Paper | Credit |
|---|---|---|---|---|
| | VAC | MIB 102 VA 20 | Fundamentals of Agriculture | 2 |

## 6.2 One Year/Two Semester Master Degree Programme (Coursework & Research)

### Credit Summary Total Credits: 45

| Semester | Credits | | | Total credits |
|---|---|---|---|---|
| | Core courses | Elective courses | | |
| | | Department specific elective (DSE): | Multidisciplinary Courses (MDC): | |
| I | 17 | 4 | 4 | 25 |
| II | 20 | - | - | 20 |
| **Total** | **37** | **4** | **4** | **45** |

**Semester-I (Total credits – 25)**

| Course Code | Course Title | L | T | P | Credit |
|---|---|---|---|---|---|
| MIB 501 DM 30 | Environmental Biotechnology# | 3 | 0 | 0 | 3 |
| MIB 503 DM 40 | Industrial Microbiology | 4 | 0 | 0 | 4 |
| MIB 505 DM 40 | Medical Microbiology and Immunology | 4 | 0 | 0 | 4 |
| MIB 507 SE 40 | Practical-III | 0 | 0 | 8 | 4 |
| MIB 509 SE 20 | Seminar | 0 | 4 | 0 | 2 |
| MIB 511 DS 40 | Plant pathology* | 4 | 0 | 0 | 4 |
| MIB 513 DS 40 | Biorefinery* | 4 | 0 | 0 | 4 |
| MIB 515 DS 40 | Biosafety, Bioethics and IPR* | 4 | 0 | 0 | 4 |
| | **Multidisciplinary Elective Courses** (to be opted from other Department) | 4 | 0 | 0 | 4 |

*One of the DSE course will be opted by the student.
# Likely to be offered from Swayam

## Semester-II (Total credits - 20)

Skill Enhancement Course

| Course Code | Course Title | Type of Course | Credit |
|---|---|---|---|
| MIB 550 SRP | Research thesis/ Industrial Project | Core | 20 |
| | **Total credits of the Program** | | **45** |

## 6.3 One Year/Two Semester Master Degree Programme (Coursework)

### Credit Summary Total Credits: 45

| Semester | Credits | | | Total credits |
|---|---|---|---|---|
| | Core courses | Elective courses | | |
| | | Department specific elective (DSE): | Multidisciplinary Courses (MDC): | |
| I | 17 | 4 | 4 | 25 |
| II | 16 | 4 | - | 20 |
| **Total** | **33** | **8** | **4** | **45** |

**Semester-I (Total credits – 25)**

| Course Code | Course Title | L | T | P | Credit |
|---|---|---|---|---|---|
| MIB 501 DM 30 | Environmental Biotechnology# | 3 | 0 | 0 | 3 |
| MIB 503 DM 40 | Industrial Microbiology | 4 | 0 | 0 | 4 |
| MIB 505 DM 40 | Medical Microbiology and Immunology | 4 | 0 | 0 | 4 |
| MIB 507 SE 40 | Practical-III | 0 | 0 | 8 | 4 |
| MIB 509 SE 20 | Seminar | 0 | 4 | 0 | 2 |
| MIB 511 DS 40 | Plant pathology* | 4 | 0 | 0 | 4 |
| MIB 513 DS 40 | Biorefinery* | 4 | 0 | 0 | 4 |
| MIB 515 DS 40 | Biosafety, Bioethics and IPR* | 4 | 0 | 0 | 4 |
| | **Multidisciplinary Elective Courses** (to be opted from other Department) | 4 | 0 | 0 | 4 |

*One of the DSE course will be opted by the student.
# Likely to be offered from Swayam

**Semester-II (Total credits - 20)**

| Course code | Course title | L | T | P | Credit |
|---|---|---|---|---|---|
| MIB 402 DM 40 | Advanced Analytical Techniques# | 4 | 0 | 0 | 4 |
| MIB 404 DM 40 | Microbial Genetics | 4 | 0 | 0 | 4 |
| MIB 406 DM 40 | Microbial Physiology and Metabolism | 4 | 0 | 0 | 4 |
| MIB 408 SE 40 | Practical-II | 0 | 0 | 8 | 4 |
| MIB 410 DS 40 | Soil and Agriculture Microbiology* | 4 | 0 | 0 | 4 |
| MIB 412 DS 40 | The Microbiome* | 4 | 0 | 0 | 4 |
| MIB 414 DS 40 | Food Microbiology * | 4 | 0 | 0 | 4 |
| | **Total credits of the Program** | | | | **45** |

*One of the DSE course will be opted by the student.
# Likely to be offered from Swayam

## 6.4 One Year Master Degree Programme (Research)

### Credit Summary Total Credits: 40

| Year | Credits | | | Total credits |
|---|---|---|---|---|
| | Core courses | Elective courses | | |
| | | Department specific elective (DSE): | Multidisciplinary Courses (MDC): | |
| I | 45 | - | - | 45 |
| **Total** | **45** | **-** | **-** | **45** |

## One Year Master Degree Programme

Skill Enhancement Course

| Course Code | Course Title | Credit |
|---|---|---|
| MIB 550 SRP | Research thesis | 45 |
| | | |

## SEMESTER-I

**Course title: Cell Biology** **Credit: 4**
**Course code: MIB 401 DM 40** **Lectures: 60**
**Course objectives:**

1. Detailed knowledge on fine structure and function of the cell.
2. Familiarity with oncogenes and cancer biochemistry
3. Practical knowledge on cell fractionation, dialysis and mitosis

**Course Learning outcomes**

1. Understanding the organization of cell.
2. Understanding the mechanisms of cell division.
3. Knowledge on oncogenes and cancer biochemistry.
4. Practical knowledge on cell fractionation, dialysis and mitosis

### UNIT I

Prokaryotic and Eukaryotic cells, Plant and animal cells, Chemical components of biological membranes. Organization and Fluid Mosaic Model, Extracellular Structures, Cytosol, Enzymes, Eukaryotic Cell organelles, Mitochondria, Chloroplast, ribosomes and nucleus, Endoplasmic Reticulum, Golgi apparatus, Lysosomes and Peroxisomes, Membrane Vacuolar system.

### UNIT II

Cytoskeletons and Cell Membrane, Membrane Transport, Protein Trafficking, Ubiquitin Receptors and Protein Quality Control, Subcellular Fractionation, Nucleus: Structure and Function, Chromosomes and their structure Cell division: Comparison between Mitosis and Meiosis and crossing over, Symmetric and asymmetric cell divisions, Cell Cycle and its regulation, Regulation of DNA replication, Cell differentiation and stem cells,

### UNIT III

Tumor Suppressor Genes and Oncogenes, Brief outline of Cancer Biochemistry and Cancer Phase of Cell Cycle, Cell Migration and Cancer Metastasis, Brief Treatment on cell culturing: Apoptosis and ageing, Agents promoting carcinogenesis

### UNIT IV

Autophagy, Nerve cell signaling, Signal Transduction by Cytokine and Nuclear Receptors, Signal Transduction by G proteins, Demonstration of dialysis, Study of plasmolysis and de-plasmolysis, Enzyme activity assay, Study of structure of Prokaryotic and Eukaryotic cell, Cell viability assay, Study of mitosis in onion root, Preparation of Nuclear, Mitochondrial & cytoplasmic fractions

**Suggested readings:**

1. Cooper, GM, (2018) The Cell: A Molecular Approach. 8th ed., Sinauer Associates is an imprint of Oxford University Press, ISBN: 1605357073.

2. Lodish H, Berk A, Zipursky SL, Matsudaira P, Baltimore D and Darnell J, WH (2016) Molecular Cell Biology 8th ed., Freeman & Company (New York), ISBN: 978-1-4641-0981-2 / ISBN:10: 1464183392.

3. Alberts B, Johnson A. Lewis J and Enlarge M (2008) Molecular Biology of the Cell 6th ed., Garland Science (Princeton), ISBN: 0-8153-1619-4 / ISBN:0-8153-1620-8.

## SEMESTER-I

**Course Title: Principles of Biochemistry** **Credit: 3**

**Course Code: MIB 403 DM 30** **Lectures: 45**

**Course Objectives**

1. To provide students with an understanding of biomolecules, the basic building blocks of living organisms
2. To impart knowledge on structure and functions of biomolecules.

**Course Learning Outcomes:**

1. Acquainted with chemical and molecular structures of biomolecules
2. Able to determine the significance of biomolecules
3. Able to determine the metabolic function of biomolecules

### UNIT-I

Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides, Glycoprotein's and their biological functions.

Lipids: Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol.

### UNIT-II

Amino acids & Proteins: Structure & Function. Structure and properties of Amino acids, Types of proteins and their classification, Forces stabilizing protein structure and shape. Different Level of structural organization of proteins, Protein Purification. Denaturation and renaturation of proteins.

Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines & pyrimidines, Biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z – DNA, denaturation and renaturation of DNA.

## UNIT-III

Enzyme substrate complex: concept of E-S complex, binding sites, active site, specificity, Kinetics of enzyme activity, Michaelis-Menten equation and its derivation, Different plots for the determination of Km and Vmax and their physiological significance, Significance of activation energy and free energy.

Two substrate reactions (Random, ordered and ping-pong mechanism) Enzyme inhibition types of inhibition, determination of Ki. Allosteric enzymes with special reference to aspartate transcarbomylase and phosphofructokinase. Qualitative description of concerted and sequential models. Negative co-operativity and half site reactivity. Isoenzymes– multiple forms of enzymes with special reference to lactate dehydrogenase. Multienzyme complexes. Ribozymes. Multifunctional enzyme-e.g. Fatty Acid synthase.

## UNIT-IV

Vitamins and Human Health: Structure and functions of water soluble and lipid soluble vitamins, Importance in Metabolism, Symptoms of diseases due to poor absorption of vitamins, Alleviation of deficiency symptoms; Biochemical Function of vitamins as coenzymes. Importance of trace elements in biological reaction mechanism.

**Suggested Readings:**


1. Nelson D and Cox MM. (2010). Lehninger's Principles of Biochemistry. W.H. Freeman and Company, New York.
2. Voet D and Voet JG. (2013). Principles of Biochemistry. John Wiley and Sons, New York.
3. Moat AG and Foster J W (2003). Microbial Physiology. John Wiley and Sons, New York.
4. Stryer. L (2003). Biochemistry. W. H. Freeman and Co.
5. Willey J, Sherwood L. and Woolverton C (2014). Prescott's Microbiology, 9th edition McGraw Hill Higher Education.
6. J.L. Jain (2015). Fundamentals of Biochemistry, S. Chand and Co., India
7. U. Satyanarayan (2015). Biochemistry, Elsevier
8. Palmer, T., & Bonner, P. L. (2007). Enzymes: biochemistry, biotechnology, clinical chemistry. Elsevier.

## SEMESTER-I

**Course Title: Essentials of Microbiology** **Credit: 3**

**Course Code: MIB 405 DM 30** **Lectures: 45**

**Course Objectives:**

1. To impart knowledge of historical discoveries and basic concepts in domain of Microbiology

0To make students familiar with the potential of microorganisms in driving sustainable development

**Course Learning outcomes:**

1. Illustration of the historical developments, scope of microbiology and career opportunities of microbiologists in different areas
2. Demonstrate bacterial cell structure and organization
3. Demonstration of the basic microbiological techniques
4. Sensitization about the role of microbes in sustainable development
5. Familiarize with the latest global advancements in microbiology

### UNIT 1

History and Scope: Major historical milestones and Golden era of Microbiology; Spontaneous generation controversy and Germ theory of disease; Contributions of pioneer and modern microbiologists; Evolution of microbes and the concept of microbial species; Members of the microbial world; Nutritional categories of microorganisms; Major subdisciplines of microbiology; Scope and relevance of Microbiology.

### UNIT-II

Bacterial ultrastructure and cellular organization: General characteristics of eubacteria and archaea with representative examples; Bacterial cell wall types and organization, and its damage; Cell membrane structure and transport mechanisms; Cytoplasmic structures and inclusion bodies; Cellular appendages including flagella, pili and fimbriae (types, structure and their role); External cell surface structures such as capsule, glycocalyx, slime layer and S-layer; Bacterial genome organization; General features of acellular microorganisms (viruses, virusoids, satellites, viroids and prions); Resting structures including endospores, cysts, and akinetes.

### UNIT-III

Methods in microbiology: Microbial growth and influence of environment, Batch and continuous culture, microbial growth and death kinetics; Enumeration of microbial cells by direct and indirect

methods; Culture media (classification and examples of media for culturing aerobic, anaerobic and microaerophilic bacteria; fungi, protozoa, and algae); Pure culture techniques (isolation, enrichment, streak plate, pour plate, and spread plate methods); Methods to study difficult to culture and unculturable microorganisms; Sterilization and disinfection techniques for control of microbial growth (types, principles, and applications); Evaluation of the effectiveness of antimicrobial agents and activities; Staining techniques (types, visualization of cell structures and appendages); Culture preservation methods, Cell banks and Culture collections. Traditional methods for controlling microbial growth.

**UNIT IV**

Recent Advancements In Microbiology: Recent advancements in Microbiology and the role of microbiologists in sustainable development; Microbial interactions (microbe-microbe, microbe-animal, microbe-plant); Role of quorum sensing in microbial conversations; Pathogenicity islands and their role in virulence; Biofilms: formation, examples, role and control strategies; Horizontal gene transfer: mechanisms, role and implications; Antimicrobial resistance and emergence of superbugs; Bacterial two-component regulatory system as targets for antimicrobial therapy; Systems microbiology and synthetic microbiology; Human microbiome; Space microbiology and the role of microbes in exploring life beyond Earth.

**Suggested readings:**


1. Willey JM, Kathleen MS, Wood DH, Prescott LM (2020). Prescott's Microbiology. 12th ed. McGraw-Hill. ISBN10: 1264088396; ISBN13: 9781264088393.
2. Madigan MT, Bender KS, Buckley DH, Sattley WM, Stahl DA (2021) Brock Biology of Microorganisms, 16th ed., Pearson Education, ISBN-10: 1292404795; ISBN-13: 978-1292404790
3. Tortora GJ, Case CL, Bair WB, Weber D, Funke BR (2023) Microbiology: An Introduction, 14th ed. Pearson Inc. ISBN: 0137941617; ISBN-13: 9780137941612
4. Chain ECS, Pelczar Jr, Krieg NR, (2025) Microbiology 6th ed., Medtech Science Press - A Division of Scientific International. ISBN-10: 9395161183; ISBN-13: 978-9395161183.
5. Kapoor KK, Sequeira MG, Yadav KS, Tauro P (2023) An Introduction to Microbiology, 3rd ed., New Age International Publishers. ISBN-10: 9395161183; ISBN-13: 978-9395161183.
6. Dubey RC, Maheswari DK (2022) A Textbook of Microbiology, 5th ed. Revised S. Chand and Company Ltd, New Delhi. ISBN: 9789355015273, 9355015275.

## SEMESTER-I

**Course Title: Molecular Biology** **Credit: 3**

**Course Code: MIB 407 DM 30** **Lectures: 45**

**Course Objectives:**

1. Familiarity with molecular biology history and concepts
2. Familiarity with molecular biology pathways as cellular processes

**Course Learning Outcomes:**

1. Knowledge on structure and function of DNA as genetic material.
2. Molecular basis of genetic information and function
3. Knowledge of gene regulation and operons

### UNIT-I

History of DNA; Miescher to Watson & Crick. Central Dogma of molecular genetics. Types of genetic material. DNA as genetic material, forms of DNA, A, B, Z DNA; structure of various type of DNA; chromatin structure; super coiling; polytene and lamp brush chromosomes; properties of DNA in solution; denaturation and renaturation; reassociation reactions; COT curves; Bidirectional and unidirectional DNA replication. Conservative. Dispersive and semi- conservative replication of DNA. Mechanism of DNA replication: Enzymes and proteins involved in DNA replication. Various models of DNA replication including rolling circle and Θ (theta) mode of replication.

### UNIT-II

Transcription. Transcriptional machinery and mechanism followed in bacteria and eukaryote. Major difference of transcription in bacteria and eukaryote; initiation, elongation termination. RNA polymerase and sigma factors. Transcription factors. Post-transcriptional processing; splicing, capping and polyadenylation. mRNA, tRNA, rRNA. Transcriptional inhibitors. DNA amplification *in vitro*. Restriction enzymes. Gene cloning. Blue-White selection.

### UNIT-III

Translation. Codon and the role RNA adapter on the flow of information. Codon degeneracy and implications. Revisit to “one gene one enzyme” theory. Translational machinery. Ribosome in bacteria and eukaryote. Amino acid loading on tRNA. Mechanism of translation; Initiation, elongation, termination, AP site, Elongation factors. Translational inhibitors. Post translational modifications. Reverse transcriptase. Riboswitch.

## UNIT-IV

Gene regulation; Prokaryotic operon lac, trp and ara operons, lambda gene regulation during lysogeny and lytic cycle; Positive and negative regulation of operon; Inducer and repressor; Attenuation; Plasmids and transposons; Evolution of genome sequencing strategies; Genomic libraries. chromosome walking to NGS. Genotyping methods.

**Suggested Readings:**


1. Walter P, Raff M, Roberts K, Johnson AD, Morgan D, Alberts B, Heald R (2022) Molecular Biology of the Cell 7th ed., WW Norton & Co, ISBN: 0393884856
2. Nelson DL, Cox MM, (2021) 8th ed., Lehninger Principles of Biochemistry. W.H. Freeman and Company, New York, USA. ISBN: 1319381499
3. Berg J, Gatto G, Hines J, Tymoczko JL, Stryer L (2023) Biochemistry 10th ed., W.H. Freeman and Company, New York, USA. ISBN: 1319498507
4. Lewin B, Krebs J, Kilpatrick ST, Goldstein ES, (2017) Genes XII 12th Revised ed., Jones and Bartlett Publishers, Inc. Sudbury, Massachusetts, USA. ISBN No. 9781284104493.
5. Watson JD (2024) Molecular Biology of the Gene 8th ed., Affiliated East West Press, ISBN: 8176711349.

## SEMESTER-I

**Course Title: Microbial Systematics** **Credit: 3**
**Course Code: MIB 409 DM 30** **Lectures: 45**

### Course Objectives

1. Introduce the principles, scope, and relevance of microbial taxonomy.
2. Equip students with knowledge of both classical phenotypic and advanced molecular techniques for microbial classification and identification.
3. Examine the diversity, structure, distribution, and ecological roles of algae and fungi.

### Course Learning Outcomes

1. Understand the scope and importance of microbial taxonomy.
2. Explain bacterial and archaeal classification based on Bergey's Manual.
3. Compare traditional and modern classification systems (Haeckel, Whittaker, Woese).
4. Describe the diversity and ecological roles of fungi, lichens, and mycorrhizae.

### UNIT I

Definition and scope of microbial taxonomy, phenotypic (phenetic) methods and their importance in bacterial classification and identification, comparison of phenetic vs. phylogenetic approaches, morphological and staining characteristics, biochemical and physiological test, enzyme activities, chemotaxonomic characteristics. genotypic and molecular Methods for microbial classification.

### UNIT II

Bacterial Classification - Basis of bacterial classification and archaea according to the Bergey's manual of systematic bacteriology, Haeckel's three kingdom concept, Whittaker's five kingdom concept, three domain concept of Carl Woese, conventional, molecular and recent approaches to polyphasic bacterial taxonomy; evolutionary chronometers.

### UNIT III

Classification of algae and fungi; algae - occurrence and distribution, thallus structure and characteristics; algal toxins, algal bloom; algae as a source of antibiotics; Blue green algae; fungi – occurrence and distribution; lichens and mycorrhiza - occurrence, structure, types and importance; fungal metabolites and their potential applications in food, agriculture, industry and environment.

### UNIT IV

Discovery and general characteristics of viruses; capsid symmetry; enveloped and non-enveloped viruses; classification and nomenclature of different groups (animal viruses and plant viruses) of viruses; viroids, virusoids, satellite viruses and prions.

**Suggested Reference Books**


1. Garrity, G. M., Boone, D. R., Castenholz, R. W., & others (Eds.). (2001–2012). Bergey's Manual of Systematic Bacteriology (Volumes 1–5). Springer.
2. Tindall, B. J., & Garrity, G. M. (2015). Systematics of Prokaryotes: The Microbial Road Map. Springer.
3. Osborn, A. M., & Smith, C. J. (Eds.). (2005). Molecular Microbial Ecology. Taylor & Francis.
4. Brown, J. W. (2010). Principles of Microbial Diversity. ASM Press.
5. Priest, F. G. (1993). Modern Bacterial Taxonomy (2nd ed.). Chapman & Hall.
6. Konstantinidis, K. T., & Rosselló-Móra, R. (2021). Microbial Taxonomy and Systematics in the Genomic Era. Elsevier.
7. Microbial Diversity in the Genomic Era (2018) 1st ed., Das S and Dash H, Academic Press, ISBN: 9780128148501.
8. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. (2018). Brock Biology of Microorganisms (15th Edition). Pearson.
9. Whitman, W. B., Goodfellow, M., Kämpfer, P., Busse, H.-J., Trujillo, M. E., Ludwig, W., Suzuki, K.-I., Parte, A. C., & Rosenberg, E. (Eds.). (2019). Bergey's Manual of Systematic

## SEMESTER-I

**Course Title: Practical-I** **Credit: 4**
**Course Code: MIB 411 SE 40** **Lectures: 120**

**Course Objectives (COs)**

1. To introduce essential microbiological laboratory techniques and safety practices.
2. To develop skills in microbial identification, culture, and preservation.

**Course Learning Outcomes (CLOs)**

1. Perform basic microbial staining, isolation, and culture techniques.
2. Apply aseptic and safety procedures in laboratory settings.
3. Identify microbes using microscopy and biochemical tests.
4. Preserve microbial cultures using standard methods.

**List of Practicals**

1. To learn and follow general microbiology laboratory safety rules.
2. To study the principles and uses of common microbiological instruments.
3. To practice aseptic techniques in microbiology.
4. To prepare and sterilize different types of culture media.
5. To study the use and handling of compound microscope.
6. To perform direct microscopic count (DMC) of bacterial cells.
7. To measure microbial cell dimensions using micrometry (ocular and stage micrometer).
8. To perform simple staining for bacterial cell morphology.
9. To perform Gram staining for differentiation of bacteria.
10. To perform acid-fast staining (Ziehl-Neelsen method).
11. To perform endospore staining (Schaeffer-Fulton method).
12. To perform capsule staining using negative staining technique.
13. To perform flagella staining.
14. To prepare and observe fungal structures using lactophenol cotton blue staining.
15. To perform nuclear staining of yeast.
16. To isolate pure cultures using streak plate method.
17. To isolate pure cultures using pour plate method.
18. To isolate pure cultures using spread plate method.
19. To perform serial dilution and viable plate count method.
20. To estimate microbial population using turbidity method.
21. To enumerate microorganisms from soil or water sample by standard plate count method.

22. To subculture and maintain bacterial cultures on agar slants.
23. To study and record colony morphology of different bacterial isolates.
24. To perform enrichment culture technique for selective isolation.
25. To prepare glycerol stocks for long-term bacterial preservation.
26. To perform lyophilization (freeze-drying) of microbial culture for long term preservation.
27. To determine motility of bacteria using hanging drop method.
28. To study different oxygen requirements using thioglycollate medium.
29. To perform qualitative tests for carbohydrates (Molisch, Benedict's, Fehling's, etc.).
30. To estimate carbohydrate concentration using the DNS or Anthrone method.
31. To perform IMViC tests for bacterial identification.
32. To perform catalase and oxidase tests.
33. To perform nitrate reduction test.
34. To perform starch hydrolysis test.
35. To perform gelatin liquefaction test.
36. To perform carbohydrate fermentation tests.
37. To perform urease test.
38. To perform hydrogen sulfide production test.
39. To perform triple sugar iron (TSI) test.
40. To estimate the enzyme activity (amylase, catalase, or phosphatase)
41. To determine viral or bacteriophage titer using plaque assay method.

**Suggested readings:**


1. Sheehan, D, Wiley Blackwell (West Sussex) (2010) Physical Biochemistry: Principles and Applications. 2nd ed., ISBN: 978-0-470-85602-4 / ISBN: 978-0-470-85603-1.
2. Plummer, DT., (2017) An Introduction to Practical Biochemistry 3rd ed., McGraw Hill Education, ISBN: 978-0070994874.
3. Wilson K, and Walker J (2018) Principles and Techniques of Biochemistry and Molecular Biology 8th ed., Cambridge University Press. ISBN: 131661476X.
4. Harry W, Seeley, Paul JV, John J, (1990) Microbes in Action: A Laboratory Manual of Microbiology 4th ed., W. H. Freeman ISBN: 978-0716721000.
5. American Society of Agronomy; Lab Manual edition (2009) Genetics: A Laboratory Manual 2nd ed., ISBN: 978-0891185611.
6. Aneja KR (2014) Laboratory Manual of Microbiology and Biotechnology 1st ed., Scientific International Pvt., Ltd. ISBN: 9789381714553.
7. Cappuccino, JH, Sherman, N., (2017) Microbiology: A Laboratory Manual. 11th ed., Pearson Education Inc, ISBN: 9780134298597

## SEMESTER - I

**Course Title: General Microbiology** **Credit: 4**
**Course Code: MIB 101 MD 40** **Lectures: 60**

**Course objective:**

1. To provide an understanding of basic concepts and techniques in Microbiology.

**Learning outcomes:**

2. Demonstrate the practical skills in basic microbiological techniques
3. Designate the role of microorganisms in different ecosystems
4. Retrieve and use contemporary information on different microbial groups

### UNIT-I

Introduction to Microbiology**,** Definition and scope of microbiology**,** History and development of microbiology in 20th century; The spontaneous generation controversy; Germ theory of disease**,** Methods in microbiology: Physical and chemical methods of sterilization; Pure culture techniques, maintenance and preservation of microbial cultures, Solid Media Culture Methods: (Streak Plate Method, Spread Plate Method, Pour Plate Method), Liquid Media Culture Methods (broth culture, Enrichment Cultures), Specialized Culture Methods (Anaerobic Culture Techniques, Slant and Stab Cultures), Serial Dilution and Plate Count and Most Probable Number (MPN) Method, Selective and Differential Media

### UNIT-II

Prokaryotic vs. eukaryotic cells**,** Morphology and arrangement of microorganisms, Organization of Bacterial Cell - Structure and function of cell wall, cell membrane, cytoplasm, flagella, endoflagella, fimbriae, glycocalyx, capsule, endospore, nutritional types: autotrophs, heterotrophs, phototrophs, chemotrophs, archaebacteria.

### UNIT-III

Microbes in different environment: extreme environment, deep ocean, space, air and Indian traditional foods. Special features of the thermophilic, methanogenic and halophilic bacteria; Photosynthetic bacteria, Cyanobacteria.

## UNIT-IV

Scope of Microbiology - Microbial interactions with environment and hosts, Symbiosis, mutualism, commensalism, parasitism, Biodegradation and Bioremediation; Biofilms; Microbes in composting; Biofertilizers and Biopesticides; Microbes and Industry - SCP, microbial enzymes and fermented foods, Vaccines

**Suggested readings:**


1. An Introduction to Microbiology (2019), 3rd ed., Tauro P, Kapoor KK, Yadav KS, and Sequeira MG. New Age International Publishers. ISBN: 0852268785.
2. Brock Biology of Microorganisms (2018), 15th ed., Madigan MT, Martinko JM, Bender KS, Buckley DH, Stahl DA, Pearson Education, ISBN 9781292235103.
3. Prescott's Microbiology (2017). 10th ed., Sherwood LM, Woolverton C.J McGraw-Hill Education. ISBN 9781259281594.
4. A textbook of Microbiology (2013), 3rd ed. Dubey, R.C. and Maheswari, D.K. Revised S. Chand and Company Ltd, New Delhi. ISBN: 9788121926201.
5. Microbiology (2001) 5th ed., Pelczar Jr. M, McGraw Hill Education, ISBN: 9780074623206

## Semester-II

**Course Title: Advanced Analytical Techniques** **Credit: 4**
**Course Code: MIB 402 DM 40** **Lecture: 60**

**Course objectives:**

1. To provide an advanced understanding of the core principles of various techniques used in biological experiments.
2. To impart technical skills on the use of advanced equipments

**Course Learning outcomes:**

1. Demonstrate principles of various basic and advanced techniques used in biological experiments
2. Critically analyze and interpret the results obtained from biological experiments
3. Utilization of advanced techniques in the determination of structures of biomolecules

### UNIT-I

Aqueous solutions, Acids, Bases, buffers systems and pH meter, Colorimetry and UV-VIS absorption spectroscopy, Introduction to Hydrodynamic Techniques, Centrifugation: Principles & Methodology, Density Gradient centrifugation: Rate Zonal and isopycnic, Differential centrifugation for Sub-cellular Fractionation, SDS-PAGE, Western Blotting Techniques, 2D Electrophoresis and DIGE, Principles of Mass spectrometry

### UNIT-II

Gel filtration: Principle, Methodology & Applications, Planar Chromatography: Principles and Applications, Ion-exchange chromatography, Affinity chromatography, Gas chromatography, HPLC, Protein Estimation Techniques, Clinical Proteomics,

### UNIT-III

Light Microscopy and Confocal Microscopy, Fluorescence Microscopy: Application to live cell imaging, IHC and IF, Flow cytometry: Theory and concept, Flow cytometry: Application in biology and medicine, Electron Microscopy, TEM and SEM,

### UNIT-IV

Methods to quantify and Integrity check of DNA, Methods to quantify and Integrity check of RNA, PCR and Real Time PCR, Blotting techniques for Nucleic acids, Sequencing techniques of nucleic acids, Introduction to Recombinant DNA Technology, Expression techniques of recombinant proteins using Bacteria and yeast, Expression techniques of recombinant proteins by insects and mammalian cells, Introduction to Genomic Techniques, Techniques for studying Nucleic acid

protein interactions, ELISA, RIA :Diagnostic applications CLIA and its Diagnostic applications, PET and its Diagnostic applications, Single cell biology.

**Suggested readings:**


1. Sheehan, D, Wiley Blackwell (West Sussex) (2010) Physical Biochemistry: Principles and Applications. 2nd ed., ISBN: 978-0-470-85602-4 / ISBN: 978-0-470-85603-1.
2. Plummer, DT., (2017) An Introduction to Practical Biochemistry 3rd ed., McGraw Hill Education, ISBN: 978-0070994874.
3. Wilson K, and Walker J (2018) Principles and Techniques of Biochemistry and Molecular Biology 8th ed., Cambridge University Press. ISBN: 131661476X
4. Freifelder D (1982) Physical Biochemistry: Applications to Biochemistry and Molecular Biology 2nd ed., W.H. Freeman and Company (New York), ISBN:0-7167-1315-2 / ISBN:0-7167-1444-2.

## Semester-II

**Course Title: Microbial Genetics** **Credit: 4**
**Course Code: MIB 404 DM 40** **Lecture: 60**

**Course objectives:**

1. To provide a comprehensive detail on microbial genomes on impart thorough knowledge on gene regulation and transfer mechanisms.

**Course Learning outcomes:**

1. Understanding the structure and functions of the genomes of different microbial groups
2. To extend the knowledge on the molecular basis of mutation at the microbial level
3. To understand the principal role of plasmids and gene transfer methods
4. Identifying and distinguishing genetic regulatory mechanisms at different levels

### UNIT-I

Understanding microbial genome organization and structure: Microbial circular or linear genomes and microbes composed of a single chromosome or multiple chromosomes. Plasmids: Types and Properties of plasmids – sex factors, drug resistant, colicinogenic, Agrobacterium Ti and broad host range plasmid. Copy number, replication- circular and theta, amplification and incompatibility

### UNIT-II

Origin of mutation. Biochemical basis of mutation: Spontaneous mutation – random and non–adaptive mutation. Mutation rates, Origin of spontaneous mutation – isolation of mutants. Selection of bacterial variation: Direct - fluctuation test, indirect - replica plating. Mutagenesis and mutagenic agents. Detection of mutagen – Ames test, *in-vitro* mutagenesis. DNA Damages- Deamination of Bases, Alkylation, Damage Due to Reactive Oxygen, UV Induced Damage, Repair Pathways (Methyl-Directed Mismatch Repair, Nucleotide Excision Repair, Base Excision Repair, Recombinational Repair, SOS Inducible Repair

### UNIT-III

Gene transfer in bacteria - conjugation, transformation and transduction; Regulation of gene transfer by conjugation; Mapping the bacterial genomes using Hfr strains; transfer systems in gram positive bacteria; transformation - molecular basis of natural transformation; transduction- generalized versus specialized transduction. Transposons and gene regulation; Yeast Ty -1 transposon; methods of gene cloning and sequencing

### UNIT-IV

Sequencing of microbial genomes; database of microbial genomes; housekeeping genes, essential genes; cluster of orthologous genes, genome transplantation (Synthetic genome) and minimal genome, Epigenetics- Definition, Molecular basis, Mechanisms, Functions and Epigenetics in Bacteria. application of crispr-cas9 system-based genome editing.

**Suggested readings:**


1. Essentials of Genetics (2020) 10th ed. William S, Michael K, Cummings R, Spencer, CA and Palladino MA, Prentice Hall Internationals, ISBN 13: 9780134898414
2. Stryer, L. (2019). Biochemistry (9th ed). New York: W.H. Freeman and Company.
3. Genetics (2017) 9th ed. Daniel L. Hartal&B. Cochrane, ISBN: 128412293X
5. Evolution 4th ed. (2017) D. Futuma and M. Kirkpatrick, ISBN: 9781605356051 7. An Introduction to Genetic Analysis (2015) Griffith AJFJ, Wessler SR, Carroll SV and Doebley J, ISBN: 0-7167-3520-2.
6. Stanley R. Maloy, John E.C. and Freifelder, D. (2008). Microbial Genetics. New Delhi: Narosa Publishing House.
7. Principles of Genetics (2006) 8th ed. Gardner EJ, Simmons, MJ and Snustad DP, John Wiley & Sons Inc, ISBN: 8126510439.

## Semester-II

**Course Title: Microbial Physiology and Metabolism** **Credit: 4**
**Course Code: MIB 406 DM 40** **Lecture: 60**

**Course objectives:**

1. To describe metabolic and physiological diversity among prokaryotes.
2. To impart knowledge on the metabolic cycles of prokaryotic microorganisms

**Course learning outcomes:**

1. Learning of principles of microbial catabolic and anabolic pathways
2. Understanding the transport systems and the mechanisms of energy conservation in
3. microbial metabolism
4. Understanding of the biosynthesis of basic biomolecules.

### UNIT-I

Nutritional categories of microorganisms based on carbon and energy sources; Metabolite transport - passive and facilitated, primary and secondary active transport, group translocation (phosphotransferase system), symport, antiport and uniport, electrogenic and electroneutral transport, transport of iron; Microbial Growth - Definition balanced and unbalanced growth, growth curve, the mathematics of growth, generation time, specific growth rate, batch and continuous culture, synchronous growth, diauxic growth curve; Effect of physical and chemical factors on growth.

### UNIT-II

Brief account of photosynthetic and accessory pigments - chlorophyll, bacteriochlorophyll, rhodopsin, carotenoids, phycobiliproteins; Autotrophy - oxygenic, anoxygenic photosynthesis; Autotrophic generation of ATP; Fixation of CO2; Calvin cycle pathway. Chemolithotrophy - Sulphur, iron, hydrogen, nitrogen oxidations, Anamox reaction; Methanogenesis, Bioluminescence.

### UNIT-III

Respiratory metabolism - Embden-Mayer Hoff pathway, Entner Doudoroff pathway, Pentose phosphate pathway, Krebs cycle, Branched TCA cycle, Reverse TCA cycle, glyoxalate pathway, oxidative and substrate level phosphorylation, gluconeogenesis, Pasteur effect; Fates of pyruvate; Stickland reaction; Halophiles and ATP synthesis.

### UNIT-IV

Biosynthesis of peptidoglycan, polyamines, lipids; β oxidation of fatty acids; assimilation of nitrogen; Transamination and deamination; Urea cycle; Dormancy and germination; microbial differentiation, sporulation and morphogenesis; cell division cycle in *E. coli* and yeast.

**Suggested readings:**


1. Tortora GJ, Funke BR, Case CL, Bair WB, Weber D. (2023), Microbiology: An Introduction. 16th ed., Pearson. ISBN: 0137941625
2. Cohen GN (2014) Microbial Biochemistry. 3rd edition. Springer Netherlands. ISBN 978-90-481-9437-7
3. White D, Dummond J and Fuqua, C. (2011) The Physiology and Biochemistry of Prokaryotes. 4th ed. Oxford University Press. ISBN: 9780195393040
4. Wood Dorothy, Willey Joanne, Sandman Kathleen (2022) Prescott's Microbiology. 12th ed., McGraw-Hill Education, ISBN: 1265123039
5. Dubey RC and Maheswari, DK (2023) A textbook of Microbiology. 5th Ed., S. Chand and Company Ltd, New Delhi. ISBN: 9789355011862
6. Madigan MT, Bender KS, Buckley DH, David A. (2021). Brock Biology of Microorganisms. 16th Ed. ISBN: 1292404795

## Semester-II

**Course Title: Practical-II** **Credit: 4**
**Course Code: MIB 408 SE 40** **Lectures: 120**

**Course Objectives (COs)**

1. To develop laboratory skills in microbial genetics, molecular biology, and biochemical analysis.
2. To understand the principles and applications of key analytical instruments and microbial techniques used in research and industry.

**Course Learning Outcomes (CLOs)**

1. Estimate and analyze biomolecules using spectrophotometry, chromatography, and electrophoresis.
2. Perform molecular biology techniques such as DNA extraction, plasmid profiling, PCR, transformation, and conjugation.
3. Evaluate microbial growth and survival under different physical and chemical conditions.
4. Isolate and characterize functionally significant microbes from soil, food, and clinical environments.

**List of Practicals**

1. To estimate nucleic acids by UV-Vis spectrophotometry
2. To estimate protein concentration using the Bradford or Lowry method
3. To detect proteins by SDS-PAGE
4. To separate biomolecules using thin-layer chromatography (TLC)
5. To perform paper chromatography for amino acid analysis
6. To determine the percentage of killing of bacterial cells by UV exposure
7. To plot a UV survival curve of the bacterial culture
8. To calibrate and use a pH meter and conductometer
9. To understand the working principle of HPLC or GC (demonstration or interpretation)
10. To understand the working principle of AFM (demonstration)
11. To extract genomic DNA from a pure bacterial culture
12. To extract plasmid DNA from a pure bacterial culture
13. To separate plasmid and genomic DNA using agarose gel electrophoresis
14. To perform bacterial transformation using plasmid DNA
15. To study conjugation and determine recombination frequency
16. To analyze the reversion of auxotrophy in mutant strains
17. To identify auxotrophic mutants using the replica plating technique

18. To analyze restriction digestion patterns of DNA
19. To perform molecular identification using PCR and 16S/18S rRNA sequencing (demo/simulation)
20. To demonstrate the lac operon concept using blue-white screening (simulation)
21. To study the diauxic growth curve of *E. coli*
22. To study the effect of temperature on bacterial growth
23. To study the effect of pH on bacterial growth
24. To study the effect of salt (NaCl) concentration on bacterial growth
25. To test nitrate/nitrite assimilation by bacterial cultures
26. To measure oxygen consumption during aerobic respiration
27. To isolate rhizobia from root nodules of legumes
28. To enumerate microbial population from soil by serial dilution and plate count
29. To study phosphate solubilization ability of soil bacteria
30. To isolate and characterize plant growth-promoting rhizobacteria (PGPR)
31. To assess nitrogen-fixation potential by acetylene reduction assay
32. To collect and process environmental samples for microbial isolation
33. To perform Gram staining of skin or oral microbiota
34. To extract microbial DNA from gut/oral microbiome samples (or mock samples)
35. To analyze microbiome data from 16S rRNA sequencing (demo/bioinformatics)
36. To enumerate total viable count from milk or curd samples
37. To perform methylene blue reduction test for milk quality assessment
38. To isolate and characterize lactic acid bacteria from curd
39. To analyze microbial contamination in spoiled food samples
40. To detect coliforms in food or water using the multiple tube fermentation test (MPN method)

**Suggested readings:**


1. Sheehan, D, Wiley Blackwell (West Sussex) (2010) Physical Biochemistry: Principles and Applications. 2nd ed., ISBN: 978-0-470-85602-4 / ISBN: 978-0-470-85603-1.
2. Plummer, DT., (2017) An Introduction to Practical Biochemistry 3rd ed., McGraw Hill Education, ISBN: 978-0070994874.
3. Wilson K, and Walker J (2018) Principles and Techniques of Biochemistry and Molecular Biology 8th ed., Cambridge University Press. ISBN: 131661476X.

4. Harry W, Seeley, Paul JV, John J, (1990) Microbes in Action: A Laboratory Manual of Microbiology 4th ed., W. H. Freeman ISBN: 978-0716721000.
5. American Society of Agronomy; Lab Manual edition (2009) Genetics: A Laboratory Manual 2nd ed., ISBN: 978-0891185611.
6. Aneja KR (2014) Laboratory Manual of Microbiology and Biotechnology 1st ed., Scientific International Pvt., Ltd. ISBN: 9789381714553.
7. Cappuccino, JH, Sherman, N., (2017). Microbiology: A Laboratory Manual. 11th ed., Pearson Education Inc, ISBN: 9780134298597

## Semester-II

**Course Title: Agricultural Microbiology** **Credit: 4**
**Course Code: MIB 410 DS 40** **Lectures: 60**

**Course objectives:**

1. To make understand the students about role of soil microbes in biogeochemical cycle of nutrients and organic matter degradation
2. To make students familiar with PGPR and other microbial inoculants, and their role in maintaining soil fertility
3. To make Students Understand the interactions between plants and microbes

**Learning outcome:**

1. Understanding of the role of microorganisms in the biogeochemical cycles of nutrients
2. Understanding of the role of microorganism in degradation of solid organic waste and soil health
3. Understanding of the different types of interactions between plants and microbes

### UNIT-I

History of development of soil microbiology, Contribution of Indian scientists; Soil microorganisms: major groups, their diversity, abundance, characteristics; Influence of soil and environmental factors on microflora; Soil health-major indicators and their significance; Direct and indirect methods of studying soil microorganisms and their activities

### UNIT-II

Microorganisms in biogeochemical cycles of carbon, nitrogen, phosphorus, sulphur, iron and manganese; Decomposition of organic matter, Quantity and distribution of organic matter in soil, Humus and its fractions, contribution of humus to soil quality; Biodegradation of starch, cellulose, hemicellulose, and lignin in soil; Composting-microbiology, types and factors affecting composting; Production of biogas, retting, silage; Vermicomposting, Green manuring

### UNIT-III

Types of Plant-microbe interactions; Concepts of Rhizosphere, R:S ratio, Rhizoplane, spermosphere, phyllosphere; PGPR, Biological Nitrogen fixation - symbiotic, non-symbiotic, associative symbiotic and endophytic organisms; Process of nitrogen fixation; Molecular biology of Nitrogen fixation

### UNIT-IV

Biofertilizers – Types (Bacterial, fungal and algal), mass production and quality assurance; Mycorrhizae, Types of mycorrhizae and their interactions with plants; Microbial Biocontrol agents for insects and diseases- development and their significance.

**Suggested readings:**


1. Paul EA (2017) Soil Microbiology, Ecology and Biochemistry, 4th ed., Academic Press, New York, USA. ISBN: 9780124159556.
2. Sylvia D, Fuhrmann J, Hartel P and Zuberer D (2005). Principles and Applications of Soil Microbiology 2nd ed., Pearson Education, USA. ISBN: 9780130941176.
3. Subba Rao, N.S. (2020). Soil Microbiology, 5th Ed. Oxford &IBH. ISBN: 9788120413832
2. Ashutosh Singh (2023). Soil Testing and Soil Microbiology. Gyanavi Publishers & Distributors. ISBN: 9788195880980
3. Marcus Silva (2022). Principles of Soil Microbiology. States Academic Press. ISBN: 978-1639894420

**Semester-II**

**Course Title: The Microbiome** **Credit: 4**
**Course Code: MIB 412 DS 40** **Lectures: 60**

**Course objectives:**

1. To define the microbiome of human, animal and plants
2. To know the techniques used in studying the microbiomes

**Course Learning outcomes**

1. Understanding the use of omics technologies in studying the microbiomes
2. Understanding of changes of microbiome on health

**UNIT-I**

History of the study of the microbiome; methods to study microbiome- DNA-based analysis of microbial communities, 16S rRNA gene amplicon sequencing and shotgun metagenomics sequencing methods; Functional analysis of the microbiome from DNA sequences.

**UNIT-II**

Techniques used to analyse microbiome data- assignment of taxonomy; generating OTU tables, quality control: Describing the complexity of the microbiome eg. alpha and beta-diversity; comparing microbial communities, phylogenetic trees, UniFrac, principal coordinate analyses, Venn diagrams, heat maps; development of new bioinformatics methods for microbiome studies.

**UNIT-III**

Functional studies of the Microbiome- Measurement of microbial products (the metabolome, proteome and glycome; role of microbiome and its products, nutrition, metabolism, the gut brain axis, and in immune- inflammatory processing. Introduction to the Human Microbiome; The Human Microbiome Project (HMP); Diversity of the Human Microbiome

**UNIT-IV**

Gut microbiome changes in various diseases including liver diseases, obesity, diabetes, and other disorders; the mycome and virome in health and disease. Direct health effects of gut microbiome; Use of the microbiome in screening, diagnosis and monitoring diseases.

**Suggested readings:**

1. Unravelling the Soil Microbiome: Perspectives for Environmental Sustainability (2020) 1st ed., Dubey RK, Tripathi V, Prabha R, Chaurasia R, Singh DP, Rao CS, El-Keblawy A and Abhilash PC, Springer Cham, ISBN: 978330155155.

2. Microbiome and Metabolome in Diagnosis, Therapy and other strategic Applications (2019) 1st ed., Faintuch J and Faintuch S. Academic Press (New York) ISBN: 9780128152492.
3. Diet, Microbiome and Health (2018) 1st ed., Holban AM, Grumezescu AM. Academic Press (New York), ISBN: 9780128114407.
4. Functional importance of the plant microbiome: Implications for agriculture, forestry and bioenergy (2017) 1st ed., Doty SL. Springer Cham. ISBN: 978-3-319-65896-4.
5. Microbiome Analysis: Methods and Protocols. (2018) 1st ed., Beiko RG, Hsiao W and Parkinson J. Springer New York. ISBN: 9781493987269.
6. The Gut Microbiome in Health and Disease (2018). 1st ed., Haller D. Springer International Publishing. ISBN 978-3-319-90544-0.

**SEMESTER-II**

**Course Title: Food Microbiology** **Credit: 4**
**Course Code: MIB 414 DS 40** **Lecture: 60**

**Course Objectives:**

- To provide the knowledge about food associated microorganisms and microbial spoilage and preservation of foods
- To provide insights on producing dairy and non-dairy fermented foods, and role of probiotics and prebiotics in improving human health

**Course Learning outcomes:**

- Understanding about the interactions between microorganisms and the food environment
- Knowledge of the various food fermentations, and methods for preservation of foods
- Understanding about the detection, preventive measures and sources of food infections and intoxications caused by various microorganisms

**Unit-I**

Food associated microorganisms; Natural flora and sources of contamination of foods; intrinsic and extrinsic factors affecting growth and survival of microbes in foods; microbial spoilage of cereals, vegetables and fruits, meat products and sea foods, eggs, milk and milk products, and canned foods; microbial succession during food spoilage

**Unit-II**

Principles of food preservation; various methods of food preservation - physical, chemical and biological methods; hurdle technology; recent developments in food preservation methods including predictive microbiology, and modified atmospheric packaging; food sanitation - HACCP, indices and regulations of food quality and safety

**Unit-III**

Fermentation process for producing dairy foods - (yogurt, acidophilus milk, curd, kefir, kumiss, cheese) and non-dairy foods (plant based- sauerkraut, soy sauce and tempeh; and animal based, distilled and non-distilled alcoholic beverages); industrial considerations of dairy starter cultures; probiotics - health benefits, mechanisms of action, types and availability; prebiotics, Indian traditional fermented foods.

**Unit-IV**

Gut microbiome and human health; food-borne infections of bacterial, fungal and viral origin (causative agents, foods involved, symptoms and preventive measures); Food intoxications of microbial origin; methods for detection of food-borne pathogens.

**Suggested readings:**

1. Ray, B, and Bhunia, A (2014) Fundamental Food Microbiology. 5th ed. CRC Press, Taylor and Francis Group. ISBN 9781466564435.

2. Erkman, O, and Bozoglu, TF (2016). Food Microbiology: Principles into Practice. Microorganisms related to foods, foodborne diseases and food spoilage, Volume 1 and 2, John Wiley & Sons, Inc. ISBN: 9781119237761.
3. Adams MR, Moss M, and McClure P (2016) Food Microbiology. 4th ed., Royal Society of Chemistry. ISBN: 978-1849739603.
4. Poltronieri P (2017) Microbiology in Dairy Processing: Challenges and Opportunities, John Wiley & Sons Ltd and the Institute of Food Technologists ISBN: 1119114802.
5. Frazier WC, and Westhoff DC (2013) Food Microbiology 5th ed., Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
6. Jay JM, Loessner MJ, and Golden, DA (2006) Modern Food Microbiology. 7th edition. Springer.
7. Rayand B, and Bhunia A (2013) Fundamental Food Microbiology. 5th edition. CRC press.
8. Doyle MP, and Beuchat LR (2007) Food Microbiology: Fundamentals and Frontiers. 3rd edition. ASM press.
9. Montville T, Matthews K, and Kniel K (2017) Food Microbiology: An Introduction. 4th edition. ASM press.

## SEMESTER-III

**Course Title: Environmental Biotechnology** **Credit: 3**
**Course Code: MIB 501 DM 30** **Lectures: 45**

**Course objectives:**

1. To provide an advanced understanding of the core principles of environmental biotechnology
2. To impart knowledge on microbial ecology
3. To impart knowledge on biodegradation and biodeterioration

**Course Learning outcomes:**

1. Demonstrate principles of environmental biotechnology and sustainability
2. Knowledge on how to assess microbial communities
3. Knowledge on carbon storage and capture

### UNIT-I

Environmental Biotechnology and Sustainability. Scope and applications of the subject. Basics of ecosystem structure and function, Microbial Ecology and Environmental Biotechnology: Concepts and importance of microbial ecology in Environmental Biotechnology, Microbiology of Environmental Engineering System: Microbial diversity, growth and decay. Stoichiometry of microbial energetics and kinetics, Resource Exploitation by Microorganisms: Functions of various microbial groups relevant to environmental systems, including waste treatment and resource recovery, implications in biogeochemistry.

### UNIT-II

Methods in Microbial Ecology with relevant to Environmental Biotechnology: Culture dependent and - independent analyses of microbial communities; PCR based methods, Microarray, Environmental genomics, Microbial Principles of Biodegradation, Biodetoxification and other processes relevant for Environmental Applications: Microbial engines, (metabolism), Requirements for biodegradation, acclimation, Common biotransformation mechanisms; Effect of organic contaminant structure on biodegradability; Cooperation between different microbial species for enhanced biodegradation; Applying biodegradation kinetics to fate and transport modelling

### UNIT-III

Bioremediation Technologies: Concepts, methods and applications of natural attenuation and engineered bioremediation (e.g bioaugmentation and biostimulation), Microbial Interactions with Heavy Metals and Metalloids: Bioremediation, Biohydrometallurgy and other aspects of

Environmental Biotechnology**:** Aerobic and Anaerobic Degradation of Aliphatic and Aromatic Compounds. Microbial interaction with plastics, antibiotics and others emerging pollutants.

**UNIT-IV**

Microbially Enhanced Phosphorus and Nitrogen Removal, Microbially Enhanced Oil Recovery; Microbial role in Carbon Storage and Capture (sequestration, conversion to useful biopolymers, etc.). Case studies: Bioremediation, Carbon Storage and Capture, Bioenergy.

**Suggested readings:**


1. Manual of Environmental Microbiology (2016), 4th ed., Yates, MV, Nakatsu CH, Miller RV and Pillai RV, ASM Press (USA), Print ISBN: 9781555816025, e-ISBN:781555818821.
2. Environmental Microbiology for Engineers (2016), 1st ed., Ivanov V, ISBN: 9780429109003.
3. Environmental Microbiology: From Genomes to Biogeochemistry (2015), 2nd ed., Madsen EL, John Wiley & Sons, Inc., ISBN: 978-1-118-43963-0.
4. Environmental Microbiology: Fundamentals and Applications (2015), 1st ed., Bertrand JC, Caumette P, Lebaron, P, Matheron R, Normand P and Sime-Ngando T, Springer Netherlands, eBook ISBN: 978-94-017-9118-2, Hardcover ISBN: 978-94-017-9117-5.
5. Environmental Microbiology (2016-17), 1st ed., Sharma, PD, Rastogi Publications (India), ISBN: 978-93-5078-140-1.

## SEMESTER-III

**Course Title: Industrial Microbiology** **Credit: 4**
**Course Code: MIB 503 DM 40** **Lecture: 60**

**Course Objectives:**

1. To provide knowledge of the features of industrially important microorganisms, their screening and selection from natural resources
2. To provide insights on design and types of fermenters, their modes of operation for achieving maximum product output and various strategies for product recovery after fermentation

**Learning outcomes:**

1. Understand the role of microorganisms in industrial processes for the benefit of humankind
2. Be familiar with the principles of the industrial fermentation process and equipment
3. Learn microbial strain improvement strategies, large-scale applications of microbes for commercial production of valuable products

### UNIT-I

Historical perspectives and recent developments in Industrial Microbiology; Scope of Industrial Microbiology; Fermentation processes and types of microbial products; Sources of Industrially important microorganisms and their screening (including high throughput techniques) and selection; Characteristics of industrially relevant microbes, their maintenance and preservation; Characteristics of solid substrate and submerged fermentations.

### UNIT-II

Fermentation media- characteristics of substrates and nutrients (carbon and nitrogen) balance during fermentation, stoichiometric principles; formulation and optimization of media using one-factor and statistical approaches; methods and principles of media sterilization (batch and continuous methods); Inoculum development; Batch, continuous and fed-batch cultivation of microorganisms; Kinetics of microbial growth, substrate utilisation and product formation during fermentation bioprocess

### UNIT-III

Basic components of fermenters (impellers, seal, baffles and spargers, sampler, foam control), construction material and designing; Fermenter types - Stirred tank, bubble column, airlift, packed and fluidized bed, photobioreactors, solid state reactors; Instrumentation and control of bioprocesses. Scale-up and scale-down principles. Downstream processes for product recovery -

cell disruption, precipitation, filtration, centrifugation, extraction, chromatography, membrane process, drying, crystallization, packaging).

**UNIT-IV**

Concept of primary and secondary metabolites; microbial applications for production of alcohols, organic acids, industrial enzymes, antibiotics, health products (hormones and recombinant vaccines), bioenergy; Microbial transformations; Microbial Strain Improvement using recombinant DNA technology and metabolic engineering; Fermentation process economics.

**Suggested Readings:**


1. Glazer, A.N., and Nikaido, H. 2007. Microbial Biotechnology: Fundamentals of Applied Microbiology. 2nd ed. Cambridge University Press.
2. Casida, L.E.J.R. 2016. Industrial Microbiology. Second Edition. New Age International (P) Ltd., Publishers. New Delhi, India.
3. Crueger, W., and Crueger, A. 2000. Biotechnology: A Test Book of Industrial Microbiology, Second Edition, Panima Publishing Corporation, New Delhi.
4. El-Mansi, E.M.T., Bryce, C.F., Demain, A.L., and Allman, A.R. 2012. Fermentation Microbiology and Biotechnology, edited. 3rd ed. CRC Press.
5. Flickinger, M.C., and Drew, S.W. 1999. Encyclopaedia of Bioprocess Technology Fermentation, Biocatalysis and Bioseparation Vil. V., John Wiley and Sons Publications.
6. Crommelin, J.A.D., Sindelar, R.D., and Meibohm, B. 2013. Pharmaceutical Biotechnology: Fundamentals and Applications. 4th Edition. Springer.
7. Joe, M.M., Sivakumar, P.K. and Sukesh, K. 2010. An Introduction to Industrial Microbiology. S. Chand Publishing, New Delhi.
8. Kalaichelvan, P.T., and Arul Pandi, I. 2007. Bioprocess Technology, MJP publishers, Chennai.
9. M. L. Shuler, and F. Kargi. 2015. Bioprocess Engineering: Basic Concepts by 2nd edition. Pearson Education India.
10. N. Okafor. 2020. Modern Industrial Microbiology & Biotechnology. 2nd edition. CRC Press, USA.

## SEMESTER-III

**Course Title: Medical Microbiology and Immunology** **Credit: 4**
**Course Code: MIB 505 DM 40** **Lecture: 60**

**Course Objectives:**

1. To understand the various components of the host immune system, their structure and organization, and functions to serve as the defense system of the body
2. To understand the operational mechanisms which underlie the host defense system, allergy and organ transplantation.

**Course Learning Outcomes**:

1. To understand normal human microflora, role of microbes in causing diseases and Anti-microbial resistance
2. To understand the fundamental bases of immune system and immune response
3. To understand about the structure and organization of various components of the immune system
4. To understand the immunological reactions

### UNIT-I

Normal microflora of the human body and its importance: normal microflora of skin, throat and gastrointestinal tract; Collection, transport and culturing of clinical samples (sputum, urine, blood, stools) for microbiological analysis; Human microbiome. Causative agents, symptoms, mode of transmission and control of diseases caused by *Staphylococcus aureus*, *Streptococcus pyogenes*, *Haemophilus influenzae*, *Mycobacterium tuberculosis*, *Escherichia coli*, *Salmonella typhi*, *Vibrio cholerae*, *Helicobacter pylori*, *Bacillus anthracis*, *Clostridium tetani*, *Treponema pallidum* and TORCH group of pathogens; causative agents, symptoms, mode of transmission and control of diseases dermatomycoses, histoplasmosis, candidiasis, malaria and kala-azar; mechanism of action of various antimicrobial agents - inhibitors of nucleic acid synthesis, cell wall synthesis, cell membrane function and protein synthesis.

### UNIT-II

Host-defenses, hematopoiesis, cells of the immune system, primary and secondary lymphoid organs and tissues (MALT). Anatomical barriers, cell types of innate immunity, soluble molecules and membrane associated receptors (PRR), connections between innate and adaptive immunity, chemokines. Antigens and haptens, factors that dictate immunogenicity, B and T cell epitopes. Structure and distribution of classes and subclasses of immunoglobulins (Ig), Ig fold, effector functions of antibody, antigenic determinants on Ig and Ig super family. Multigene organization of Ig locus, mechanism of V region DNA rearrangement, ways of antibody diversification. Antigen

independent phase of B cell maturation and selection, humoral response–T-dependent and T-independent response.

**UNIT-III**

Complement activation by classical, alternate and MB lectin pathway, biological consequences of complement activation, regulation and complement deficiencies. General organization and inheritance of MHC, structure, distribution and role of MHC class I and class II proteins, pathways of antigen processing and presentation. Structure and role of T cell receptor, and co-receptor, T cell development, generation of receptor diversity, selection and differentiation. General properties of effector T cells, cytotoxic T cells (Tc), natural killer cells; NKT cells and antibody dependent cellular cytotoxicity (ADCC).

**UNIT-IV**

Mechanism of tolerance, Organ specific and systemic autoimmune diseases, possible mechanisms of induction of autoimmunity, IgE mediated (Type I) hypersensitivity, antibody mediated cytotoxic (Type II) hypersensitivity, immune complex mediated (type III) hypersensitivity and delayed type (Type IV) hypersensitivity. Immunological basis of graft rejection, clinical manifestations, immunosuppressive therapy, Immunohistochemistry, Immunocytochemistry and privileged sites. Vaccines - active and passive immunization, types of vaccines.

**Suggested readings:**


1. Kuby Immunology (2018) 8th ed., Punt J, Stranford S, Jones P and Owen JA, W.H Freeman and Company, ISBN: 978-1319114701.
2. Janeway's Immunobiology (2017) 9th ed., Murphy KM and Beaver C, WW Norton and Company, ISBN: 978-0815345510.
3. Roitt's Essential Immunology (2017) 13th ed., Delvis PJ, Martin SJ, Burton DR and Roitt, IM, Wiley-Blackwell, ISBN: 978-1118415771.
4. Lehninger: Principles of Biochemistry (2017) 7th ed., Nelson, DL and Cox, MM, WH Freeman and Company (New York), ISBN: 978-1319108243.
5. Abul, K. Abbas, Andrew H. H. Lichtman& Shiv Pillai. (2015). Basic Immunology, Functions and Disorders of the Immune System (5th ed). Elsevier.
6. Geha, R., & Notarangelo, L. (2012). Case studies in immunology: a clinical companion. GarlandScience.
7. Joseph, A. Bellanti. (2016). Immunology IV: Clinical Applications in Health and Disease. Washington, DC: Georgetown University School of Medicine.

## SEMESTER-III

**Course Title: Practical-III** **Credit: 4**
**Course Code: MIB 507 SE 40** **Lectures: 120**

**Course Objectives**

1. To provide practical skills in environmental and industrial microbiology with a focus on microbial applications in water quality, bioprocessing, and bioremediation.
2. To train students in basic clinical, diagnostic, and agricultural microbiology techniques, emphasizing biosafety, antimicrobial resistance, and pathogen detection.

**Course Learning Outcomes**

1. Perform microbiological, chemical, and instrumental analyses of water and wastewater for quality assessment.
2. Conduct industrial and biotechnological microbial processes including enzyme production, fermentation, and biomass conversion.
3. Isolate and evaluate agriculturally and environmentally significant microorganisms involved in bioremediation, plant health, and composting.
4. Apply molecular and immunological methods for the detection and analysis of microbes and their biomolecules.

**List of Practicals**

1. To determine Biological Oxygen Demand (BOD) of a water sample
2. To determine Chemical Oxygen Demand (COD) of a water sample
3. To estimate total dissolved solids (TDS) in wastewater
4. To isolate phosphate-solubilizing and nitrifying bacteria from soil
5. To study microbial degradation of dyes or phenolic compounds
6. To assess microbial activity during composting
7. To observe activated sludge floc structure under the microscope
8. To perform microbial bioassay for water toxicity evaluation
9. To study ethanol production using sugar fermentation by yeast
10. To determine alcohol content in fermented broth
11. To produce citric acid using *Aspergillus niger* in submerged fermentation
12. To perform solid-state fermentation using agro-waste
13. To screen microbes for antibiotic production from soil samples
14. To test antibiotic susceptibility using Kirby-Bauer disc diffusion method
15. To determine MIC and MBC values for an antimicrobial agent
16. To perform Widal slide agglutination test for typhoid diagnosis
17. To conduct ABO blood grouping by direct agglutination method
18. To perform differential leukocyte count (DLC) from blood smear

19. To isolate and enumerate red blood cells (RBCs) from blood
20. To perform electrophoretic separation of serum proteins
21. To isolate bacteria from clinical samples (e.g., throat swab)
22. To identify pathogenic fungi from infected specimens
23. To determine antibiotic resistance using MIC/MBC methods
24. To perform ELISA for antigen or antibody detection (demo/simulation)
25. To amplify target gene using PCR
26. To perform restriction digestion of PCR-amplified DNA
27. To isolate fungal or bacterial phytopathogens from diseased plant tissue
28. To perform Koch's postulates for a plant pathogen
29. To evaluate the efficacy of biocontrol agents against plant pathogens
30. To demonstrate biosafety practices and label biological waste
31. To explore microbiology-related patents using public databases (demo/guided)
32. To isolate and screen cellulase-producing microbes from soil
33. To perform mechanical and physico-chemical pretreatment of lignocellulosic biomass
34. To produce biorefinery enzymes (laccases, cellulases) using solid-state or submerged fermentation
35. To estimate the activity of lignocellulolytic enzymes (e.g., cellulase, xylanase, laccase)
36. To carry out enzymatic hydrolysis of pretreated lignocellulosic biomass and estimate reducing sugars
37. To produce bioethanol from pretreated biomass using microbial fermentation

**Suggested readings:**


1. Sheehan, D, Wiley Blackwell (West Sussex) (2010) Physical Biochemistry: Principles and Applications. 2nd ed., ISBN: 978-0-470-85602-4 / ISBN: 978-0-470-85603-1.
2. Plummer, DT., (2017) An Introduction to Practical Biochemistry 3rd ed., McGraw Hill Education, ISBN: 978-0070994874.
3. Wilson K, and Walker J (2018) Principles and Techniques of Biochemistry and Molecular Biology 8th ed., Cambridge University Press. ISBN: 131661476X.
4. Harry W, Seeley, Paul JV, John J, (1990) Microbes in Action: A Laboratory Manual of Microbiology 4th ed., W. H. Freeman, ISBN: 978-0716721000.
5. American Society of Agronomy; Lab Manual edition (2009) Genetics: A Laboratory Manual 2nd ed., ISBN: 978-0891185611.
6. Aneja KR (2014) Laboratory Manual of Microbiology and Biotechnology 1st ed., Scientific International Pvt., Ltd. ISBN: 9789381714553.
7. Cappuccino, JH, Sherman, N., (2017) Microbiology: A Laboratory Manual. 11th ed., Pearson Education Inc, ISBN: 9780134298597

## SEMESTER - III

**Course Title: Seminar** **Credit: 2**

**Course Code: MIB 509 SE 20** **Lectures: 30**

**Course objective:**

1. To enhance student learning and development through active engagement with a topic.
2. To gain in-depth knowledge, improve critical thinking and communication skills

**Course Learning Outcomes:**

1. Students will be able to define key concepts related to the seminar topic.
2. Students will be able to present information effectively, ask thoughtful questions, and engage in meaningful discussions.
3. Students will be able to analyze information critically, evaluate different perspectives, and formulate their own arguments.

Seminar will be of 45-minute duration during which the presentation will be followed by questions session by the audience comprising of faculty and students. Every student shall be required to submit the topic of his/her seminar in consultation with the Head of the Department/Faculty members/student advisors well in advance so that the same may be displayed on the notice board. The presenter has to write an Abstract to be distributed during Seminar in addition to two copies of write-up giving relevant details of the background of the subject, methods used and references/List of sources from where the material for presentation has been collected.

## SEMESTER-III

**Course Title: Plant Pathology** **Credit: 4**
**Course Code: MIB 511 DS 40** **Lectures: 60**

**Course objective:**

1. To appraise the students about principles of plant pathology and diseases of agricultural crops.
2. To upraise the students about disease resistance and various methods of controlling diseases

**Course Learning Outcomes:**

1. Understanding of factors responsible for diseases in the crops
2. Determining the mechanisms of pathogens for causing diseases in plants
3. Demonstrating the techniques for management of crop diseases

### UNIT-I

Introduction and history of plant pathology; Definitions and concepts of plant diseases; Biotic and abiotic factors responsible for plant diseases; Interaction of microorganisms with plants and their effect on plant growth; Modern detection methods

### UNIT-II

Host-pathogen interactions - recognition and infection, symptomatology; Disease development-role of enzymes, toxins, growth regulators; Defense strategies- hypersensitivity responses including oxidative burst, phenolics, phytoalexins, PR proteins, elicitors and their effects on host plants.

### UNIT-III

Growth, reproduction, survival and dispersal of important plant pathogens; Role of environment and host nutrition on disease development; Diseases of some important cereals (Rice, wheat); Diseases of some important horticultural crops (Tomato, Potato, Mango, Citrus, Grapes); Diseases of some important commercial crops (Cotton, Sugarcane); Important Post harvest diseases of crops

### UNIT-IV

Plant disease resistance – pathogen associated molecular patterns, pattern recognition receptors, PTI, effectors, ETI; Disease control in plants - physical, chemical methods; Disease control in plants - use of biocontrol agents - bacteria and fungi; Molecular approaches for plant protection - applications and constraints.

**Suggested readings:**


1. Introduction to Principles of Plant Pathology (2018) 5th ed. Singh RS, Scientific International Pvt. Ltd. ISBN: 9739386479488.
2. Plant Pathology (2018) 1st ed., Burchett, S and Burchett, S CRC Press, ISBN: 9780815344834.
3. Plant Pathology, (2005) 5th ed., Agrios GN, Academic Press (New York) ISBN: 9780120445653.
4. Modern Plant pathology (2023) Dube HC 2nd Ed. Agrobios India. ISBN: 9788188826650
5. Fundamental of Plant Pathology (2021) Kumar, Sanjeev, 1st Ed. New India Publishing Agency ISBN: 978-9390591206

**Course Title: Biorefinery** **Credit: 4**
**Course Code: MIB 513 DS 40** **Lectures: 60**

**Course Objectives:**

1. To impart knowledge of biorefinery concept and role of microbial processes in biorefineries
2. To make students familiar with recent technological developments, challenges and future needs in biorefinery industries

**Course Learning outcomes:**

1. Illustration of the biorefinery concept and its role in sustainable development
2. Demonstrate types of biorefinery and biorefinery feedstock
3. Sensitization about the role of microbes in sustainable development via biorefineries
4. Familiarize about the latest developments and global advancements in biorefineries

## UNIT-I

**Biorefinery Concept:** Overview of biofuels, biorefinery and circular bioeconomy, biorefinery, History and development, Types of biofuels: first, second, and third generation, Types of biomasses: agricultural residues, energy crops, forestry waste and municipal wastes, algae and others, Characteristics and selection of biomass for biofuel production. Types of biofuels (biogas, bioethanol, biobutanol, biomethane, biodiesel, biohydrogen). Biorefinery products other than biofuels

## UNIT-II

**Biorefinery Operations:** Biofuel production technologies, chemical/thermochemical conversion (pyrolysis, gasification, combustion), biochemical conversion (pretreatment, hydrolysis, fermentation), pretreatment and its types (mechanical, physical, chemical, physicochemical, biochemical, etc), hydrolysis (enzymatic, acid, autohydrolysis), fermentation (simultaneous saccharification and fermentation, separate hydrolysis fermentation, simultaneous saccharification and co-fermentation, consolidated bioprocessing, reactors (batch, semi-continuous-flow, and continuous-flow).

## UNIT-III

**Microbes in Biorefineries:** Roles of microbes in biofuels development, characterization (effect of pH, temperature, etc.) and strain improvement (mutation, adaptive laboratory evolution, genetic and metabolic engineering, systems biology approaches), fourth generation biofuels production (significance, microorganisms, process).

## UNIT-IV

**Case studies:** Case study in biofuel industries (bioethanol, biodiesel, microbial fuel cells, biohydrogen, biogas or other value-added product), Recent biofuels policies and regulations, future aspects, life cycle assessment of biofuels and technologies, Biofuels/ bioenergy related environmental, socio-economic aspects.

**Suggested Readings:**


1. Kuila, A., & Mukhopadhyay, M. (2020). Biorefinery Production Technologies for Chemicals and Energy. Wiley. ISBN: 9781119593065.
2. Mehariya, S. (2024). Microbial Cell Factories in Food Waste Biorefinery. Elsevier. ISBN: 9780443363023.
3. Agrawal, K. (2024). Biotechnological Advances in Biorefinery. Springer. ISBN: 9789819755430
4. Mehariya, S., & Bhatia, S. K. (2025). Algal Biorefinery: A Sustainable Solution for Environmental Applications. Elsevier. ISBN: 9780443239670.
5. Torres, M. D. (2020). Sustainable Seaweed Technologies: Cultivation, Biorefinery, and Applications. Elsevier. ISBN: 9780128179437.
6. Cardona Alzate, C. A., Sanchez, O. J., Gutierrez, A. F., Botero, D. A., & Marulanda, J. A. (2020). Biorefineries: Design and Analysis. Routledge. ISBN: 9780367571074.

## SEMESTER-III

**Course Title: Biosafety, Bioethics and IPR** **Credit: 4**
**Course Code: MIB 515 DS 40** **Lecture:60**

**Course objectives:**

1. To impart knowledge of biosafety issues on microbes and genetically modified organisms
2. To introduce the concept of intellectual property rights, patenting.

**Course learning outcomes**

1. Learning of importance of Personnel Protective Equipment (PPE), general biosafety rules and different biosafety levels
2. Understanding the role of regulatory agencies for working products derived from biotechnology
3. Awareness on ethical issues involving biological material
4. Knowledge on intellectual property rights and their implications in biological research and product development.

### UNIT-I

Biosafety: introduction; historical background; introduction to biological safety cabinets; primary containment for biohazards; biosafety levels; PPE, GRAS organisms, biosafety levels of specific microorganisms; recommended biosafety levels for infectious agents and infected animals; definition of GMOs & LMOs; principles of safety assessment of transgenic plants –Regulations: International regulations-Cartagena protocol, Nagoya Protocol Codex Alimentarius; regulatory framework-RCGM, GEAC, IBSC and other regulatory bodies.

### UNIT-II

Bioethics: Introduction, Principles of bioethics, ethical conflicts in biological sciences-, bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy, transplantation. Bioethics in research - cloning and stem cell research, Human and animal experimentation, animal rights/welfare, Protection of environment and biodiversity - biopiracy.

### UNIT-III

Patenting: Basics of patents: types of patents; Patents, Trade Mark, Copyright & related rights, Industrial design, Traditional knowledge, Geographical indications, Indian Patent Act 1970; recent amendments; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty (PCT) and implications;

procedure and guidelines for filing a PCT application; guidelines from National Bio-diversity Authority (NBA) and other regulatory bodies.

UNIT- IV

Ownership of patent, Rights of patent holder and co-owners, Duties of patent holder and co-owners, Transfer of patent Rights, Limitations of patent Rights, Restoration of Patents, Patent infringement-meaning, scope, types, litigation, case studies and examples; Remedies against patent infringement, licensing-outright sale, licensing, royalty; Patent Case study: Basmati Case, Neem Controversy, Turmeric Case

Suggested readings:

1. Office of the Controller General of Patents, Design & Trademarks; Department of Industrial Policy & Promotion; Ministry of Commerce & Industry; Government of India. http://www.ipindia.nic.in/

2. World Trade Organisation. http://www.wto.org

3. World Intellectual Property Organisation. http://www.wipo.int

4. International Union for the Protection of New Varieties of Plants. http://www.upov.int

5. Laboratory biosafety manual (2020), 4th edition, WHO, ISBN: 978-92-9-49001131-1

6. Parashar S, Goel D (2013) IPR, Biosafety and Bioethics Pearson Publishing India, ISBN: 9788131774700.

7. Nambisan P (2017) An Introduction to Ethical, Safety and Intellectual Property Rights Issues in Biotechnology. Academic Press, ISBN: 9780128092316.

8. http://dbtindia.gov.in/guidelines-biosafety

## SEMESTER - III

**Course Title: Applied Microbiology** **Credit: 4**
**Course Code: MIB 103 MD 40** **Lectures: 60**

**Course objective:**

1. To understand the fundamental principles of microbial growth and their control
2. To analyze microbial interactions with humans and the immune system
3. To explore the environmental, agricultural, industrial, and food-related roles of microbes

**Learning outcomes:**

1. Understanding of basic knowledge of microbial growth and control methods
2. Identify and classify microbial diseases and interpret immunodiagnostic techniques
3. Understanding of the roles of microbes in medical, environmental, industrial and food processes

### UNIT-I

History, applications and scope of microbiology. Growth kinetics, Microbial growth - Batch culture, Synchronous growth, Continuous growth, Chemostat and Turbidostat; Control of microorganisms- Physical, chemical etc, Indicators microorganisms

### UNIT-II

Microbial Interactions with humans –Classification of diseases based on etiology, duration, scale, mode of transmission, pathology, organs affected etc. Some common examples of food, air, water borne diseases, and their causative agents, Antibiotics and Vaccines; Introduction to immunodiagnostics – RIA, ELISA.

### UNIT-III

Role of microorganisms in environment and agriculture, biogeochemical cycles (N, C, P), plant growth promoting bacteria, beneficial associations and interactions of microbes with microbe themselves, plant and animals, biodegradation of plant material into compost and humus, bioremediation.

### UNIT-IV

Industrial and food applications of microbes, food fermentations (sauerkraut, tofu, tempeh, cheese, fermented milk), starter cultures, probiotics and prebiotics, industrial production of microbial biomass (baker yeast and SCP), primary (alcohol, microbial plastic, vinegar and enzymes) and secondary metabolites (antibiotics).

**Suggested readings:**


1. Kuby Immunology (2018) 8th ed., Punt J, Stranford S, Jones P and Owen JA, W.H Freeman and Company, ISBN: 978-1319114701.
2. Manual of Environmental Microbiology (2016), 4th ed., Yates MV, Nakatsu CH, Miller, RV and Pillai RV, ASM Press (USA), Print ISBN: 9781555816025, e-ISBN : 9781555818821
3. Environmental Microbiology: Fundamentals and Applications (2015), 1st ed., Bertrand, JC, Caumette P, Lebaron P, Matheron R, Normand P and Sime-Ngando T, Springer Netherlands, eBook ISBN: 978-94-017-9118-2, Hardcover ISBN: 978-94-017-9117-5.
4. Environmental Microbiology (2016-17), 1st ed., Sharma, PD, Rastogi Publications (India), ISBN: 978-93-5078-140-1
5. Industrial Microbiology (2019), 2nd ed., Casida LEJR, New Age International (P) Ltd., New Delhi, India., ISBN: 9788122438024
6. Modern Industrial Microbiology and Biotechnology (2017), 2nd ed., Okafor N and Okeke, BC, CRC Press, ISBN: 9781138550186
7. Biotechnology: A Test Book of Industrial Microbiology (2017) 3rd ed., Crueger W, Crueger A and Aneja KR., Panima Publishing corporation (New Delhi), ISBN: 9789385998638

## SEMESTER-IV

**Course Title: Research thesis/ Industrial Project** **Credit: 20**

**Course Code: MIB 550 SRP**

**Course Learning outcomes:**

1. Identifying appropriate research question and applying suitable research designs
2. Execution of independent research experiments
3. Application of knowledge and skills previously gained for selected research problem
4. Establishing links between theory and methods in selected area of research
5. Understand and apply ethical standards of conduct in the collection and evaluation of data and other resources

**Overview:** The Research Thesis/Industrial Project is a mandatory requirement for students in the Research only of the Master of Microbiology program, undertaken during the 3rd semester. As the culminating academic requirement, it provides students with the opportunity to apply their acquired knowledge, research methodologies, and analytical skills to an independent research project in Microbiology & allied sciences. The Research Thesis/ Industrial Project reflects the student's ability to conduct rigorous research and contribute meaningfully to the field.

**Supervision:** Each student is assigned a Faculty Supervisor at the beginning of the 3rd semester to provide academic guidance throughout the Research Thesis/ Industrial Project process. Students are expected to consult regularly with their supervisor to refine their research, receive feedback, and ensure alignment with academic standards.

**Topic Selection and Approval:** Students must select a research topic relevant to microbiology and allied sciences. The proposed topic and research plan must be formalized in a research proposal, which requires approval from the Department before proceeding.

**Student Responsibilities:** Students are responsible for:

- Developing a research proposal in consultation with their Faculty Supervisor.
- Conducting independent research that adheres to ethical and academic standards.
- Regularly engaging with their Faculty Supervisor for guidance and feedback.
- Ensuring the Research Thesis/ Industrial Project meets all academic, structural, and formatting requirements.
- Submitting the final Research Thesis/ Industrial Project, accompanied by a plagiarism

report, by the Department-specified deadline.

**Formatting Guidelines:** All Research Thesis/ Industrial Projects must adhere to the following formatting standards:

- Font: Times New Roman, 12-point.
- Spacing: 1.5-line spacing throughout.
- Margins: 1 inch (2.54 cm) on all sides.
- Page Numbering: Bottom center or bottom right.
- Binding: Hardbound or spiral-bound, as per Department instructions.
- Citation Style: APA (latest edition) or as prescribed by the Department.

**Research Thesis/ Industrial Project Structure:** The Research Thesis/ Industrial Project must include the following components:

- Title Page
- Declaration by the Student
- Certificate from the Supervisor
- Acknowledgements
- Table of Contents
- List of Tables and Figures (if applicable)
- Abstract
- Main Chapters
- References
- Appendices (if applicable)

**Submission and Evaluation:**

The final Research Thesis/Project, along with a plagiarism report, must be submitted by the Department-specified deadline. The Department will recommend a student for the conferral of the Master of Microbiology degree only when the Research Thesis/Project fully complies with the academic, structural, and formatting requirements outlined in these guidelines.

**Research Thesis/Project Evaluation:**

| **Component** | **Credits (20)** | **Credits (45)** | **Weightage** | **Evaluated By** |
|---|---|---|---|---|
| Research Thesis/Project Evaluation | 350 | 700 | 100% | External Expert |
| Internal | 150 | 300 | | Internal |
| **Total** | **500** | **1000** | **100%** | |

**Course Title: Fundamentals of Agriculture**

Course Description:

This course introduces students to the basic principles and practices of agriculture, including its relevance to society, food security, sustainability, and the environment. It is designed for non-agriculture majors who wish to understand the agricultural systems that sustain human life.

**Course Objectives:**

1. To provide an overview of agriculture and its role in the economy and society.
2. To introduce the basics of soil, crop production, and natural resource management.
3. To explore sustainable practices, food systems, and innovations in agriculture.

**Course Outcomes:**

1. By the end of this course, students will be able to:
2. Understand the foundational concepts and societal relevance of agriculture.
3. Recognize basic agricultural practices and their environmental implications.
4. Appreciate the role of sustainable and technological innovations in modern agriculture.

UNIT I

Introduction to Agriculture: Development of human culture and beginning of agriculture, Agriculture during Indus Civilization, Definition and significance of agriculture, History and development of agriculture in India, Branches of agriculture and types of farming (commercial, natural, organic), Role of agriculture in national development and food security

UNIT II

Basics of Soil and Water: Introduction to soil: formation, types, and basic properties, Soil and plant health: importance of nutrients, Water resources and basic irrigation methods, Sustainable soil and water management practices

Unit III

Crop Production and Sustainability : Classification of crops and cropping systems (rotation, mixed cropping), Introduction to fertilizers, manures, and pest control, Role of climate and technology in crop production

UNIT IV

Agriculture and Society: Agricultural marketing and food supply chains, Urban agriculture and kitchen gardening, Government initiatives and support systems (e.g., MSP, subsidies, crop insurance), Future of agriculture: Agri-tech, smart farming, and climate resilience

Suggested Readings / Resources:

Introduction to Agriculture (2024) Vyas A.K and Raj, Rishi; 9th Ed. Jain Brothers, New Delhi India, ISBN: 9788183602112

Fundamentals of Agriculture, Volume 1 and Volume 2 (2024) Arun Katyayan, 11th Ed. Kushal Publications and Distributors, India, ISBN: 9789393704795

http://eagri.org/eagri50/AGRO102/index.html

ICAR. (2017). Handbook of agriculture. Indian Council of Agricultural Research. New Delhi, India ISBN: 9788171640508

## 8. Curricular Components

**Two Year PG Programme**: Students entering Two-year PG programme can choose the following option after completion of 1st year; (i) course work in the third semester and research in the fourth semester or (ii) only research in the third and fourth semester.

**One Year PG Programme:** Students entering 1-year PG after a 4-year UG programme can choose to do (i) only coursework or (ii) only research or (iii) coursework and research.

**Note:** The department may offer either Coursework or Coursework + Research or Research only, or all the three options for one-year/2nd year (3rd and 4th semester) of PG programme, subject to availability of resources.

## 9. Exit Options and Award of Degree

A candidate who has passed the first year/two semester of M.Sc. Microbiology (Two Year/Four Semester Master Degree Programme) shall be allowed to exit, and shall be awarded **Postgraduate Diploma in Microbiology.** Such candidates shall be eligible for admission to M.Sc. Microbiology under Lateral Entry Scheme subject to the availability of seats. After completion of all the four semesters Master of Microbiology degree (Two Year/Four Semester Master Degree Programme) shall be awarded to the candidate.

## 10. Provision of Lateral Entry into Third Semester

A candidate who has qualified any of the following examination shall be eligible to seek admission in the third Semester of the course under Lateral Entry Scheme:

i. Who has passed the first and second Semester of Master of Microbiology of this University or any other University recognized as equivalent thereto.
ii. Who has passed the four-year graduation programme with Microbiology as a core subject.

Under option 8(i), mapping of the qualifying degree of the lateral entry students will be done by departmental staff council and any shortfall course shall be required to complete through MOOCs/by the Department to fulfill the minimum requirements for the degree.

Note: Admissions to third Semester under Lateral Entry scheme shall be available subject to the availability of vacant seats in the third semester. Admission criteria and selection procedures shall be determined by the University in accordance with prevailing norms. After completion of two semesters such students will be awarded **Master of Microbiology (One Year Programme)** degree.

### 11. Credit Requirement and Eligibility for the PG Programme

1. A bachelor's degree with Honours/ Honours with Research with a minimum of 160 credits for a 1-year/2-semester PG programme at level 6.5 on the NHEQF.
2. A 3-year/6-semester bachelor's degree with a minimum of 120 credits for a 2-year/4-semester PG programme at level 6.5 on the NHEQF.
3. A 4-year Bachelor's degree (e.g. B.E., B.Tech. etc.) with a minimum of 160 credits for
4. 2-year/4-semester PG programme (e.g. M.E., M. Tech. etc.) at level 7 of NHEQF.

## 12. Teaching Learning Process

- Classroom Lectures
- Interactive sessions
- Animation and videos demonstration
- Quizzes
- Flipped classroom
- Group discussions
- Seminars
- Electronic learning
- Tutorials
- Laboratory demonstrations
- Collaborative Learning
- Self-assessed or peer-assessed assignments

## 13. Blended Learning

Blended learning mode will be adopted in teaching the courses. This mode of learning uses direct as well as indirect mode of instructions through application of ICT. Students gets individualized computer assisted learning. This will also include live discussion on the topic in the theory classroom. This provides more flexible teaching learning environment.

## 14. Assessment and Evaluation

- Continuous Comprehensive Evaluation at regular after achievement of each Course-level learning outcome
- Formative Assessment on the basis of activities of a learner throughout the programme instead of one-time assessment
- Oral Examinations to test presentation and communication skills
- Open Book Examination for better understanding and application of the knowledge acquired
- Group Examinations on Problem solving exercises
- Seminar Presentations
- Review of Literature
- Collaborative Assignments

## 15. Key words

- Microbiology
- LOCF
- NEP-2020
- Blended Learning
- Face to face (F to F) Learning
- Programme Outcomes
- Programme Specific Outcomes
- Course-level Learning Outcomes
- Postgraduate Attributes
- Learning Outcome Index
- Formative Assessment and Evaluation
- Comprehensive and Continuous Evaluation

## 16. References


- National Education Policy-2020. https://www.education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf
- The draft subject specific LOCF templates available on UGC website. https://www.ugc.ac.in/ugc_notices.aspx?id=MjY5OQ==
- Draft Blended Mode of Teaching and Learning: Concept Note available on UGC website. https://www.ugc.ac.in/pdfnews/6100340_Concept-Note-Blended-Mode-of-Teaching-and-Learning.pdf
- National Higher Education Qualifications Framework (NHEQF) https://www.ugc.gov.in/pdfnews/2990035_Final-NHEQF.pdf
- Curriculum and Credit Framework for Postgraduate Programmes https://www.ugc.gov.in/pdfnews/4682468_Curriculum-and-Credit-Framework-for-Postgraduate-Programmes.pdf
- National Credit Framework (NCrF) https://www.education.gov.in/sites/upload_files/mhrd/files/National_Credit_Framework.pdf

# Research Thesis Guidelines

1. **GENERAL :**

The manual is intended to provide broad guidelines to the M.Sc. candidates in the preparation of the Research thesis report. In general, the project report shall report, in an organised and scholarly fashion an account of original research work of the candidate leading to the discovery of new facts or techniques or correlation of facts already known.

**2. NUMBER OF COPIES TO BE SUBMITTED:**

Students should submit three copies to the Head of the Department concerned on or before the specified date.

**3. ARRANGEMENT OF CONTENTS OF RESEARCH THESIS:**

Research thesis material should be arranged as follows:

1. Cover Page & Title page
2. Declaration
3. Certificate
4. Abstract (Hindi and English)
5. Acknowledgements
6. Table of Contents
7. List of Tables
8. List of Figures
9. List of Symbols, Abbreviations and Nomenclature (Optional)
10. Chapters
11. References
12. Appendices
13. One page CV

The Tables and Figures shall be introduced in the appropriate places.

**4. PAGE DIMENSIONS AND MARGIN:**

The dimensions of the Research thesis should be standard A4 size paper may be used for preparing the copies, **standard margin** with 1.5 line spacing.

**5. MANUSCRIPT PREPARATION:**

The general text of thesis shall be typed in font style Times New Roman and font size 12. Same quality of paper should be used for the preparation of the entire report/thesis; except figure, photos are shown.

5.1 **Cover Page & Title Page** - A specimen copy of the Cover page & Title page for report/thesis are given in Annexure I.

5.2 **Certificate**-The Bonafide Certificate as per the format shown in Annexure II

5.3 **Abstract**: Abstract should be an essay type (HINDI and ENGLISH) of narration not exceeding 500 words outlining the research problem, the methodology used for tackling it and a summary of the findings, typed in 1.5line spacing.

5.4 **Acknowledgements:** The acknowledgements shall be brief and should not exceed onepage. The student's signature shall be made at the right bottom above his / her name typed in capitals.

5.5 **Table of contents** - The table of contents should list all material following it as wellas any material which precedes it. The title page, Bonafide Certificate and Acknowledgment will not find a place among the items listed in the Table of Contents but the page numbers in lower case Roman letters are to be accounted for them. One and a half spacing should be adopted for typing the matter under this head. A specimen copy of the Table of Contents for report / thesis is given in Annexure III.

5.6 **List of Table** - The list should use exactly the same captions as they appear above thetables in the text and the caption shall follow 'sentence case'. One and a half spacing should be adopted for typing the matter under this head.

5.7 **List of Figures** - The list should use exactly the same captions as they appear belowthe figures in the text and the caption shall follow 'sentence case'. One and a half spacing should be adopted for typing the matter under this head

5.8 **List of Symbols, Abbreviations and Nomenclature** - One and a half spacing shouldbe adopted for typing the matter under this head. Standard symbols, abbreviations etc. should be used.

5.9 **Chapters** - The chapters may include

Chapter I – Introduction

Chapter II - Literature Review

Chapter III –Materials and Methods

Chapter IV- Results and Discussion

1.10. Research output/outcome if any published or presented in conference/seminar/symposium may be included.

**1.11. List of References** - Any works of other researchers, if used either directly orindirectly, should be indicated at appropriate places in the report/thesis. The citation may assume any one of the following forms**. APA Style.**

APA in-text citation style uses the author's last name and the year of publication, for example: (Field, 2005).

Example:

Derwing, T. M., Rossiter, M. J., & Munro, M. J. (2002). Teaching native speakers to listen to foreign-accented speech. *Journal of Multilingual and Multicultural Development*, 23(4), 245-259.

Thomas, H. K. (2004). *Training strategies for improving listeners' comprehension of foreign-accented speech* (Doctoral dissertation). University of Colorado, Boulder.

## 6. TYPING INSTRUCTIONS

### 6.1 General

This section includes additional information for final typing of the thesis. Some information given earlier under 'Manuscript preparation' shall also be referred. The impressions on the typed/duplicated/printed copies should be black in colour. Corrections, interlineations and crossing out of letters or words will not be permitted in any of the copies of the report/thesis intended for submission. Erasures, if made, should be neatly carried out in all copies. A sub-heading at the bottom of a page must have at least two full lines below it or else it should be carried over to the next page. The last word of any page should not be split using a hyphen. One and a half spacing should be used for typing the general text. The general text shall be typed in Font Style Times New Roman and Font Size 12.

Single spacing should be used for typing:

(i) Long Tables

(ii) Long quotations
(iii) Foot notes

(iv) Multilane captions
(v) References

**6.2 Chapters** The format for typing chapter headings, division headings and sub division headings shall be same as given in Table of Contents.

## 7. BINDING SPECIFICATIONS

Thesis should be spiral or soft cover book bound, the cover of thesis should be of dark greencolor, printed with golden ink and the text for printing should be identical as prescribed for the title page.

**APPENDIX I A:**(A typical Specimen of Cover Page & Title Page–**RESEARCH THESIS**)

<Font Style Times New Roman - Bold>

# TITLE OF RESEARCH THESIS

<Font Size 18><1.5 line spacing>

**RESEARCH THESIS**

<Font Size 14>

***Submitted by***

<Font Size 14><Italic>

## NAME OF THE CANDIDATE

<Font Size 16>

Under the Supervision of

## NAME OF THE SUPERVISOR

***in partial fulfillment for the award of the degree of***

<Font Size 14><1.5 line spacing>

## MASTER OF SCIENCE IN

## NAME OF THE PROGRAMME

<Font Size 16>

## DEPARTMENT OF

## SCHOOL OF ……..

## CENTRAL UNIVERSITY OF HARYANA

## MAHENDERGARH-HARYANA

<Font Size 14><1.5 line spacing>

**MONTH AND YEAR**

***Certificate Format -1 for students doing dissertation in CUH (On letter pad)***

**DECLARATION**

I ……, student of the School of Interdisciplinary and Life Sciences, Central University of Haryana, Mahendergarh hereby declare and certify with my signature that my thesis entitled

…… submitted to the Department of ……., Central University of Haryana, India in partial fulfillment of the requirements for the award of the Degree of Master of Science is a record of original research work done by me from ……to …….and the Research thesis has not been the basis for the award of any degree/diploma/associateship/fellowship or similar title of any candidate of any University. I have faithfully and accurately cited all my sources, including books, journals, handouts and unpublished manuscripts, as well as any other media, such as the Internet, letters or significant personal communications.

I understand the concept of "plagiarism" and declare that while drafting this Research thesis I have refrained from plagiarism. I know that plagiarism not only includes direct copying, but also the extensive use of other's ideas without proper referencing or acknowledgement (which includes the proper use of references and quotation marks).

If my Research thesis found to be plagiarized at any point of time, I'll be solely responsible and will be ready to accept any decision taken by the competent authority including rejection of my Research thesis.

(Supervisor) (Signature of student)

***Additional Certificate Format -2 for students doing dissertation in outside CUH***

# CERTIFICATE*

This is to certify that the dissertation entitled "**……..**", being submitted to the Department of …….., of the School of Interdisciplinary and Life Sciences at Central University of Haryana, India in partial fulfillment of the requirements for the award of the Degree of …… in ……(Subject)…….. is a record of original research work done by Ms/Mr**…….. (Roll No ……)** in the (Institute name)…….. under my guidance from …….to ……..... (Period)

Dated :

Signature and stamp of External Supervisor/Guide

*The certificate should be on letter pad of the external guide/organization.

## For example

(A typical Specimen of Table of Contents)

<Font Style Times New Roman, Font Size 14>

**TABLE OF CONTENTS**

# ANNEXURE II

*Curriculum vitae*

<Font Style Times New Roman, Font Size 14>

**Personal Details**

Name :

Date of birth : DD Month, YYYY

Place of birth :

Nationality : Indian

Permanent Address :

Email Id :

Mobile No. :

**Education**

M.Sc. (Subject) : YYYY Central University of Haryana, India

B.Sc. (Subject). : YYYY (Name of the University) with …. % of marks

Higher Secondary : YYYY (Name of the board) with …. % of marks

Secondary : YYYY, ( Name of the board) with …. % of marks

**APPENDIX I A:**(A typical Specimen of Cover Page & Title Page– **Industrial Project**)

<Font Style Times New Roman - Bold>

# TITLE OF INDUSTRIAL PROJECT

<Font Size 18><1.5 line spacing>

**INDUSTRIAL PROJECT**

<Font Size 14>

**Logo of the Industry**

***Submitted by***

<Font Size 14><Italic>

**NAME OF THE CANDIDATE**

<Font Size 16>

***in partial fulfillment for the award of the degree of***

<Font Size 14><1.5 line spacing>

**MASTER OF SCIENCE IN**

**NAME OF THE PROGRAMME**

<Font Size 16>

**Logo of the University**

**DEPARTMENT OF**

**SCHOOL OF ……..**

**CENTRAL UNIVERSITY OF HARYANA**

**MAHENDERGARH-HARYANA**

<Font Size 14><1.5 line spacing>

**MONTH AND YEAR**

***Certificate Format -1 for students doing dissertation in CUH (On letter pad)***

**DECLARATION**

I ……, student of the School of Interdisciplinary and Life Sciences, Central University of Haryana, Mahendergarh hereby declare and certify with my signature that my thesis entitled

…… submitted to the Department of ……., Central University of Haryana, India in partial fulfillment of the requirements for the award of the Degree of Master of Science is a record of original research work done by me from ……to …….and . I have faithfully and accurately cited all my sources, including books, journals, handouts and unpublished manuscripts, as well as any other media, such as the Internet, letters or significant personal communications.

I understand the concept of "plagiarism" and declare that while drafting this Industrial Project I have refrained from plagiarism. I know that plagiarism not only includes direct copying, but also the extensive use of other's ideas without proper referencing or acknowledgement (which includes the proper use of references and quotation marks).

If my Industrial Project found to be plagiarized at any point of time, I'll be solely responsible and will be ready to accept any decision taken by the competent authority including rejection of my Industrial Project.

(Supervisor) (Signature of student)

***Additional Certificate Format -2 for students doing dissertation in outside CUH***

# CERTIFICATE*

This is to certify that the Industrial Project entitled "**……..**", being submitted to the Department of …….., of the School of Interdisciplinary and Life Sciences at Central University of Haryana, India in partial fulfillment of the requirements for the award of the Degree of …… in ……(Subject)…….. is a record of industrial project work done by Ms/Mr**…….. (Roll No ……)** in the (Industry name)…….. under my guidance from …….to ……..... (Period)

Dated :

Signature and stamp of Host Organization/Head of the Organization

*The certificate should be on letter pad of the external guide/organization.

**Formatting Guidelines:** All Industrial Projects must adhere to the following formatting standards:

- Font: Times New Roman, 12-point.
- Spacing: 1.5-line spacing throughout.
- Margins: 1 inch (2.54 cm) on all sides.
- Page Numbering: Bottom center or bottom right.
- Binding: Hardbound or spiral-bound, as per Department instructions.
- Citation Style: APA (latest edition) or as prescribed by the Department.

**Industrial Project Structure:**

# Table of Contents

3.2 Description of Daily Tasks and Procedures

3.3 Standard Operating Procedures (SOPs) Followed

3.4 Handling of Instruments and Reagents

3.5 Observations on Quality and Process Flow

Chapter 4: Learning and Skill Development

4.1 Technical Skills Acquired

4.2 Familiarity with Industrial Protocols

4.3 Interdepartmental Exposure (if any)

4.4 Health, Safety and Hygiene Practices

Chapter 5: Reflections and Outcomes

5.1 Summary of Learning

5.2 Challenges Faced During Routine Work

5.3 Suggestions for Improvement (if applicable)

Chapter 6: Conclusion and Recommendations

6.1 Overview of Training Outcomes

6.2 Alignment with Academic Knowledge

6.3 Recommendations for Future Trainees

References / Bibliography

Appendices

A. Weekly Work Log or Attendance Sheet

B. List of Equipment / Chemicals Handled

C. Sample SOPs or Data Sheets

D. Safety Training Certificates (if any)

Note: MOU/Certificate stating the IPR agreement need to signed with industry before starting the Industrial project.