ADAMAS UNIVERSITY

PURSUE EXCELLENCE

KOLKATA

# ADAMAS UNIVERSITY
# SCHOOL OF LIFE SCIENCE AND BIOTECHNOLOGY
## Department of Biological Sciences
## M.Sc. (Microbiology)
## NEP compliant curriculum
## (2026-28)
## Programme Code – MIB4207

**ADAMAS UNIVERSITY, KOLKATA**
**SCHOOL OF LIFE SCIENCE AND BIOTECHNOLOGY**
**DEPARTMENT OF BIOLOGICAL SCIENCES**

## VISION OF THE UNIVERSITY

To be an internationally recognized university through excellence in inter-disciplinary education, research and innovation, preparing socially responsible well-grounded individuals contributing to nation building.

## MISSION STATEMENTS OF THE UNIVERSITY

**M.S 01:** Improve employability through futuristic curriculum and progressive pedagogy with cutting-edge technology

**M.S 02:** Foster outcomes-based education system for continuous improvement in education, research and all allied activities

**M.S 03:** Instill the notion of lifelong learning through culture of research and innovation

**M.S 04:** Collaborate with industries, research centres and professional bodies to stay relevant and up-to-date

**M.S 05:** Inculcate ethical principles and develop understanding of environmental and social realities

**CHANCELLOR / VICE CHANCELLOR**

**ADAMAS UNIVERSITY, KOLKATA**
**SCHOOL OF LIFE SCIENCE AND BIOTECHNOLOGY**
**DEPARTMENT OF BIOLOGICAL SCIENCES**

## VISION OF THE SCHOOL

To achieve global standard and **excellence in research** on various **interdisciplinary and multidisciplinary domains** of biological sciences through **biotechnological innovation** along with **producing global citizens** as graduates by **intensive teaching learning process** who would be vanguard to **sustainable societal development**.

## MISSION STATEMENTS OF THE SCHOOL

**M.S 01:**To disseminate knowledge of life science and biotechnology for scholarly progression, intellectual development and strive for innovation.

**M.S 02:** To enable latest skill sets in the domain of microbiology, biotechnology, biochemistry (biological sciences) with ability to evolve and engage in learn-unlearn and relearn, being a lifelong learner.

**M.S 03:** To establish state of art infrastructure and research ambiance in attracting the best minds to serve under the single roof of school of life science and biotechnology in undertaking scientific investigation of social relevance.

**M.S 04:** To inculcate values, culture along with scientific knowledge to foster the spirit of self-reliance and entrepreneurship development.

**DEAN / SCHOOL CONCERNED**

**ADAMAS UNIVERSITY, KOLKATA**
**SCHOOL OF LIFE SCIENCE AND BIOTECHNOLOGY**
**DEPARTMENT OF BIOLOGICAL SCIENCES**

## VISION OF THE DEPARTMENT

To achieve **excellence in microbiological education and research** for **societal development** through **innovation** and producing **technologically sound graduates** as **global citizen** fostering **life-long learning.**

## MISSION STATEMENTS OF THE DEPARTMENT

**M.S 01:** Adopt and implement latest curriculum in microbiology with futuristic approach and innovative pedagogy fostering knowledge, intellectual and skill development.

**M.S 02:** To enable and enhance microbiological skill sets through rigorous training and research through multidisciplinary approach.

**M.S 03:** To cater professional and societal need of cutting-edge microbiological research through collaboration and industry-academic partnership.

**M.S 04:** To inculcate values, culture along with microbiological knowledge to foster the spirit of self-reliance and entrepreneurship development.

**HOD** **DEAN / SCHOOL CONCERNED**

**ADAMAS UNIVERSITY, KOLKATA**
**SCHOOL OF LIFE SCIENCE AND BIOTECHNOLOGY**
**DEPARTMENT OF BIOLOGICAL SCIENCES**

**Name of the Programme: M.Sc. (Microbiology)**

**PROGRAMME EDUCATIONAL OBJECTIVES (PEO)**

**PEO 01 :** Ability to do research, comprehend fundamentals and expertise in the domain.

**PEO 02 :** Acquainted with tools and technology related to the field of study.

**PEO 03 :** Ability to find routes of solution of existing scientific problems of the domain through identification of research gaps.

**PEO 04 :** Develop as professional aspirants and sustainable learners.

**PEO 05 :** Global outlook with imbibed human values

**HOD** **DEAN / SCHOOL CONCERNED**

**ADAMAS UNIVERSITY, KOLKATA**
**SCHOOL OF LIFE SCIENCE AND BIOTECHNOLOGY**
**DEPARTMENT OF BIOLOGICAL SCIENCES**

**Name of the Programme: M.Sc. (Microbiology)**

**GRADUATE ATTRIBUTE / PROGRAMME OUTCOME (PO)**

**GA 01/ PO 01:** Develop research approaches to meet the scientific gaps on microbiology and allied interdisciplinary or multidisciplinary fields.

**GA 02/ PO 02:** Foster the knowledge and skills in microbiology to identify and approach towards suitable solution.

**GA 03/ PO 03:** Ability to salvage significant biological data for meaningful solution.

**GA 04/ PO 04:** Develop skill set related to microbiology and allied fields

**GA 05/ PO 05:** Familiarized with latest and advanced tools and techniques of microbiology.

**GA 06/ PO 06:** Investigate an existing problem to find a suitable solutions, beneficial to the society.

**GA 07/ PO 07:** Strong basic knowledge to support diversification in applied field of microbiology.

**GA 08/ PO 08:** Ability to set career and professional goals based on a proper career planning process.

**GA 09/ PO 09:** Develop capacity to uphold integrity and collaborative approach in workplace.

**GA 10/ PO 10:** To accept and implement changes in learning towards a sustainable development through learn, unlearn-relearn approach.

**GA 11/ PO 11:** Practice ethical philosophies and systems in creating and partnering a progressive society.

**GA 12/ PO 12:** Develop as global citizen to contribute in the greater benefits of humanity.

**HOD** **DEAN / SCHOOL CONCERNED**

**M.Sc. (Microbiology)**

**Program Structure for 2-year Postgraduate Programs with Exit Option 1st Year of PG curricular structure for 2-year PG Programmes (3+2)**

**Total Credits = 95**

| 1st Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **SEMESTER I** | | | | | | | | |
| **S. No.** | **Type of Course** | **Code** | **Title of the Course** | **Contact Hours Per Week** | | | | **Remarks** |
| | | | | **L** | **T** | **P** | **C** | |
| 1 | CC | MIB455 | Bacteriology and Eukaryotic Microbiology | 2 | 1 | 1 | **4** | CC-1 |
| 2 | CC | MIB456 | Bioenergetics and Metabolism | 2 | 1 | 1 | **4** | CC-2 |
| 3 | CC | MIB457 | Ecology and Evolution | 3 | 1 | 0 | **4** | CC-3 |
| 4 | DSE | MIB458 | Computational Biology | 2 | 1 | 1 | **4** | DSE-1 |
| | | MIB461 | Environmental Impact Assessment | | | | | |
| | | MIB462 | Bioimaging | | | | | |
| | MDE | | To be chosen from the pool of elective courses of other departments / SWAYAM MOOC courses approved by the department | | | | | MDE-1 |
| 5 | RM | MIB459 | Biostatistics and Research Methodology | 3 | 1 | 0 | **4** | RM |
| 6 | AEC | AEC408 / AEC409 / AEC410 | French I / German I / Spanish I | 2 | 0 | 0 | **2** | AEC-1 |
| 7 | SEC | MIB460 | Drug-Design and Development | 2 | 0 | 0 | **2** | SEC-1 |
| 8 | SEC | CLL551 | Advanced Soft Skills & Aptitude I | 0 | 0 | 1 | **1** | General SEC – 1 |
| **Semester Credits** | | | | | | | **25** | |

| SEMESTER II | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | CC | MIB463 | Virology | 2 | 1 | 1 | **4** | CC-4 |
| 2 | CC | MIB464 | Molecular Genetics | 2 | 1 | 1 | **4** | CC-5 |
| 3 | CC | MIB465 | Applied Molecular Biology | 2 | 1 | 1 | **4** | CC-6 |
| 4 | DSE | MIB466 | Infection Biology and Immunology | 2 | 1 | 1 | **4** | DSE-2 |
| | | MIB468 | Host-pathogen interaction | | | | | |
| 5 | MDE | | To be chosen from the pool of elective courses of other departments / SWAYAM MOOC courses approved by the department | | | | **4** | MDE-2 |
| 6 | AEC | AEC503 / AEC504 / AEC505 | French II / German II / Spanish II | 2 | 0 | 0 | **2** | AEC-2 |
| 7 | SEC | MIB467 | AI in Biology | 2 | 0 | 0 | **2** | SEC-2 |
| 8 | SEC | CLL552 | Advanced Soft Skills & Aptitude II | 0 | 0 | 1 | **1** | General SEC – 2 |
| **Semester Credits** | | | | | | | **25** | |
| **Exit option with Post-Graduate Diploma after the first year or two semesters with the completion of courses equivalent to 50 Credits** | | | | | | | | |

**PG Curricular Structure for 2nd Year**
**with**
***Coursework and Research***

**Specialisations Offered –**

| | |
|---|---|
| • | **Toxicology** |
| # | **Quality Management Systems** |
| **Δ** | **Bioprocess Technology** |

| **2nd Year** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **SEMESTER III** | | | | | | | | | |
| **Sr. No** | **Type of Course** | **Code** | | **Title of the Course** | **Contact Hours Per Week** | | | | **Remarks** |
| | | | | | **L** | **T** | **P** | **C** | |
| 1 | CC | MIB501 | | Environmental Microbiology | 2 | 1 | 1 | **4** | CC-7 |
| 2 | CC | MIB502 | | Bioanalytical Techniques | 2 | 1 | 1 | **4** | CC-8 |
| 3 | DSE | MIB503 | • | Natural Products and Toxicology | 2 | 1 | 1 | **4** | DSE-3 |
| | | MIB504 | # | Food and Pharmaceutical Microbiology | | | | | |
| | | MIB505 | Δ | Bioprocess Technology | | | | | |
| | MDE | | | To be chosen from the pool of elective courses of other departments / SWAYAM MOOC courses approved by the department | | | | | |
| 4 | CC | MIB506 | • | Research Approaches in Environmental Toxicology | 2 | 0 | 0 | **2** | CC-9 |
| | | MIB507 | # | Research Practices in Microbial Safety and Sustainability in Food Systems | | | | | |
| | | MIB508 | Δ | Critical Reading and Writing on Enzyme Technology | | | | | |
| 5 | INT | MIB509 | | Internship | 2 | 0 | 0 | **2** | INT |
| 6 | SEC | CLL651 | | Advanced Soft Skills & Aptitude III | 0 | 0 | 1 | **1** | General SEC – 3 |
| 7 | Research | MIB516 | | Dissertation Part I* | 0 | 0 | 6 | **6** | RP-1 |
| **Semester Credits** | | | | | | | | **23** | |

| SEMESTER IV | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | CC | MIB510 | | Bioethics and IPR | 3 | 1 | 0 | **4** | CC-10 |
| 2 | DSE | MIB511 | • | Environmental Monitoring and Surveillance | 3 | 1 | 0 | **4** | DSE-4 |
| | | MIB512 | # | Quality Management Systems | | | | | |
| | | MIB513 | Δ | Process plant and Bioreactor Design | | | | | |
| 3 | ENT | MIB514 | | Innovations and Entrepreneurship in Biotechnology | 2 | 0 | 0 | **2** | |
| 4 | Project | MIB517 | | Dissertation Part II** | 0 | 0 | 12 | **12** | RP-1 |
| **Semester Credits** | | | | | | | | **22** | |

**For 2 yrs (Coursework + Research):**

| **Semester** | **1** | **2** | **3** | **4** | **Total** |
|---|---|---|---|---|---|
| **Credits** | 25 | 25 | 23 | 22 | **95** |
| **Total Yearly** | **50** | | **45** | | |

**PG Curricular Structure for 2nd Year**
**with**
***Research***

**Specialisations Offered –**

| | |
|---|---|
| • | **Toxicology** |
| # | **Quality Management Systems** |
| Δ | **Bioprocess Technology** |

| **2nd Year** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **SEMESTER III** | | | | | | | | | |
| **Sr. No** | **Type of Course** | **Code** | | **Title of the Course** | **Contact Hours Per Week** | | | | **Remarks** |
| | | | | | **L** | **T** | **P** | **C** | |
| 1 | CC | MIB502 | | Bioanalytical Techniques | 2 | 1 | 1 | **4** | CC-8 |
| 2 | DSE | MIB503 | • | Natural Products and Toxicology | 2 | 1 | 1 | **4** | DSE-3 |
| | | MIB504 | # | Food and Pharmaceutical Microbiology | | | | | |
| | | MIB505 | Δ | Bioprocess Technology | | | | | |
| | MDE | | | To be chosen from the pool of elective courses of other departments / SWAYAM MOOC courses approved by the department | | | | | |
| 3 | CC | MIB506 | • | Research Approaches in Environmental Toxicology | 2 | 0 | 0 | **2** | CC-9 |
| | | MIB507 | # | Research Practices in Microbial Safety and Sustainability in Food Systems | | | | | |
| | | MIB508 | Δ | Critical Reading and Writing on Enzyme Technology | | | | | |
| 4 | SEC | CLL651 | | Advanced Soft Skills & Aptitude III | 0 | 0 | 1 | **1** | General SEC – 3 |
| 5 | Research | MIB519 | | Research Project Part I* | 0 | 0 | 6 | **12** | RP-1 |
| **Semester Credits** | | | | | | | | **23** | |

| SEMESTER IV | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | SEC | MIB515 | Field Project in Microbiology | 0 | 0 | 2 | **2** | SEC-1 |
| 2 | Research | MIB520 | Research Project Part II** | 0 | 0 | 20 | **20** | RP-2 |
| **Semester Credits** | | | | | | | **22** | |

**For 2 yrs (Research):**

| **Semester** | **1** | **2** | **3** | **4** | **Total** |
|---|---|---|---|---|---|
| **Credits** | 25 | 25 | 23 | 22 | **95** |
| **Total Yearly** | **50** | | **45** | | |

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*The following **four** outcomes must be achieved by the end of III Semester

1. Research Problem identification
2. Review of literature
3. Research design formulation
4. **Phase I** of research (for e.g. Initial phase of research experimentation, completion of pilot project etc.)

**The following **three** outcomes must be achieved by the end of IV Semester

1. **Phase II** of research - Final phase of experimentation/ fieldwork
2. Dissertation/ project report submission
3. Attain **at least one** of the following outcomes:

i. Developed a prototype or product which meets the **Technology Readiness Level 3/4** (TRL-3 or TRL-4) as defined by CSIR
ii. Publication/submission with proof, in Scopus/Equiv. indexed journals #
iii. Patent
iv. Any other scholastic work as recommended by the University R&D Cell and approved by the Academic Council
v. Publication of a book by a reputed publisher (National/International) as recommended by the R&D Cell and approved by the Academic Council.

# Publication must be in Scopus indexed journals and the authors have to be the student concerned and his/her supervisor(s). All PG dissertations should comply with the guidelines set by R&D Cell and duly approved by the Academic Council.

## List of MDE Courses Offered by Dept. of Biological Sciences

| Semester | Course Code | Course Name | Credit Distribution | | | Credits |
|---|---|---|---|---|---|---|
| | | | L | T | P | |
| I | **MIB469** | Biosafety and Bioethics | 3 | 1 | 0 | 4 |
| II | **BIC456** | Indian Traditional Medicine | 3 | 1 | 0 | 4 |
| | **BIC460** | Nutritional Biochemistry and Health Physiology | 3 | 1 | 0 | 4 |
| III | **MIB521** | Biomedical Nanotechnology | 3 | 1 | 0 | 4 |

| | Course-wise Credit Distribution Across Semesters | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | Semester | CC | DSE | MDE | RM | AEC | SEC | CLL | Courses per Semester | Total Credits |
| | | 4 | 4 | 4 | 4 | 2 | 2 | 1 | | |
| *1st Year* | I | 3 | 1 | | 1 | 1 | 1 | 1 | 8 | 25 |
| | II | 3 | 1 | 1 | - | 1 | 1 | 1 | 8 | 25 |
| Exit option with *Post-Graduate Diploma* with credit equivalent to | | | | | | | | | | 50 |
| *2nd Year* | III | CC | CC | DSE | MDE | INT | RP | CLL | *Coursework and Research* | 23 |
| | | 4 | 2 | 4 | 4 | 2 | 6 | 1 | | |
| | | 2 | 1 | 1 | | 1 | 1 | 1 | 7 | |
| | | Any one of the curricular structures to be chosen | | | | | | | | |
| | | CC | CC | DSE | MDE | INT | RP | CLL | *Research* | |
| | | 4 | 2 | 4 | 4 | 2 | 12 | 1 | | |
| | | 1 | 1 | 1 | | - | 1 | 1 | 5 | |
| | | | | | | | | | | |
| | IV | CC | DSE | RP | ENT | | | | *Coursework and Research* | 22 |
| | | 4 | 4 | 12 | 2 | | | | | |
| | | 1 | 1 | 1 | 1 | | | | 4 | |
| | | Continuation of the curricular structure chosen in Semester III | | | | | | | | |
| | | SEC | | RP | | | | | *Research* | |
| | | 2 | | 20 | | | | | | |
| | | 1 | | 1 | | | | | 2 | |
| Total Credits of Program after 2 Years (4 Semesters) | | | | | | | | | | 95 |

| MIB455 | Bacteriology and Eukaryotic Microbiology | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | **V1.2** | **2** | **1** | **1** | **4** |
| **Pre-requisites/Exposure** | **UG level microbiology** | | | | |
| **Co-requisites** | | | | | |

**Course Objectives**

1. To provide those students with apt understanding of microbiology.
2. It will also provide in depth knowledge of bacteriology and archaea
3. It will also offer an outline of eukaryotic microbes
4. In depth understanding of structure-function, and phylogenetics of prokaryotic and eukaryotic microbes

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** the basics of microbial world
CO2 : **Understand** the concepts of microbial ultrastructure and physiology
CO3 : **Apply** techniques of microbial characterization
CO4 : **Analyze** the significance of algae, fungi, and protozoa in health and environment.
CO5 : **Evaluate** the contribution of microbiology to achieving the SDGs.

**Catalogue Description**

This course provides an integrated postgraduate-level understanding of bacteriology and eukaryotic microbiology, emphasizing structure, physiology, genetics, diversity, and ecological significance. The bacteriology component covers bacterial cell organization, growth, metabolism, pathogenicity, antimicrobial action, resistance, and host–microbe interactions, alongside modern molecular approaches to taxonomy and identification. The eukaryotic microbiology component introduces fungi, protozoa, and algae, focusing on cellular organization, life cycles, medical and industrial relevance, and environmental roles. Through theoretical instruction and practical exposure, the course equips students with conceptual clarity and analytical skills essential for research, diagnostics, and applied microbiology.

**Course Content**

**Unit 1 Bacterial Cell Organization and Diversity** **9 hours**

Prokaryotic cell structure: cell wall, cell membrane, cytoskeleton, inclusions, endospores; Bacterial morphology and staining techniques; Bacterial taxonomy, nomenclature, and classification; Molecular approaches in bacterial systematics (16S rRNA, whole genome analysis); Microbial diversity and extremophiles

**Unit 2 Bacterial and Archaeal Physiology, and Metabolism** **9 hours**

Bacterial growth kinetics and cultivation methods, Nutritional requirements and metabolic pathways, Regulation of metabolism and growth kinetics. Outline of fermentation. *Archaea*- classification, adaptation strategies, and application.

**Unit 3 Pathogenicity, Antimicrobials, and Host-Microbe Interaction 9 hours**

Mechanisms of bacterial pathogenicity and virulence factors, Host immune response to bacterial infections, Antimicrobial agents: mode of action and spectrum, Antimicrobial resistance: mechanisms and emerging challenges, Biofilms and quorum sensing

**Unit 4 Genome annotation and analysis 9 hours**

Overview of eukaryotic microorganisms Cell structure and organelles of eukaryotic microbes;
Classification and life cycles of fungi, protozoa, and algae. Reproduction and developmental biology. Molecular tools for identification and phylogeny

**Unit 5 Applied and Medical Eukaryotic Microbiology 9 hours**

Medically important fungi and protozoa – diseases and diagnostics: *Candida*, *Aspergillus*, *Plasmodium*, and *Leishmania*.
Industrially important fungi and algae. Mycotoxins and fungal allergens. Environmental roles of eukaryotic microbes. Emerging trends in eukaryotic microbiology and biotechnology

**Unit 6 Practical 30 hours**

Study of bacterial morphology and arrangement using simple staining, Gram staining, and endospore staining techniques, and to differentiate bacteria based on cell wall characteristics.
Isolation of bacteria from environmental or clinical samples followed by observation of colony morphology and maintenance of pure cultures.
Study of Bacterial Growth Curve
Antibiotic Sensitivity Testing
Morphological and Cultural Characteristics of Fungi
Examination and Identification of Eukaryotic Microorganisms

**Experiential Learning**

1. Case study: identification and industrial application of bacteria
3. Case study: *Naegleria* outbreak in Southern India

**Textbooks**


1. Madigan, M.T., Bender, K.S., Buckley, D.H., Sattley, W.M., and Stahl, D.A. (2025). *Brock Biology of Microorganisms*. 16th Edition. Pearson Education.
2. Willey, J.M., Sandman, K., and Wood, D.H. (2018). *Prescott's Microbiology*. Global Edition. McGraw-Hill Education.


**Reference Books**


1. Cappuccino, J.G. and Welsh, C.T. (2023). *Microbiology: A Laboratory Manual*. 11th Edition. Pearson Education.

**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| Weightage (%) | 10 | 20 | 20 | 50 |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| CO2 | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| CO3 | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| CO4 | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| CO5 | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| Average | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| MIB456 | Bioenergetics and Metabolism | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | **V1.2** | **2** | **1** | **1** | **4** |
| **Pre-requisites/Exposure** | **UG level biology** | | | | |
| **Co-requisites** | **Basics of biochemistry** | | | | |

**Course Objectives**

1. To provide students with a basic understanding of application of thermodynamics in Biology.
2. Understanding of photosynthesis
3. Providing basic concept of carbohydrate and lipid metabolism.
4. In depth concept of electron transport chain.
5. Understanding amino acid and lipid metabolism

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** a foundational understanding of thermodynamic principles in biological systems.
CO2 : **Understand** the physicochemical processes in metabolic pathways
CO3 : **Apply** the concept of energy metabolism to biomolecules
CO4 : **Analyse** the concepts of electron transport chain, oxidative phosphorylation, and anaerobic metabolism.
CO5 : **Evaluate** the contribution of metabolic pathways to systemic physiology.

**Catalogue Description**

The core-course of 'bioenergetics and metabolism' deals with intrinsic laws of thermodynamics in the field of metabolism. The syllabus includes different types of anabolic and catabolic pathways as well as their relation to our lives. Three main classes of biomolecules, *i.e.*, carbohydrates, lipids and protein metabolism have been included in the syllabus for a better understanding of life processes. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will enable the students with problem-solving ability led by the course coordinator. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

**Course Content**

**Unit 1 Biothermodynamics** **9 hours**

Biological thermodynamics: entropy, chemical potential, free energy of reaction biochemical standard state. Biological redox reactions, Energy transformation, Standard redox potentials, Hydrolysis of energy rich intermediates and ATP. Diffusion, Osmotic potential, Transport of solutes across the membrane, Active and Passive transport, Group Translocation, Carrier mediated transport mechanism, thermodynamics of transport process.

**Unit 2 Photosynthesis** **9 hours**

Plank equation, quantum yield, PICS, Photosynthetic pigments, Ultrastructure of reaction centre, arrangements of light harvesting pigments, light reaction & electron flow in photosynthesis, photophosphorylation, CO2 fixation pathways, Photo synthetic microbes and microbial consortia

**Unit 3 Carbohydrate and Lipid Metabolism** **6 hours**

Regulation and energetics of hexose and pentose metabolism. Peptidoglycan synthesis. Specialized metabolic pathways like ED. Glycogen metabolism, Gluconeogenesis. TCA cycle. Beta oxidation of even and odd chain fatty acids. Fatty acid and phospholipid biosynthesis. Cholesterol synthesis.

**Unit 4 Electron Transport Chain and Oxidative Phosphorylation** **12 hours**

Mitochondrial Electron Transport chain and bioenergetics of ETC and oxidative phosphorylation, mechanism of oxidative phosphorylation. Inhibitors of electron Transport chain. Anaerobic respiration: electron transport & bioenergetics, $NO_3$, $SO_4$- electron sink, fermentation, secondary fermentation. Chemolithotrophy: Iron, Carbon, Hydrogen and Sulphur oxidation, Methanotrophy Acetogenesis, Methanogenesis, Anammox, ATP synthesis in Halobacterium.

**Unit 5 Amino acid and Nucleic acid metabolism** **9 hours**

Transamination, oxidative deamination, Decarboxylation of amino acid. Stickland reaction. Urea cycle. Synthesis of Branched chain aliphatic and aromatic amino acids. Glutathione non ribosomal peptide synthesis. Synthesis and degradation of purines and pyrimidines.

**Unit 6 Laboratory Exercises in Metabolism** **30 hours**

Study of Calorimeteric Principles
Determination of Amylase and Urease activity in germinating seeds
Isolation of Starch from Potato and its microscopic observation
Preparation of Starch Agar media from Isolated Starch and identification of amylase producing bacteria
Estimation of Glucose by GOD-POD Assay

**Experiential Learning**

1. Case study: metabolic disorders
2. Drug designing targeting metabolic pathways.

**Textbooks**

1. Voet, Voet, and Pratt (2018)
2. Berg and Stryer (2024), Biochemistry, 10th Edn, Springer Verlag

**Reference Books**

1. Pratt (2024) Essential Biochemistry (International Adaptation, 5th Edn), Wiley
2. Garret Grisham (2023) Biochemistry, (7th Edn), Brooks/ Cole

**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| Weightage (%) | 10 | 20 | 20 | 50 |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| CO2 | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| CO3 | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| CO4 | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| CO5 | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| Average | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| MIB457 | Ecology and Evolution | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | **V1.2** | **3** | **1** | **0** | **4** |
| **Pre-requisites/Exposure** | **UG level biology** | | | | |
| **Co-requisites** | **-** | | | | |

**Course Objectives**

1. Provide students with the scope to develop knowledge base covering all attributes of the environment and enable them to attain scientific/technological capabilities to find answers to the fundamental questions before the society with regards to human action and environmental effects with due diligence.
2. Enhance the ability to apply this knowledge and proficiency to find solutions relating to environmental and ecological concerns of varied dimensions of present times through research activities.
3. Provide with direction and technical capability to carry on collaborative endeavour, and decision making.
4. Help graduates appreciate requirement of framing environmental policy guidelines.
5. Motivate graduates to appreciate that they are an integral stakeholder in the environmental management of India irrespective of their future jobs or working.

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** and identify key concepts and terms related to ecology and evolution such as population dynamics, succession, evolutionary genetics, theories of evolution, and population genetics.

CO2 : **Understand** the fundamental principles of ecology and evolution, including the mechanisms of natural selection, genetic drift, and gene flow.

CO3 : **Apply** ecological and evolutionary concepts to analyze and interpret data related to population dynamics, genetic variation, and evolutionary processes.

CO4 : **Analyze** scientific literature on ecology and evolution to draw conclusions and generate hypotheses related to population dynamics and evolutionary patterns.

CO5 : **Evaluate** and plan research projects to investigate ecological and evolutionary patterns in natural populations.

**Catalogue Description**

The course on Ecology and Evolution' will help understand the basic concept and application of ecological principles and evolutionary approach in biology. This course includes comprehensive approach through studying environmental and population-based analysis. Furthermore, the application of molecular evolution will also be elaborated. All the lectures will be devoted to discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will

enable the students with problem-solving ability led by the course coordinator. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

**Course Content**

**Unit 1 Ecological Principles** **15 hours**

The Environment: Physical environment; biotic environment; biotic and abiotic interactions.
Habitat and niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.
Population ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); the concept of metapopulation – demes and dispersal, intergenic extinctions, age-structured populations.
Species interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.
Community ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones.
Ecological succession: Types; mechanisms; changes involved in succession; the concept of climax.

**Unit 2 Ecosystem and conservation biology** **15 hours**

Ecosystem: Structure and function; energy flow and mineral cycling (CNP); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (freshwater, marine, estuarine). Biogeography: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India. Conservation biology: Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

**Unit 3 Biological, chemical, and molecular evolution** **5 hours**

Lamarckism, Darwinism, Neo-Darwinism, Geological time scale. Synthesis, mutation, Gradualism, and punctured equilibrium. Chemical evolution- theories and experiments. Concepts of molecular and genome evolution.

**Unit 4 Population and behavioral** **15 hours**

Micro evolutionary changes (inter-population variations, clines, races, Species concept, Isolating mechanisms, modes of speciation—allopatric, sympatric, Adaptive radiation / macroevolution (exemplified by Galapagos finches). Founder and bottlenecks. Allelic frequency, Hardy-Weinberg equilibrium and its deviations (models), Instinctive and learning behaviour, Fixed action pattern, Communication in honeybees (dance Language), Elements of Sociobiology: Altruism and selfishness-models. Sexual selection. Microbial ecotypes and analysis.

**Unit 5 Classical and molecular phylogeny** **10 hours**

Convergent, divergent evolution, Morphic characters, Phylogeny from phenotype, Cladogram and phylogram, Multiple sequence alignment, construction of phylogenetic trees, interpretation of trees.

**Experiential Learning**

1. Case study: assessing biodiversity of local environment
2. Articles on chemical and molecular evolution

**Textbooks**

1. PD Sharma (2017) Ecology and Environment, Rastogi
2. Lisa Urry, Michael Cain, Steven Wasserm, Peter Minorsky, Jane Reece (2017), Campbell Biology, Pearson

**Reference Books**

1. Brian K. Hall, Benedikt Hallgrímsson (2013), Strickberger's Evolution, Jones and Bartlett
2. Benjamin A. Pierce (2026), Genetics: a conceptual approach, W H Freeman & Co

**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| Weightage (%) | 10 | 20 | 20 | 50 |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| CO2 | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| CO3 | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| CO4 | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| CO5 | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| Average | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| MIB458 | Computational Biology | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | **V1.2** | **2** | **1** | **1** | **4** |
| **Pre-requisites/Exposure** | **UG level bioinformatics** | | | | |
| **Co-requisites** | **Basics of computer application** | | | | |

**Course Objectives**

1. To provide those students with apt understanding of informatics for biological data.
2. It will also provide in depth knowledge of use of programing language in biology
3. It will also offer an outline of basic prediction methods for evolutionary analysis
4. In depth understanding of structure prediction for biological macromolecules.

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall:** List and describe the basics of programming language
CO2 : **Understand:** Explain the concepts of data base and database management
CO3 : **Apply:** Implement molecular phylogenetic analysis
CO4 : **Analyzing:** Critically analyse and annotate genomes
CO5 : **Create:** Predict protein structure and investigate molecular interactions.

**Catalogue Description**

The course of 'Computational Biology' will help to understand the basic concept and application of computational biology. This course includes comprehensive approach through studying data bases, sequence alignment and phylogenetic analysis. Furthermore, the application of computation structure prediction will also be elaborated. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will enable the students with problem-solving ability led by the course coordinator. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

**Course Content**

**Unit 1 OS and Database** **9 hours**
Relational an object oriented data bases. OS, Codes and languages. Python Basics: Syntax, Variables, Loops. Using Python Libraries: NumPy, Pandas, Simple Data Visualization using Matplotlib

**Unit 2 Databases, servers, and tools** **9 hours**
Data base concept; Database management system; Database browsing and Data retrieval; Sequence database and genome database; Data Structures and Databases; Databases such as GenBank; EMBL; DDBJ; Swissprot; PIR; MIPS; TIGR; Hovergen; TAIR; PlasmoDB; ECDC; Searching for sequence database like FASTA and BLAST algorithm. Alignment (PWA and MSA) tools.

**Unit 3 Molecular Phylogeny** **9 hours**

Scoring matrices, PAM & BLOSUM series of matrices Types of phylogenetic trees, Different approaches of phylogenetic tree construction - UPGMA, Neighbour joining, Maximum Parsimony, Maximum likelihood. Sequence Comparison; Sequence pattern- motifs; Profiles and PSSM; Markov models; Concept of HMMS; Baum-Welch algorithm; Use of profile HMM for protein family classification; Pattern recognition methods. ANN and CNN.

**Unit 4 Genome annotation and analysis** **9 hours**

Gene prediction based on diversity of Genomes: Viral, prokaryotic & eukaryotic genomes, Genome, transcriptome, proteome. Basics of WGS analysis. Genome annotation. Prediction of sequence motifs, domains, and function. GEF files. Annotation tools- GENSAS or equivalent. Gene ontology.

**Unit 5 Structure prediction** **9 hours**

Methods for modelling; Homology and *ab initio* modelling; Threading and protein structure prediction; AlphaFold, Structure-structure comparison of macromolecules with reference to proteins; Force fields; Molecular energy minimization; Monte Carlo and molecular dynamics simulation. Docking, MD-simulation.

**Unit 6 Lab Exercises on Computational Biology** **30 hours**

1. Exploring simple python scripts for data visualization
2. Pairwise and multiple sequence alignment, BLAST, phylogenetic tree preparation.
3. Gene prediction and genome annotation
4. Homology modelling, structure prediction and evaluation of predicted models.
5. Protein-small molecule docking.
6. WGS analysis- GALAXY server

**Experiential Learning**

1. Case study: Variant calling using GALAXY server
3. R-studio and Jupyter Note book- Use

**Textbooks**


1. Xiong Jin (2013). Essential Bioinformatics, , OXFORD
2. Wilson and Walker (2023) Principles and Techniques of Biochemistry and Molecular Biology, CAMBRIDGE


**Reference Books**


1. Agostino (2013). Practical Bioinformatics, Garland Sciences
2. David W. Mount (2004) Bioinformatics: Sequence and Genome Analysis, Second Edition, CSHL

**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| Weightage (%) | 10 | 20 | 20 | 50 |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| CO2 | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| CO3 | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| CO4 | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| CO5 | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| Average | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| MIB461 | Environmental Impact Assessment | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | **V1.0** | **2** | **1** | **1** | **4** |
| **Pre-requisites/Exposure** | UG-level Environmental Microbiology, Ecology, or Environmental Science | | | | |
| **Co-requisites** | Microbial Ecology, Bioremediation, Environmental Biotechnology | | | | |

**Course Objectives**

1. To introduce concepts, methods, and regulations of EIA with relevance to microbial ecosystems.
2. To analyze environmental impacts of microbiological industries and pollution sources.
3. To evaluate microbial roles in bioremediation and their consideration in EIA frameworks.
4. To understand EIA laws and public participation in environmental governance.
5. To build capability in environmental monitoring and report preparation.

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** EIA principles and the microbial role in ecosystem assessments.
CO2 : **Understand** environmental risks associated with microbiological and industrial activities.
CO3 : **Apply** microbial data for environmental prediction and monitoring.
CO4 : **Analyse** bioremediation, bioaccumulation, and biodegradation strategies in environmental impact assessments.
CO5 : **Evaluate** microbial-inclusive EIA reports and critically evaluate environmental mitigation plans.

**Catalogue Description**

This course introduces Environmental Impact Assessment as a regulatory and scientific tool. It emphasizes microbiological perspectives in evaluating and mitigating environmental impacts, especially from waste management, industrial discharges, and biotechnological processes.

**Course Content**

**Unit 1 Introduction to EIA & Microbial Relevance** **8 hours**
EIA concepts, evolution, legal mandates (EPA 1986, EIA Notification 2006); role of microorganisms in soil, water, and air ecosystem functioning; introduction to EIA frameworks.

**Unit 2 Screening, Scoping & Baseline Data Collection** **8 hours**
EIA process steps; microbial parameters in baseline studies (microbial diversity, indicators of pollution); tools for environmental sampling and analysis (CFU count, MPN, metagenomics)

**Unit 3 Impact Prediction and Risk Assessment** **10 hours**
Checklists, matrices, overlays; risk assessment for microbial contamination, pathogenic load in effluents; GMOs and biosafety levels; microbial risk mapping.

**Unit 4 Bioremediation and Mitigation** **9 hours**

Use of microbes in bioremediation of oil spills, pesticides, heavy metals; case studies in industrial waste treatment; EMP with microbiological control.

**Unit 5 EIA Reporting and Case Studies** **10 hours**

Components of a microbiology-relevant EIA report; environmental clearance process; audits; post-project monitoring; case studies from wastewater plants, composting sites, biogas units.

**Unit 6 Laboratory Exercises** **30 hours**

Analysis of microbial diversity indices from baseline environmental datasets used in EIA studies.
Risk assessment modeling of microbial contamination using checklist and matrix approaches.
Simulation of bioremediation potential of microbial consortia for oil- or pesticide-contaminated sites
Comparative evaluation of microbial indicators for potable water quality assessment under EIA guidelines.

**Experiential Learning**

1. Visit to effluent treatment plants or composting units for microbial analysis.
2. Practical: microbial load testing of soil or water samples.
3. Student simulation of EIA report for a biotech or food processing plant.
4. Bioinformatics-based microbial diversity assessment in a polluted environment.

**Textbooks**


1. Canter, L.W. *Environmental Impact Assessment*, McGraw-Hill.
2. Paliwal, R. *Environmental Impact Assessment in India*, LexisNexis.
3. Pandey, G.N. *Environmental Management*, Vikas Publishing.


**Reference Books**


1. Glasson, J. et al. *Introduction to EIA*, Routledge.
2. Mohapatra, P.K. *Textbook of Environmental Microbiology*, I.K. International.
3. Atlas, R.M. & Bartha, R. *Microbial Ecology: Fundamentals and Applications*, Pearson.


**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| Weightage (%) | 10 | 20 | 20 | 50 |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 3 | 2 | - | 2 | 1 | - | - | - | - |
| **CO2** | 3 | 3 | 3 | 3 | 3 | - | 3 | 2 | - | - | - | - |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 1 | 3 | 2 | - | - | - | - |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | - | - | - | - |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | - | - | - | - |
| **Average** | **3** | **3** | **3** | **3** | **3** | **1** | **3** | **2** | - | - | - | - |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| MIB462 | Bioimaging | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | **V1.2** | **2** | **1** | **1** | **4** |
| **Pre-requisites/Exposure** | Basic Biochemistry, Cell Biology, Instrumentation | | | | |
| **Co-requisites** | Molecular Biology, Analytical Techniques | | | | |

**Course Objectives**

1. To introduce students to principles and instrumentation of imaging techniques used in biological systems.
2. To explore qualitative and quantitative applications of bioimaging in microbiology and biochemistry.
3. To develop practical skills in microscopy and image analysis.
4. To understand fluorescent labelling, live-cell imaging, and spectral imaging.
5. To correlate imaging data with biochemical and microbiological experiments

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** the principles and components of different imaging systems.
CO2 : **Understand** various microscopy techniques and their biological applications.
CO3 : **Apply** fluorescent labelling and imaging techniques.
CO4 : **Analyse** the working principles of imaging instrumentation and imaging output.
CO5 : **Evaluate** imaging results in context with biochemical or microbiological data.

**Catalogue Description**

This course covers major imaging techniques including light, fluorescence, confocal, electron, and live-cell microscopy. It emphasizes practical training and the integration of imaging into experimental workflows in microbiology and biochemistry.

**Course Content**

**Unit 1 Fundamentals of Bioimaging** **9 hours**
Resolution, contrast, magnification, numerical aperture. Basic components of microscopes. Sample preparation and staining techniques.

**Unit 2 Light and Fluorescence Microscopy** **9 hours**
Brightfield, phase contrast, DIC microscopy. Principles of fluorescence, fluorophores, filters, labelling strategies. Immunofluorescence and reporter proteins (GFP, RFP).

**Unit 3 Advanced Microscopy Techniques** **9 hours**
Confocal microscopy, TIRF, FRAP, FRET, super-resolution techniques (SIM, STED, STORM). Multicolor and time-lapse imaging.

**Unit 4 Electron and Live-cell Microscopy** **9 hours**

SEM and TEM: sample preparation, resolution limits. Cryo-EM overview. Live-cell imaging: environmental chambers, photo-toxicity, data acquisition.

**Unit 5 Image Analysis and Applications** **9 hours**

Image capture, processing, and analysis. Quantification of signal intensity and colocalization. Software tools (ImageJ, Zen). Applications in diagnostics, drug targeting, and microbiome studies.

**Unit 6 Laboratory Exercises in Bioimaging** **30 hours**

Demonstration of Microscopes and their methodology.

Virtual fluorophore selection and filter-set optimization for multicolor fluorescence imaging experiments.

Theoretical analysis of FRAP and FRET datasets to estimate molecular mobility and interaction efficiency.

Comparison of widefield, confocal, and super-resolution microscopy outputs for the same biological sample.

ImageJ-based in-silico quantification of fluorescence intensity and colocalization from provided bioimaging datasets.

**Experiential Learning**

1. Visit to imaging facilities
2. ImageJ-based analysis of fluorescence data.
3. Immunofluorescence staining and imaging of microbial or tissue samples.

**Textbooks**


1. Murphy, D.B., Davidson, M.W. *Fundamentals of Light Microscopy and Electronic Imaging*. Wiley.
2. Sluder, G., Wolf, D.E. *Digital Microscopy*. Academic Press


**Reference Books**


1. Pawley, J. *Handbook of Biological Confocal Microscopy*. Springer
2. Diaspro, A. *Confocal and Two-Photon Microscopy*. Wiley.


**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| Weightage (%) | 10 | 20 | 20 | 50 |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 2 | 3 | 2 | 2 | 1 | 1 | 2 | 1 | 1 |
| **CO2** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 2 | 1 | 1 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 1 | 1 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 |
| **Average** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 1 | 1 |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| MIB459 | Biostatistics and Research Methodology | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | **1.0** | **2** | **1** | **1** | **4** |
| **Pre-requisites/Exposure** | Basic understanding of biological techniques, statistics, awareness about research and scientific writing. | | | | |
| **Co-requisites** | Preliminary knowledge of biostatistical analyses | | | | |

**Course Objectives**

1. To introduce the fundamentals of research methodology and the role of biostatistics in scientific investigations.
2. To equip students with knowledge of data collection, sampling, statistical analysis, and interpretation methods relevant to microbiology.
3. To familiarize students with ethical considerations and good laboratory practices, including responsible AI integration in research.
4. To develop skills for planning, executing, documenting, and presenting microbiological research, following regulatory and quality standards.
5. To provide hands-on experience in data analysis using modern tools like Excel, R, and SPSS, and develop research planning documents.

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** foundational concepts in research methodology, data types, sampling, and basic biostatistical measures.
CO2 : **Understand** hypothesis testing, statistical inference, and the integration of AI tools in research and data analysis.
CO3 : **Apply** ethical principles and responsible use of AI in research planning, proposal development, and microbiological data management.
CO4 : **Analyse** research data using biostatistical tools and assess compliance with laboratory standards, GLP, and quality systems.
CO5 : **Evaluate** research findings, formulate scientific reports, and propose AI- and GMP-compliant methodologies in microbiology research.

**Catalogue Description**

This course introduces postgraduate microbiology students to the principles and practices of research methodology and biostatistics, with a focus on scientific inquiry, data analysis, and ethical research conduct. Topics include research design, hypothesis formulation, sampling techniques, statistical testing, and data interpretation using tools like Excel, R, and SPSS. Emphasis is placed on Good Laboratory Practices (GLP), quality management systems, and responsible use of AI in research planning and analysis. Students gain hands-on experience in preparing research proposals, performing statistical evaluations, and ensuring compliance with national and international regulatory standards relevant to microbiology and allied interdisciplinary fields.

**Course Content**

**Unit 1 Foundations of Research and Biostatistics 10 hours**

Introduction to research; Research process and problem formulation; Literature review; Research objectives and hypothesis; Data types and sources; Sampling and data collection; Reliability and bias; Graphical and statistical analysis; Probability and probability distributions

**Unit 2 Hypothesis Testing, Statistical Inference, and AI Tools 8 hours**

Hypothesis testing and statistical errors; Comparative statistical methods; Correlation and regression analysis; Inference in biological data; AI applications in data analysis; AI-assisted modelling and literature mining; Responsible use of AI in research

**Unit 3 Research Design, Ethics, and Responsible AI Use 10 hours**

Research design and sampling strategies; Data planning and analysis; Ethics in scientific research; AI in research planning and evaluation; Ethical frameworks and guidelines; Research documentation and reporting

**Unit 4 Laboratory Standards and Good Practices 9 hours**

Good Laboratory Practice and regulatory frameworks; Quality systems and compliance standards; Laboratory documentation and audits; Automation and digital systems in laboratories; AI integration in laboratory operations and data integrity

**Unit 5 Distribution, Validation, and Quality Management Systems 8 hours**

Good Distribution Practices and global standards; Quality management frameworks; Change control and deviation handling; Validation types and qualification protocols; Analytical and utility validation; Regulatory compliance and documentation

**Unit 6 Experiments in Biostatistics and Research Methodology 30 hours**

Data collection, visualization, and analysis using MS Excel, R, and SPSS
Statistical hypothesis testing: t-test, ANOVA, correlation, regression
Sample size and power calculation using open-source software
Creation of GLP-compliant documentation and standard operating procedures
Quality audit simulation, software validation checklist preparation

**Experiential Learning**

1. Design and peer-review of mini research proposals
2. Literature review and citation using Zotero/Mendeley
3. Case studies: Research misconduct, AI bias, ethical violations
4. Use of AI tools (e.g., ChatGPT, Scite.ai, Elicit.org, ResearchRabbit) for literature mining, question formulation, experimental design

**Online Resources and Textbooks**

1. NPTEL Course. *Biostatistics and Design of Experiments*. IIT Kharagpur / IIT Madras.
2. MIT OpenCourseWare. *Quantitative Research Methods* (and AI Tools in Science).

3. Zar, J.H. (2010). *Biostatistical Analysis*. 5th Edition. Pearson Education.
4. NABL India. *ISO/IEC 17025 & 15189 Related Documents*.

**Supplementary Resources**

1. World Health Organization (WHO). *Good Laboratory Practice (GLP): Quality Practices for Regulated Non-Clinical Research and Testing*.
2. UNESCO. *Ethics of Artificial Intelligence*.
3. INFLIBNET e-PG Pathshala. *Research Methodology*
4. HarvardX. *Principles, Statistical and Computational Tools for Reproducible Science*.

**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| **Weightage (%)** | **10** | **20** | **20** | **50** |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 1 | 2 | 1 |
| **CO2** | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 1 |
| **CO3** | 3 | 2 | 2 | 3 | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 2 |
| **CO4** | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 1 | 2 | 2 | 2 | 2 |
| **CO5** | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 2 |
| **Average** | 3 | 2 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 3 | 2 |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| MIB460 | Drug-Design and Development | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | **2.0** | **2** | **0** | **0** | **2** |
| **Pre-requisites/Exposure** | Basic Biochemistry, Molecular Biology, Organic Chemistry | | | | |
| **Co-requisites** | | | | | |

**Course Objectives**

1. Introduce the fundamental concepts of drug discovery and development.
2. Understand the phases of drug design, preclinical and clinical testing.
3. Study rational drug design approaches using molecular modeling.
4. Explore the role of pharmacodynamics, pharmacokinetics, and ADMET in drug design.
5. Discuss regulatory frameworks, ethics, and case studies in modern drug development.

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** the principles and stages of drug discovery and development.
CO2 : **Understand** drug-target interactions and lead identification techniques.
CO3 : **Apply** computational and experimental tools for rational drug design.
CO4 : **Analyse** ADMET properties and optimize candidate molecules.
CO5 : **Evaluate** regulatory pathways, ethical considerations, and real-world applications.

**Catalogue Description**

This course introduces the principles and modern practices of drug discovery, covering target identification, lead discovery, and rational drug design. It emphasizes preclinical development, ADMET profiling, and regulatory aspects, with special focus on biologics and biosimilars. Students gain an integrated understanding of contemporary pharmaceutical research pipelines.

**Course Content**

Unit 1 **Fundamentals of Drug Discovery** **5 hours**

Definition, scope, and significance of drug discovery, Historical perspective of drug development (e.g., penicillin, aspirin), Types of therapeutic agents: small molecules, biologics, peptides, natural products, Overview of modern drug discovery pipeline: from target identification to launch Stages of drug development: discovery, preclinical, clinical, and post-marketing, Success rate and cost of new drug discovery

**Unit 2 Target Identification and Validation** **5 hours**

Biological targets: enzymes, receptors, ion channels, transporters, nucleic acids, Genomic, transcriptomic, and proteomic approaches, Disease-gene association techniques (GWAS, knock-out models), Target validation techniques: siRNA, CRISPR/Cas9, transgenic animals, Criteria for an ideal drug target (specificity, druggability, etc.), Phenotypic vs target-based drug discovery

**Unit 3 Lead Identification and Optimization** **5 hours**

Compound libraries: natural product libraries, combinatorial chemistry libraries, High-throughput screening (HTS): methodology, instrumentation, hit identification, Hit-to-lead process: selection, confirmation, and optimization, Structure-Activity Relationship (SAR) studies, Lead optimization: improving potency, selectivity, solubility, metabolic stability Fragment-based and diversity-oriented synthesis

**Unit 4 Drug Design Strategies** **5 hours**

Rational drug design vs empirical screening, Structure-Based Drug Design (SBDD): use of crystal structures, molecular docking, Ligand-Based Drug Design (LBDD): pharmacophore modeling, QSAR, Role of AI/ML in drug discovery, Case studies of successful rational drug design, In silico ADMET prediction tools

**Unit 5 Preclinical Development** **5 hours**

In vitro testing: biochemical assays, cell-based assays, In vivo models: animal models for efficacy and toxicity testing, ADMET profiling: absorption, distribution, metabolism, excretion, and toxicity, Pharmacokinetics (PK) and pharmacodynamics (PD), Safety pharmacology and toxicological studies, GLP and regulatory requirements for preclinical data

**Unit 6 Biologics and Biosimilars** **5 hours**

Introduction to biologics and their therapeutic significance, Concept and definition of biosimilars, Distinctions between biosimilars and generic drugs, Types of biologics such as monoclonal antibodies, recombinant proteins, gene and cell therapies, Key differences between biologics and small-molecule drugs, Production of biologics including expression systems and bioprocessing, Purification and characterization techniques used in biologic manufacturing

**Experiential Learning**

1. Use of software tools for molecular docking and pharmacophore design
2. Simulated ADMET prediction exercises
3. Analyzing clinical trial protocols and data
4. Case study discussion on approved drugs (e.g., Imatinib, Remdesivir)

**Textbooks**


1. Patrick, G.L. *An Introduction to Medicinal Chemistry*, Oxford University Press
2. Silverman, R. *The Organic Chemistry of Drug Design and Drug Action*, Elsevier
3. Burger's *Medicinal Chemistry and Drug Discovery* (Vol. 1–6), Wiley
4. Nogrady, T. & Weaver, D. *Medicinal Chemistry: A Molecular and Biochemical Approach*, Oxford


**Reference Books**


1. Smith, C.G., *Drug Discovery: A History*, Wiley
2. Hughes, J. & Rees, S., *Drug Discovery: Practices, Processes, and Perspectives*, Wiley
3. Wermuth, C.G., *The Practice of Medicinal Chemistry*, Elsevier
4. FDA & ICH Guidelines for Clinical Trials and Drug Approval

**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| **Weightage (%)** | **10** | **20** | **20** | **50** |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 1 | 1 | 2 | 1 | 2 | – | – | – | 1 | – |
| **CO2** | 2 | 3 | 2 | 2 | 2 | 2 | 2 | – | – | – | 1 | – |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | – | 1 | 1 | 1 | – |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | – | 1 | 1 | 2 | – |
| **CO5** | 1 | 2 | 1 | 1 | 2 | 3 | 1 | 2 | 3 | 2 | 3 | 2 |
| **Average** | 2.2 | 2.6 | 2.0 | 2.0 | 2.4 | 2.2 | 1.8 | 2.0 | 1.7 | 1.3 | 1.6 | 2.0 |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| MIB463 | Virology | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | **2.0** | **2** | **1** | **1** | **4** |
| **Pre-requisites/Exposure** | Basic Knowledge in biology | | | | |
| **Co-requisites** | | | | | |

**Course Objectives**

1. **Explain** foundational knowledge of viral structure, classification, replication, and pathogenesis.
2. **Analyze** the role of major families of DNA and RNA viruses in human diseases.
3. **Understanding** of clinical manifestations, diagnosis, and management of viral infections across organ systems**.**
4. **Explain** the principles of viral immunology, epidemiology, outbreak investigation, and control measures.
5. **Demonstrate** practical knowledge of diagnostic virology, antiviral agents, biosafety practices, and resistance mechanisms.

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** the structure, classification, and replication strategies of DNA and RNA viruses.
CO2 : **Understand** the mechanisms of viral pathogenesis, immune responses, and the evolution of viruses in human hosts.
CO3 : **Apply** knowledge of major virus families to correlate viral characteristics with associated human diseases.
CO4 : **Analyse** principles of clinical virology and epidemiology to diagnose and interpret viral infections and outbreak scenarios.
CO5 : **Evaluate** diagnostic techniques, antiviral strategies, and biosafety protocols, and **design** appropriate laboratory or public health responses.

**Catalogue Description**

This course offers an in-depth study of viruses, emphasizing their structure, classification, replication, and interaction with the host immune system. It covers the biology of major DNA and RNA virus families, their epidemiology, and the clinical manifestations of viral infections affecting various organ systems. Students will gain insight into viral pathogenesis, immunological responses, diagnostic methods, antiviral therapies, and resistance mechanisms along with molecular genetics of phage systems. The course also addresses biosafety, outbreak investigation, and the public health relevance of emerging and re-emerging viral diseases. Practical components include diagnostic techniques and laboratory safety protocols essential for handling viral pathogens.

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**Course Content**

**Unit 1 Fundamentals of Virology** **7 hours**

Principles of virology, beginning with the structure and classification of viruses, including the Baltimore classification scheme, mechanisms of viral replication for both DNA and RNA viruses, emphasizing differences in their strategies and enzymes involved, concepts of viral pathogenesis and evolution,

immune responses mounted by the host against viral infections, introduction to bacteriophages and their biological and therapeutic relevance.

**Unit 2 Major DNA and RNA virus families that infect humans 7 hours**

Major characteristics of the following virus families: Adenoviridae, Bromoviridae, Bunyaviridae, Caulimoviridae, Flaviviridae, Geminiviridae, Hepadnaviridae, Herpesviridae, Orthomyxoviridae, Paramyxoviridae, Parvoviridae, Picornaviridae, Potyviridae, Poxviridae, Reoviridae, Retroviridae, Rhabdoviridae, Virgaviridae.

**Unit 3 Bacteriophages and sub-viral agents 12 hours**

Bacteriophages: Biology of major RNA (MS2, Qβ) and DNA (T4, lambda, Øx174, M13) bacteriophages, replication of M13, T4 and lambda phages; biology of cyanophages. Algal and fungal viruses: Biology of viruses of Phycodnaviridae, Partitiviridae and Totiviridae. Biology of sub-viral agents: Satellite viruses, sat-RNAs, DI particles, viroids, virusoids and prions.

**Unit 4 Viral epidemiology 7 hours**

Principles of epidemiology as applied to viral infections, outbreak preparedness and investigation, and strategies for prevention and control, emerging and re-emerging viruses, vector-borne viral infections and their control. The unit includes biosafety protocols, hospital infection control measures, use of personal protective equipment, and biomedical waste management.

**Unit 5 Viral Genetics 12 hours**

Phage mutants, recombination in phages, fine-structure mapping of T4 *rII* locus; Evolution in RNA viruses: The potential for rapid evolution in RNA viruses, recombination and reassortment, evolution of Influenza virus. Lambda and T4 genetics.

**Unit 6 Laboratory Exercises in Virology 30 hours**

Detection of bacteriophages from environmental water samples using the plaque assay method
Isolation and purification of bacteriophages by serial dilution and plaque picking technique
Estimation of bacteriophage titer (PFU/mL) using double-layer agar method
Study of lysogenic induction in bacteria using UV induction
Host range determination of bacteriophages using spot assay on different bacterial strains
Demonstration of bacteriophage resistance and mutation in host bacteria through plaque morphology variation

**Experiential Learning**

1. Case Studies of emerging viruses
2. Mutation profile study of RNA viruses

**Textbooks**


1. Dimmock, N.J., Easton, A.J., and Leppard, K.N. (2021). *Introduction to Modern Virology*. 8th Edition. Wiley-Blackwell.
2. Knipe, D.M. and Howley, P.M. (2020). *Fields Virology*. 7th Edition. Wolters Kluwer / Lippincott Williams & Wilkins.

3. Ptashne, M. (2004). *A Genetic Switch: Phage Lambda and Higher Organisms*. 2nd Edition. Cold Spring Harbor Laboratory Press.
4. Greenwood, D., Slack, R., Barer, M., and Irving, W. (2017). *Medical Microbiology*. 19th Edition. Elsevier Ltd.

**Reference Books**

1. White, D.O. and Fenner, F.J. (2020). *Medical Virology*. 5th Edition. Academic Press.
2. Sanford, C. and Cohen, J. (2016). *A Clinical Guide to Viral Infections*. 2nd Edition. Oxford University Press.

**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| Weightage (%) | 10 | 20 | 20 | 50 |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| CO2 | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| CO3 | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| CO4 | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| CO5 | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| Average | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| MIB464 | Molecular Genetics | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | **1.0** | **2** | **1** | **1** | **4** |
| **Pre-requisites/Exposure** | UG-level Genetics | | | | |
| **Co-requisites** | Molecular Biology and Biostatistics | | | | |

**Course Objectives**

1. To provide insights into the structural and functional organization of genomes.
2. To understand DNA damage, repair, recombination, and horizontal gene transfer.
3. To study inheritance patterns through classical and molecular genetic techniques.
4. To study inheritance patterns through classical and molecular genetic techniques.
5. To introduce contemporary techniques in genome capture and gene manipulation.

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** microbial and eukaryotic genome organization, maintenance, and sequencing.
CO2 : **Understand** mechanisms of DNA damage, repair, and recombination.
CO3 : **Apply** classical inheritance patterns, genetic linkage, and chromosomal aberrations.
CO4 : **Analyse** Hardy-Weinberg principles and population genetics models to biological data.
CO5 : **Evaluate** the use of advanced tools such as ChIP and chromosome conformation capture for genomic studies.

**Catalogue Description**

This course provides an integrated understanding of classical and molecular genetics, emphasizing genome organization, maintenance, inheritance, and variation in microbial and eukaryotic systems. It covers DNA damage and repair, recombination, horizontal gene transfer, chromosomal architecture, and population genetics. Students are introduced to modern genomic and epigenomic tools such as chromosome conformation capture and ChIP-based approaches. Through a balanced combination of theory, laboratory exercises, and in silico analyses, the course develops conceptual clarity and analytical skills essential for research in genetics, genomics, biotechnology, and biomedical sciences.

**Course Content**

**Unit 1 Genome Structure and Maintenance** **9 hours**
Microbial genomes, extra-chromosomal elements, chromosomal organization, genome sequencing technologies, genome maintenance mechanisms, overview of eukaryotic genome organisation.

**Unit 2 Chromosomal Architecture and Aberrations** **9 hours**
Structural and numerical chromosomal aberrations, chromosome capture techniques (CHIP, 3C, Hi-C), chromatin structure and epigenetic regulation, TADs in eukaryotic nucleus.

**Unit 3 DNA Damage, Repair, and Recombination** **9 hours**

Types of DNA damage, repair mechanisms (BER, NER, MMR), homologous and site-specific recombination, transposition, recombinase systems.

**Unit 4 Horizontal Gene Transfer and Applications** **9 hours**

Transformation, conjugation, transduction, classical experiments in microbial genetics (e.g., Griffith, Avery, Lederberg), applications in genome editing.

**Unit 5 Classical and Population Genetics** **9 hours**

Mendelian inheritance, allelic relationships, mono/dihybrid crosses, pedigree analysis, linkage and gene mapping, tetrad analysis, Hardy-Weinberg equilibrium, mutation, selection, gene flow, drift, genetic diversity in human populations.

**Unit 6 Laboratory Exercises in Molecular Genetics** **30 hours**

Development of Replica and Master plate.
Understanding the effect of UV as a mutagen on bacterial cells.
Observation of the survival curve of bacteria post UV exposure.
Study of Bacterial transformation and conjugation.
Lysogenic induction using UV.

**Experiential Learning**

1. Pedigree construction and analysis (case-based).
2. DNA mutation and repair simulation using bioinformatics tools.
3. Population genetics simulation using Hardy-Weinberg calculators.
4. CHIP-seq data interpretation using ENCODE genome browser.

**Textbooks**


1. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., and Doebley, J. (2020). *An Introduction to Genetic Analysis*. 12th Edition. W.H. Freeman and Company.
2. Snustad, D.P. and Simmons, M.J. (2016). *Principles of Genetics*. 7th Edition. Wiley.
3. Hartl, D.L. and Ruvolo, M. (2012). *Genetics: Analysis of Genes and Genomes*. 8th Edition. Jones & Bartlett Learning.


**Reference Books**


1. Lewin, B. (2017). *Genes XII*. 12th Edition. Jones & Bartlett Learning.
2. Weaver, R.F. (2011). *Molecular Biology*. 5th Edition. McGraw-Hill Education.
3. Henkin, T.M. and Peters, J.E. (2020). *Molecular Genetics of Bacteria* (Snyder & Champness). 4th Edition. John Wiley & Sons, Hoboken, NJ.

**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| Weightage (%) | 10 | 20 | 20 | 50 |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| CO2 | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| CO3 | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| CO4 | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| CO5 | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| Average | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| MIB465 | Applied Molecular Biology | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | **1.0** | **2** | **1** | **1** | **4** |
| **Pre-requisites/Exposure** | Knowledge of Molecular Biology and Gene Manipulation at undergraduate level | | | | |
| **Co-requisites** | | | | | |

**Course Objectives**

1. To provide an advanced understanding of genome architecture, epigenetics, and molecular evolution.
2. To explain mechanisms of DNA replication, repair, transcription, translation, and their regulation in prokaryotic and eukaryotic systems.
3. To introduce modern tools and applications of recombinant DNA technology, genome editing, and synthetic biology.
4. To develop hands-on skills in molecular biology techniques and computational analysis.
5. To train students to critically evaluate and apply molecular biology approaches in microbiology, health, agriculture, and biotechnology.

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** advanced concepts of genome organization, gene regulation, and molecular mechanisms.
CO2 : **Understand** principles of replication, transcription, translation, and regulatory networks in microbial and higher systems.
CO3 : **Apply** molecular biology techniques to microbiological problems.
CO4 : **Analyse** experimental data and regulatory models (operons, phage lambda switches, RNA–protein interactions) using molecular logic.
CO5 : **Evaluate** and integrate recombinant DNA technology approaches for applications in health, agriculture, and industrial microbiology.

**Catalogue Description**

This course provides an advanced understanding of genome architecture, gene regulation, and molecular mechanisms in prokaryotic and eukaryotic systems. It integrates DNA replication, transcription, translation, protein homeostasis, and regulatory networks with cutting-edge recombinant DNA technology, genome editing, and synthetic biology. With emphasis on computational and analytical approaches, the course equips students for innovative research in microbiology and its applications in health, agriculture, and industry, preparing them to translate molecular insights into impactful solutions.

**Course Content**

**Unit 1 DNA Replication and its applications** **9 hours**

Prokaryotic and eukaryotic replication, DNA polymerases and engineered variants; Enzymology of replication; *in vitro* replication (PCR) and its use in diagnostics and gene manipulation

**Unit 2 Transcriptional Regulation and RNA Biology** **9 hours**

Regulatory regions and transcription factors, chromatin-based regulation; prokaryotic and eukaryotic transcription mechanisms; RNA maturation; regulatory RNAs; transcriptome analysis; RNA degradation; promoter and enhancer vectors, *in vitro* transcription and its use in molecular biology

**Unit 3 Translation and Protein Homeostasis** **9 hours**

Ribosome structure and translation regulation; post-translational modifications; protein folding; overview of protein trafficking; protein-protein interactions (yeast two-hybrid and three-hybrid, Co-IP; GST-pulldown); protein degradation pathways (ubiquitin-proteasome, autophagy); *in situ* protein localisation

**Unit 4 Regulation of Gene Expression** **9 hours**

Regulation of Gene Expression in Bacteria (Operons) and Phage (Lambda); Concepts of Promoter engineering; expression vectors and fusion tags; Recombinant protein expression in bacteria, yeast and mammalian systems and their regulation

**Unit 5 Molecular Engineering and Applications in Health and Industry** **9 hours**

Advanced cloning strategies; Applications of PCR based and hybridization-based techniques in medical, environmental and industrial microbiology; protein engineering, directed evolution; genome editing; applications in health, industry, agriculture, personalized medicine.

**Unit 6 Laboratory Exercises in Applied Molecular Biology** **30 hours**

Renaturation kinetics: comparison of prokaryotic *vs*. eukaryotic DNA.
Isolation and induction of temperate phage from environmental samples.
Isolation of RNA and analysis by RT-PCR/qPCR.
Demonstration of PCR variants.
Bioinformatics/computational analysis of DNA–protein and RNA–protein interactions.

**Experiential Learning**

1. Literature Analysis of Antibiotic Resistance Operons in AMR
2. Linking Plasmid–Chromosome Interactions in Pathogenic Bacteria

**Textbooks**


1. Weaver, R.F. (2011). *Molecular Biology*. 5th Edition. McGraw-Hill Education.
2. Tropp, B.E. (2012). *Molecular Biology: Genes to Proteins*. 4th Edition. Jones & Bartlett Learning.
3. Primrose, S.B. and Twyman, R.M. (2013). *Principles of Gene Manipulation and Genomics*. 8th Edition. Wiley-Blackwell.
4. Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., and Amon, A. (2016). *Molecular Cell Biology*. 9th Edition. W.H. Freeman and Company.


**Reference Books**


1. Ptashne, M. (2004). *A Genetic Switch: Phage Lambda and Higher Organisms*. 2nd Edition. Cold Spring Harbor Laboratory Press.
2. Voet, D. and Voet, J.G. (2011). *Biochemistry*. 4th Edition. Wiley.

3. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., and Walter, P. (2014). *Molecular Biology of the Cell*. 6th Edition. Garland Science.

**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| **Weightage (%)** | **10** | **20** | **20** | **50** |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 1 | 2 | 2 | 1 | 3 | 1 | 1 | 1 | 1 | 1 |
| **CO2** | 2 | 3 | 1 | 2 | 2 | 1 | 3 | 1 | 1 | 1 | 1 | 1 |
| **CO3** | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 |
| **CO4** | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 |
| **CO5** | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 1 | 1 | 2 | 2 | 3 |
| **Average** | 2.6 | 2.6 | 1.8 | 2.4 | 2.4 | 1.8 | 2.4 | 1.0 | 1.0 | 1.2 | 1.2 | 1.4 |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| MIB466 | Infection Biology and Immunology | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | **2.0** | **2** | **1** | **1** | **4** |
| **Pre-requisites/Exposure** | **Basic knowledge of microbiology and life science** | | | | |
| **Co-requisites** | **-** | | | | |

**Course Objectives**

1. To provide those students with apt understanding of innate and adaptive immunity and mechanism by which the pathogens invade our immune system
2. It will also provide in depth knowledge about antigen-antibody interaction and their effects together with the function of complement system and MHC molecules.
3. Students will be able to elaborate organization and expression pattern of components of immune system and the medical conditions that may arise due to anomaly in expression of components of immune system.
4. Students will be proficient in application of various immunologic techniques in the field of research and medical science.
5. To provide information about the pathomechanism of different infectious diseases and the strategy to combat them.

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recognize** the components and steps of the immune response.
CO2 : **Explain** the interaction between antigens and antibodies
CO3 : **Apply** knowledge of antigens and antibodies in diagnosing and treating immunological disorders
CO4 : **Analyse** the effectiveness of different antigens in eliciting immune responses.
CO5 : **Evaluate** the effectiveness of immune responses in combating infections and diseases.

**Catalogue Description**

The core-course of 'immunology and infection biology' will help to understand the classification, components and organization of components of immune system and the strategy by which pathogens overcome its effect in causing diseases. This course comprehends the function of all components of immune system and effect of different form of interactions of antibodies, complement components, cytokines in response to invasion of antigen. Furthermore, the application of immune system in carcinogenesis, therapeutics and gene delivery would also be illuminated. Medical conditions arising from malfunctioning of one or more component of immune system would also be illustrated. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will enable the students with problem-solving ability led by the course coordinator. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

**Course Content**

**Unit 1 Introduction to Innate & adaptive immunity and its role in Infection 10 hours**

Concept of Innate and Adaptive immunity;

Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co- stimulatory signals); Killing Mechanisms by CTL and NK cells, Immune to tolerance, graft rejection. Microbial flora of healthy human body. Fundamentals of host pathogen interaction. Opportunistic infections, Nosocomial infections. Transmission of infection, PAMP and Pathophysiologic effects of LPS and exotoxins.

Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT, hematopoietic stem cells

**Unit 2 Antigens-antibody and their interaction and Complement System 12 hours**

Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T & B cell epitopes); T-dependent and T-independent antigens; Adjuvants – complete and incomplete.

Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic); VDJ rearrangements; Monoclonal and Chimeric antibodies.

Organization of MHC locus (Mice & Human); Structure and Functions of MHC I & II molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways), isotype switching, affinity maturation Components of the Complement system; Activation pathways (Classical, Alternative and Lectin pathways); Biological consequences of complement Activation

**Unit 3 Infection Biology 7 hours**

Bacterial pathogens and virulence determinants. Major infectious bacterial disease Tuberculosis, typhoid, and Cholerae. Virus infection – HIV, HSV, and Hepatitis B. Protozoan parasites- Malaria and Leishmania, Fungal diseases- Candidiasis and Histoplasmosis. Antimicrobial chemotherapy and drug resistance. Emerging and re-emerging infectious diseases. Antimicrobial resistance (AMR). Immunoprophylaxis: Types of vaccines (live, attenuated, subunit, DNA, mRNA, etc.) Vaccine development and delivery systems.

**Unit 4 Immunological Techniques 8 hours**

Immunological assays: Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Western blotting, Immunofluoresence, Flow cytometry, Immunoelectron microscopy.

**Unit 5 Immunological Disorders 8 hours**

Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies - Animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak- Higashi syndrome, Leukocyte adhesion deficiency, CGD; Types of tumors, tumor Antigens, causes and therapy for cancers.

**Unit 6 Practical application of Immunology 30 hours**

Identification of human pathogens from oral, skin and faecal samples and assessment of antimicrobial activity of antibiotics against them.

To perform ELISA with microorganisms isolated.

Separation of serum from the blood sample (demonstration).

Immunodiffusion and Immunoelectrophoresis.

**Experiential Learning**

1. Analyze patient case studies to identify the type of hypersensitivity, interpret symptoms, and propose diagnostic methods.
2. Analyze patient case studies to identify the type of autoimmunity, interpret symptoms, and propose diagnostic methods.
3. Design and Critique of Vaccine Strategies.

**Textbooks**

1. Goldsby, R.A., Kindt, T.J., and Osborne, B.A. (2007). *Kuby's Immunology*. 6th Edition. W.H. Freeman and Company, New York.
2. Abbas, A.K., Lichtman, A.H., and Pillai, S. (2007). *Cellular and Molecular Immunology*. 6th Edition. Saunders Elsevier, Philadelphia.

**Reference Books**

1. Delves, P.J., Martin, S.J., Burton, D.R., and Roitt, I.M. (2006). *Roitt's Essential Immunology*. 11th Edition. Wiley-Blackwell, Oxford.
2. Murphy, K., Travers, P., and Walport, M. (2008). *Janeway's Immunobiology*. 7th Edition. Garland Science, New York.

**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| **Weightage (%)** | **10** | **20** | **20** | **50** |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | - | 3 |
| **CO2** | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | - | 3 |
| **CO3** | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | - | 3 |
| **CO4** | | 3 | 2 | 3 | 3 | 3 | - | 3 | - | - | 3 | 3 |
| **CO5** | | 3 | 2 | 3 | 3 | 3 | - | 3 | - | - | 3 | 3 |
| **Average** | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 3 | 3 |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| MIB468 | Host-pathogen Interaction | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | **1.0** | **2** | **1** | **1** | **4** |
| **Pre-requisites/Exposure** | Fundamentals of Microbiology at B.Sc. level | | | | |
| **Co-requisites** | Knowledge of Microbiological Techniques | | | | |

**Course Objectives**

1. To introduce the fundamental concepts of the human microbiome and its diversity across body sites.
2. To understand the role of microbiome in foetal development and early life.
3. To study physiological functions and systemic integration of microbiota in human health.
4. To explore beneficial microbiome-host interactions and preventive potential.
5. To evaluate dysbiosis and emerging microbiome-based therapeutic strategies.

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** fundamental microbiome concepts, terminology, and methodologies.
CO2 : **Understand** the microbiome's role in development, physiology, and health.
CO3 : **Apply** microbiological and bioanalytical techniques for microbiome study.
CO4 : **Analyse** microbiome data to interpret health implications and microbial functions.
CO5 : **Evaluate** microbiome-targeted therapies and ethical considerations in research.

**Catalogue Description**

This course provides an in-depth study of the human microbiome, emphasizing its composition, development, and physiological roles in maintaining health. Topics include early-life microbial colonization, host–microbe interactions, immune modulation, metabolic functions, and the gut-brain axis. Students explore beneficial applications such as probiotics and synbiotics, mechanisms of colonization resistance, and microbiome-driven disease prevention. The course also covers dysbiosis, emerging microbiome-based therapies, and associated ethical issues. Practical sessions train students in microbiome sampling, culture techniques, and functional assays, integrating microbiology with interdisciplinary biomedical sciences.

**Course Content**

**Unit 1 Introduction to the Human Microbiome** **8 hours**

Definition and terminology; Historical milestones in microbiome research; Microbiome composition and diversity across body sites; Overview of analytical methods; Global initiatives including the Human Microbiome Project

**Unit 2 Foetal Programming and Early-Life Microbial Colonization** **10 hours**

Prenatal microbial exposure and maternal influence; Placental and intrauterine microbiome; Role of delivery mode, feeding, antibiotics, and hospital environment in early colonisation; Microbial programming of immune and metabolic pathways; Links to allergic, autoimmune, and neurodevelopmental disorders

**Unit 3 Physiological Integration and Functional Roles** **9 hours**

Gut microbiota in digestion, nutrient absorption, and energy harvesting; Vitamin synthesis (e.g., B-complex, K); Development and modulation of the immune system by microbiota; Role of skin microbiome in barrier function; Microbiome in endocrine regulation and hormonal signaling; Gut-brain axis and microbial neurochemistry; Role in host metabolic regulation and energy balance.

**Unit 4 Health-Promoting Interactions and Preventive Potential** **9 hours**

Probiotics, prebiotics, and synbiotics; Colonisation resistance and microbial exclusion of pathogens; Diet–microbiome interactions; Regulation of inflammation and oxidative stress; Microbiome in allergy prevention and mental health

**Unit 5 Dysbiosis, Emerging Therapies, and Future Frontiers** **9 hours**

Concept and causes of dysbiosis; Microbiome-associated diseases and drug interactions; Faecal microbiota transplantation (FMT); Next-generation probiotics, postbiotics, and microbiome editing; Personalised microbiome therapeutics; Ethical and regulatory aspects

**Unit 6 Experiments in Microbiome Analyses** **30 hours**

Microbiota Sampling and Culture from Human Body Sites
Assessment of Colonization Resistance Using Human-Associated Microbiota Isolates
Biofilm Formation by Commensal Isolates Derived from Human Microbiota Samples
pH and Bile Salt Tolerance Assay (Survival of Probiotics)
Effect of Antimicrobials (commercial mouthwash, herbal ointments) on Microbiome Cultures

**Experiential Learning**

1. Analyses of possible therapeutic interventions and microbiome restoration strategies in clinical case reports or datasets related to microbiome imbalance in disorders such as IBD, obesity, or allergies.
2. Conceptual proposal for a probiotic, prebiotic, or synbiotic product targeting a specific health condition.

**Textbooks**


1. Greenwood, D., Slack, R.C.B., Peutherer, J.F. and Barer, M.R. (2012). *Medical Microbiology*. 18th Edition. Elsevier Churchill Livingstone, Edinburgh.
2. Jawetz, E., Melnick, J.L. and Adelberg, E.A. (2013). *Medical Microbiology*. 26th Edition. McGraw-Hill Education, New York.
3. Hill, C., Guarner, F., Reid, G., Gibson, G.R., Merenstein, D.J., Pot, B., Morelli, L., Canani, R.B., Flint, H.J., Salminen, S. and Sanders, M.E. (2019). *The International Scientific Association for Probiotics and Prebiotics (ISAPP): Probiotics, Prebiotics and Synbiotics – Definitions, Applications, and Guidelines*. Springer, Cham.

**Reference Books and Review Articles**


1. Gilbert, J.A., Blaser, M.J., Caporaso, J.G., Jansson, J.K., Lynch, S.V., & Knight, R. (2018). *Current understanding of the human microbiome*. Nature Medicine, 24(4), 392–400. https://doi.org/10.1038/nm.4517
2. Zheng, D., Liwinski, T., & Elinav, E. (2020). *Interaction between microbiota and immunity in health and disease*. Cell Research, 30(6), 492–506.
3. Prescott, L.M., Harley, J.P. and Klein, D.A. (2013). *Microbiology*. 10th Edition. McGraw-Hill Education, New York.
4. Tortora, G.J., Funke, B.R. and Case, C.L. (2018). *Microbiology: An Introduction*. 13th Edition. Pearson, New York.


**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| **Weightage (%)** | **10** | **20** | **20** | **50** |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | 1 | 2 | 1 | 3 | 1 | 1 | 2 | 1 | 1 |
| **CO2** | 2 | 3 | 2 | 1 | 2 | 2 | 3 | 1 | 1 | 2 | 1 | 1 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 2 | 1 | 1 |
| **CO4** | 2 | 3 | 3 | 2 | 3 | 2 | 2 | 1 | 2 | 2 | 1 | 1 |
| **CO5** | 1 | 2 | 2 | 1 | 3 | 3 | 1 | 1 | 2 | 2 | 3 | 2 |
| **Average** | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 1 | 1 | 2 | 1 | 1 |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| MIB467 | AI in Biology | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | **V1.2** | **2** | **0** | **0** | **2** |
| **Pre-requisites/Exposure** | **UG-level bioinformatics** | | | | |
| **Co-requisites** | **Basics of computer application** | | | | |

**Course Objectives**

1. To provide students the basic understanding of Artificial Intelligence and machine learning.
2. Types and data analysis of various AI algorithms.
3. Combining Biology & Artificial Intelligence for data analysis.
4. General overview of Artificial Intelligence in revolutionizing health care.
5. Use of AI in biological data analysis.

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** the principles and techniques for artificial intelligence and machine learning.
CO2 : **Understand** AI tools and software to analyze biological data, including nucleotide and amino acid sequences.
CO3 : **Apply** AI methodologies to solve complex biological problems, such as image analysis and predicting protein structures.
CO4 : **Analyse** applications in fields like bioinformatics, medical diagnostics, and personalized medicine.
CO5 : **Evaluate** existing research and case studies that utilize AI in biology, assessing their methodologies, results, and implications for the field.

**Catalogue Description**

The core-course of 'AI in Biology' will help to understand and enhance the knowledge of Artificial Intelligence in Biology. The course examines how Artificial Intelligence has rapidly become ubiquitous in daily life and been applied to diverse areas of Biology.

**Course Content**

**Unit 1 Introduction to AI in biology** **5 hours**
Biological Intelligence Vs. Artificial Intelligence. AI Basics: concepts of generative and discriminative AI-terminologies and workflow, ML, DL. NLP.

**Unit 2 Learning and AI-algorithms** **5 hours**
Neural Networks (NN), Basics of deep Learning, decision tree and random forest, SVM, K-mean clustering. Exploratory data analysis, Plotting and data visualization, Handling big-data sets, Unsupervised learning and clustering, concept of reinforcement learning. Overview of statistical AI applications. Linear Regression and Logistic Regression Introduction to Decision Trees and Random Forests Performance metrics: accuracy, precision, recall, confusion matrix

**Unit 3 AI and Bioinformatics** **5 hours**

AI in bioinformatics analysis- analyzing sequence and structures. AI in systems biology, microbiome and data mining. Artificial Intelligence and Synthetic Biology. Introduction to Prompt Engineering and LLMs for sequence analysis

**Unit 4 Application of AI in health and pharmaceuticals** **5 hours**

AI in health diagnostics / Confluence of AI and Smart Devices for Monitoring Health and Disease. Applications of AI in medical imaging, neural engineering. AI-driven applications for drug design, lead optimization, and clinical trials. Artificial Intelligence for Biomarker Discovery. AI in Precision Medicine. AI in biology: Risks involved and ethical concerns. Future Prospects of AI in healthcare and research

**Unit 5 Using AI** **10 hours**

1. Biological data and data structure
2. Image analysis though AI
3. Identifying sequence features by NN
4. AI assisted protein structure prediction

**Experiential Learning**

1. Tutorial VDO on machine learning
2. Articles on data analysis using AI

**Textbooks**

1. Hamadani, A., Ganai, N.A., Henna, H., and Bashir, J. (2024). *A Biologist's Guide to Artificial Intelligence*. Academic Press.

**Reference Books**

1. Badar. (2023). *A Guide to Applied Machine Learning for Biologists*. Springer.
2. Aceves-Fernández, M.A. and Engelbrecht, A. (2023). *Artificial Intelligence: Applications in Medicine and Biology*. IntechOpen.

**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| Weightage (%) | 10 | 20 | 20 | 50 |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| **CO2** | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| **CO3** | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| **CO4** | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| **CO5** | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| **Average** | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

**Syllabus for 2nd Year**

**with**

***Coursework and Research***

*Specialisations Offered* –

- **Toxicology**
- **Quality Management Systems**
- **Bioprocess Technology**

| MIB501 | Environmental Microbiology | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | **2.0** | **2** | **1** | **1** | **4** |
| **Pre-requisites/Exposure** | Knowledge of Bacteriology and Ecology | | | | |
| **Co-requisites** | Fundamental Biochemistry and Microbial Physiology | | | | |

**Course Objectives**

1. To provide a mechanistic understanding of microbial processes in soil, water, and air environments.
2. To explain microbial participation and metabolic regulation of biogeochemical cycles.
3. To analyse plant–microbe and microbe–microbe interactions shaping ecosystem function.
4. To apply environmental microbiology principles to waste management, bioremediation, and engineered systems.
5. To evaluate the role of microorganisms in sustainability and achievement of Sustainable Development Goals (SDGs).

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** microbial diversity and distribution across terrestrial, aquatic, and atmospheric environments.
CO2 : **Understand** metabolic pathways and regulatory mechanisms driving biogeochemical cycles.
CO3 : **Apply** microbiological tools to assess environmental quality and microbial function.
CO4 : **Analyse** environmental processes and pollution scenarios using microbial systems thinking.
CO5 : **Evaluate** microbial strategies for environmental sustainability, waste management, and SDG implementation.

**Catalogue Description**

This course provides an advanced understanding of microorganisms as regulators of environmental processes in soil, water, and air. Emphasis is placed on microbial diversity, metabolic pathways driving biogeochemical cycles, plant–microbe interactions, and microbial responses to environmental stress. The course bridges natural and engineered ecosystems, covering waste management, bioremediation, and microbial solutions for sustainability. Integrating mechanistic insights with applied perspectives, the course prepares students for doctoral research and careers in environmental biotechnology, policy, and allied industries, while highlighting the contribution of environmental microbiology to achieving Sustainable Development Goals.

**Course Content**

**Unit 1 Microbial Diversity in Ambient Environments 10 hours**

Microbial biogeography in terrestrial (agricultural and desert soils), aquatic (freshwater and marine), atmospheric (aeromicroflora, stratosphere), and host-associated environments (rumen, termite gut, pest microbiomes); functional microbial guilds; drivers of microbial diversity; freshwater and marine microflora and nutrient cycling; microbial dispersal through air; applications of environmental microbiomes in agriculture, ecosystem services, and sustainability.

**Unit 2 Microbial Diversity in Extreme Environments 8 hours**

Occurrence and diversity of oligotrophs, thermophiles, psychrophiles, barophiles, halophiles, acidophiles, alkaliphiles, metallophiles, solvent- and radiation-tolerant microorganisms; physicochemical constraints of extreme habitats; molecular and metabolic adaptations of enzymes, membranes, DNA repair systems, osmolytes, and redox metabolism; applications of extremophiles in industry, bioremediation, and astrobiology.

**Unit 3 Soil Microbiology and Biogeochemical Cycling 12 hours**

Microbial interactions: mutualism, synergism, commensalism, competition, amensalism, parasitism, predation; rhizosphere, rhizoplane, endorhizosphere, and phyllosphere microbiology; composting, biofertilizers, and biological pest control; microbial mediation of biogeochemical cycles: Carbon cycle – degradation of cellulose, hemicellulose, lignin, chitin, soil carbon stabilization; Nitrogen cycle – nitrogen fixation, ammonification, nitrification, denitrification, nitrate reduction, anammox; Phosphorus and sulphur cycles – mineralization, solubilization, redox transformations Iron and manganese cycles – microbial redox processes, siderophores and soil structure

**Unit 4 Environmental Waste Management and Water Microbiology 8 hours**

Microbial processes in solid waste management: composting and sanitary landfills; sewage composition and strength (BOD, COD); microbial ecology of primary, secondary (oxidation ponds, trickling filters, activated sludge, septic tanks), and tertiary wastewater treatment; drinking water treatment and microbial safety; microbial indicators and risk-based assessment of potable water quality.

**Unit 5 Microbial Bioremediation and Sustainability 7 hours**

Principles of microbial bioremediation; degradation of pesticides and petroleum hydrocarbons; aerobic and anaerobic degradation pathways; microbial transformation and immobilization of metals; biosurfactants and pollutant bioavailability; bioleaching of copper, gold, and uranium; role of environmental microbiology in circular bioeconomy and achieving SDGs (clean water, soil health, climate action).

**Unit 6 Laboratory Exercises in Environmental Microbiology 30 hours**

Isolation of amylase-, protease-, urease-, and phosphatase-producing microorganisms
Presumptive, confirmed, and completed tests for coliforms
IMViC tests for differentiation of enteric bacteria
Enumeration of soil and water microorganisms by serial dilution and plate count
Isolation and characterization of phosphate-solubilizing and nitrogen-fixing microorganisms
Estimation of soil enzyme activities (dehydrogenase, phosphatase)
Microbial degradation of model organic pollutants
Assessment of drinking water microbiological quality

**Experiential Learning**

1. Case study: microbial failure and recovery in wastewater treatment plants
2. Field-based analysis of soil or water microbial quality
3. Research paper discussion on microbial biogeochemical cycling
4. SDG mapping exercise linking microbial processes to sustainability goals

**Textbooks**


1. Madigan, M.T., Bender, K.S., Buckley, D.H., Sattley, W.M., and Stahl, D.A. (2025). *Brock Biology of Microorganisms*. 16th Edition. Pearson.
2. Atlas, R.M. and Bartha, R. (2014). *Microbial Ecology: Fundamentals and Applications*. 4th Edition. Pearson.


**Reference Books**


1. Raina, M.M. (2013). *Environmental Microbiology*. Oxford & IBH Publishing.
2. Cappuccino, J.G. and Welsh, C.T. (2023). *Microbiology: A Laboratory Manual*. 11th Edition. Pearson Education.


**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| **Weightage (%)** | **10** | **20** | **20** | **50** |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 1 | 2 | 1 | 1 | 3 | 1 | – | 1 | – | 1 |
| **CO2** | 3 | 3 | 2 | 2 | 2 | 2 | 3 | – | – | 1 | – | 1 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | – | – | 2 | – | 1 |
| **CO4** | 3 | 3 | 3 | 2 | 2 | 3 | 2 | – | 1 | 2 | 1 | 2 |
| **CO5** | 2 | 3 | 2 | 2 | 2 | 3 | 2 | 1 | 2 | 3 | 3 | 3 |
| **Average** | 2.6 | 2.8 | 2.2 | 2.2 | 2.0 | 2.2 | 2.4 | 0.4 | 0.6 | 1.8 | 0.8 | 1.6 |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| MIB502 | Bioanalytical Techniques | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | 1.0 | **2** | **1** | **1** | **4** |
| **Pre-requisites/Exposure** | Basic knowledge of biomolecules, instrumentation, and quantitative analytical methods. | | | | |
| **Co-requisites** | None | | | | |

**Course Objectives**

1. To provide theoretical understanding of key bioanalytical techniques used in molecular biology, microbiology, and biochemistry.
2. To impart knowledge of qualitative and quantitative analysis of biological macromolecules.
3. To familiarize students with chromatography, electrophoresis, spectroscopy, and advanced techniques.
4. To provide hands-on experience in using bioanalytical tools in the lab.
5. To train students in interpreting data from modern analytical instrumentation.

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** the principles of major bioanalytical techniques.
CO2 : **Understand** the working and applications of spectroscopy, chromatography, and electrophoresis.
CO3 : **Apply** techniques for qualitative and quantitative analysis of biomolecules.
CO4 : **Analyze** experimental results and validate analytical methods.
CO5 : **Evaluate** appropriate analytical tools for different biological samples.

**Catalogue Description**

This course provides a comprehensive overview of qualitative and quantitative bioanalytical techniques such as chromatography, electrophoresis, spectroscopy, and immunoassays, supported by hands-on lab sessions to develop analytical competence.

**Course Content**

**Unit 1 Chromatographic Techniques** **9 hours**

Paper, Thin Layer Chromatography (TLC), Column, Ion Exchange, Gel Filtration, and Affinity Chromatography, HPLC and GC: Principles, detectors, and applications.

**Unit 2 Electrophoretic Techniques** **9 hours**

PAGE, SDS-PAGE, Native-PAGE, Agarose Gel Electrophoresis, 2D electrophoresis, Capillary electrophoresis, Immunoelectrophoresis.

**Unit 3 Spectroscopic Techniques** **9 hours**

UV-Vis spectroscopy, Fluorescence spectroscopy, Infrared (IR), Circular Dichroism (CD), Atomic Absorption Spectroscopy (AAS) and Mass Spectrometry basics.

**Unit 4 Immunoanalytical and Enzymatic Techniques** **9 hours**

ELISA (Direct, Indirect, Sandwich, Competitive), RIA, Western Blot, Lateral flow assay, Enzyme activity assays and applications in diagnostics

**Unit 5 Advanced Analytical Tools and Quality Control** **9 hours**

Flow Cytometry, Surface Plasmon Resonance (SPR), Microarrays; Instrument calibration and maintenance, Validation of analytical methods

**Unit 6 Lab Exercises in Bioanalytical Techniques** **30 hours**

a. Separation of amino acid mixture by Paper chromatography and TLC
b. Estimation of DNA and RNA of a bacterial cell.
c. Separation of DNA through Agarose Gel Electrophoresis
d. Separation of protein through SDS-PAGE electrophoresis
e. Determination of activity of amylase, protease

**Experiential Learning**

1. Separation of plant pigments using TLC and column chromatography.
2. Visit to a research institute to experience practical applications of Mass spectrometry, CD spectroscopy, etc.
3. To perform fluorescence spectroscopy for quenching study.

**Textbooks**


1. Hofmann, A. and Clokie Wilson, S (2018). Wilson And Walker's Principles And Techniques Of Biochemistry And Molecular Biology, Cambridge University Press.
2. Sheehan, D (2009). Physical Biochemistry: Principles and Applications, John Wiley & Sons Inc.
3. Robyt, J. F. (2015). Biochemical Techniques: Theory and Practice, CBS.
4. Allen, J. P. (2008). Biophysical Chemistry Wiley-Blackwell.


**Reference Books**


1. Atkins, P. and Paula, J (2011). Physical Chemistry for the Life Sciences, W.H. Freeman.
2. Kalidas, C. and Sangaranarayanan, M.V. (2023). Biophysical Chemistry: Techniques and Applications,
3. Dash, U. N (2006). Textbook of Biophysical Chemistry, Macmillan.
4. Upadhyay, A., Upadhyay, K. and Nath, N (2009). Biophysical Chemistry: Principles and Techniques, Himalaya Publishig House.


**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| Weightage (%) | 10 | 20 | 20 | 50 |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | 2 | 2 | – | 2 | – | – | – | 1 | – |
| **CO2** | 3 | 3 | 2 | 2 | 3 | – | 2 | – | – | – | 1 | – |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 2 | 3 | – | – | – | 1 | – |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 2 | 3 | – | 2 | – | 1 | – |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 2 |
| **Average** | 3 | 2.8 | 2.4 | 2.6 | 2.8 | 1.4 | 2.6 | 0.4 | 0.8 | 0.4 | 1 | 0.4 |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| MIB503 | Natural Product and Toxicology | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | **3.0** | **2** | **1** | **1** | **4** |
| **Pre-requisites/Exposure** | **Knowledge of Basic Biochemistry** | | | | |
| **Co-requisites** | | | | | |

**Course Objectives**

1. **Remember** the role of natural products in drug development, including chemical diversity and structure-based drug design.
2. **Understand** various extraction, isolation, and bioassay techniques used for identifying bioactive compounds from natural sources.
3. **Apply** analytical techniques for detecting toxicants and heavy metals in biological and food samples using chromatographic and spectroscopic methods.
4. **Analyze** the interaction between food, nutrients, and drugs, and the implications for pharmacokinetics and health outcomes.
5. **Evaluate** the toxicological risks associated with food, drugs, and natural toxins, including principles of dose-response and organ toxicity.

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** the significance of natural products and their structural diversity in guiding modern drug discovery, including real-world examples like statins and taxol.

CO2 : **Understand use of** extraction, purification, and bioassay-guided fractionation methods to isolate bioactive compounds.

CO3 : **Apply** analytical tests including chromatography, ELISA, and atomic spectroscopic techniques to detect and quantify toxicants and contaminants in food and drug samples.

CO4 : **Analyze** nutrient-drug interaction case studies to assess how diet influences drug absorption, metabolism, and effectiveness.

CO5 : **Evaluate** the toxicity and safety of various natural and synthetic substances by applying toxicological principles such as LD50, biotransformation, and organ-specific effects.

**Catalogue Description**

This course explores the role of natural products in drug discovery, focusing on plant-derived compounds, microbial metabolites, and their applications in modern medicine. It covers techniques for the extraction, isolation, and bioassay of natural substances, along with structure elucidation methods. Students will examine nutrient-drug interactions, the principles of toxicology, and the impact of food toxicants on health. Emphasis is placed on analytical toxicology, including chromatography and spectroscopic methods for detecting contaminants. Case studies and real-world examples provide a practical understanding of how natural products guide therapeutic development and toxicological assessment.

**Course Content**

**Unit 1 Natural Products in Drug Discovery 7 hours**

Approaches to modern drug development; Role of natural products in drug discovery; Plant-derived drugs and novel drug templates; Chemical diversity and structure-based drug design; Bioactive compounds from microorganisms (antibiotics, non-antibiotics, microbial phytotoxins); Structure elucidation of natural products using classical, spectroscopic, synthetic, and degradative methods; Case studies: Statins, Taxol, cardiac glycosides, vinca alkaloids, morphine, quinine, podophyllotoxin

**Unit 2 Extraction and Screening of Natural Compounds 10 hours**

Extraction, isolation, and purification techniques for bioactive compounds; Bioassay-guided fractionation of natural products; Disease conditions where natural products are preferred over synthetic drugs; Developments in adaptogens, immunomodulators, memory enhancers, anti-inflammatories, and antiparasitics; Screening methods for active compound isolation; Genetically engineered and biotechnology-derived natural products

**Unit 3 Nutraceuticals and Food-Drug Interactions 10 hours**

Food–drug and nutrient interactions affecting ADME (absorption, distribution, metabolism, excretion); Alcohol and nutrient deficiencies; Interactions of antidepressants and psychoactive drugs with nutrients; Effects of appetite changes, drug intake, and malnutrition on therapeutic outcomes; Overview of nutraceuticals, functional foods, and their biomedical significance

**Unit 4 Toxicology and Risk Assessment 10 hours**

Classification of food and environmental toxicants; Food laws, safety standards, and regulatory frameworks; Principles of toxicology: exposure, dose-response, biotransformation (Phase I & II); Carcinogenesis, mutagenesis, teratogenesis, and organ-specific toxicity; Natural toxins in food (plant origin, mushrooms, marine toxins, mycotoxins); Food adulteration, pesticide residues, and toxicants from food processing

**Unit 5 Analytical Toxicology and Instrumentation 8 hours**

Qualitative and quantitative assessment of toxicants; Toxicity exposure limits, LD50 and ED50 concepts; Chromatographic analysis of pesticides and contaminants; Spectrophotometric and atomic spectroscopy techniques: AAS, AES, ICP; Detection of drugs of abuse and environmental contaminants; Immunoassay techniques for genotoxicity: ELISA

**Unit 6 Laboratory Exercises 30 hours**

Determination of LD50 using model organisms or simulated calculations; Detection of heavy metals in food and water samples; Extraction and isolation of alkaloids and other bioactive compounds from plant material; Antibacterial activity testing of natural products; Antibiotic assay and microbial inhibition zone analysis; Case-based analysis of food-drug interactions and toxicity assessments

**Experiential Learning**

1. Chronic exposure linked to liver cancer and immunosuppression in tropical countries due to poor storage
2. Organophosphate poisoning in the Delhi Midday Meal tragedy
3. Rediscovery of *Artemisia annua* (sweet wormwood) leading to Nobel-winning antimalarial

4. Development of microtubule-targeting anticancer agents for breast and ovarian cancer

**Textbooks**


1. Barceloux, D.G. (2008). *Medical Toxicology of Natural Substances: Foods, Fungi, Medicinal Herbs, Plants, and Venomous Animals.* John Wiley & Sons, Inc. ISBN: 9780471727613.
2. Pelkonen, O., Duez, P., Vuorela, P.M., & Vuorela, H. (Eds.) (2019). *Toxicology of Herbal Products.* Springer. ISBN: 978-3319829159.


**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| **Weightage (%)** | **10** | **20** | **20** | **50** |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 2 | 1 | – | 2 | – | – | – | 1 | – |
| **CO2** | 3 | 3 | 2 | 2 | 3 | – | 2 | – | – | – | 1 | – |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 2 | 3 | – | – | – | 1 | – |
| **CO4** | 3 | 3 | 3 | 3 | 2 | 2 | 3 | – | 2 | – | 1 | – |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 2 |
| **Average** | 3 | 2.8 | 2.6 | 2.6 | 2.4 | 1.4 | 2.6 | 0.4 | 0.8 | 0.4 | 1 | 0.4 |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| MIB504 | Food and Pharmaceutical Microbiology | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | **2.0** | **2** | **1** | **1** | **4** |
| **Pre-requisites/Exposure** | Basic knowledge of microbiology and life science | | | | |
| **Co-requisites** | - | | | | |

**Course Objectives**

1. To provide a comprehensive understanding of synthesizing microbial food products and its applications.
2. To develop knowledge of food biotechnology and genetic engineering in food production with an in-depth understanding of food safety and pharmaceutical standards and regulatory frameworks
3. To enable the identification, control, and prevention of microbial contamination in food and pharmaceutical environments with technical knowledge of sterilization, disinfection, and aseptic processing.
4. To introduce the principles of vaccine development and biopharmaceutical production.

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** the role of microbiology in food production and pharmaceutical applications
CO2 : **Understand** sources of contamination and spoilage in food production and pharmaceutical environments.
CO3 : **Apply** process of sterilization, disinfection, and aseptic processing.
CO4 : **Analyse** microbial assays of antibiotics and sterility testing and examine the production, regulation, and quality control of vaccines and biopharmaceuticals.
CO5 : **Evaluate** pharmacopoeial standards and follow Good Manufacturing Practices (GMP).

**Catalogue Description**

This course provides a comprehensive overview of microbial applications in the food and pharmaceutical industries, with a focus on food safety, quality control, and biotechnology. Students will explore the production of microbial food products such as Single Cell Protein (SCP), probiotics, and edible mushrooms, as well as their nutritional and functional roles in human health. Key topics include food biotechnology, genetic modification, microbial contamination, sterilization, and disinfection processes, along with antibiotic production and vaccine development. The course emphasizes regulatory frameworks, quality assurance systems like HACCP and Good Laboratory Practices (GLP) and introduces intellectual property rights related to biotech products. Practical sessions offer hands-on training in microbial assays, probiotic development, preservative and disinfectant efficacy testing, and microbial quality assessment of food and pharmaceutical products. By the end of the course, students will gain essential skills for ensuring food and pharmaceutical safety and quality in compliance with global regulatory standards.

**Course Content**

**Unit 1 Microbial Food Products for Human Consumption 7 hours**

Microbial SCP production by bacteria, algae and mycoprotein from fungi for use as food and feed; SCP production process by using different substrates; properties and nutritional values; Industrially used SCP (Quoron, Pruteen); Advantage and disadvantages of SCP. Mushroom cultivation, harvesting and post harvesting; important edible mushroom species; Concept of probiotics, prebiotics, symbiotics and bioactive food; Production and composition of various probiotics; chemistry, metabolism and bioavailability of probiotics; Effect of probiotics on human health and potential application in risk reduction of diseases; genetically modified probiotics/prebiotics.

**Unit 2 Food Biotechnology, Food safety, Quality Control and Trade Regulation of Food Materials 14 hours**

Food safety objectives (FSO), Bacteriology of Water supplies, Sewage in waste treatment and disposal, Indicators of food microbial quality and safety, some indicators of product quality- Coliforms, Enterococci, Bifidobacterium, Coliphages; Microbiological quality standards of food, control and inspection, Enforcement and Govt. Regulatory practices and policies. FDA, EPA, HACCP,ISI; handling of recombinant product; Detection of various methods of food toxicity, Hazard analysis criteria control points (HACCP) system for food safety, HACCP principles, Application of HACCP principles; Introduction to food biotechnology; improvement of the food crops by genetic engineering; genetically modified plants and animals for enhanced food production; safety of GM food crops. Protein engineering in food technology: methods, applications of protein engineering to produce glucose isomerase, *Lactobacillus* betagalactosidase and peptide antibiotic nisin; Transgenic plant foods: golden rice, Btbrinjal, maize, tomato, potato, soyabean etc. Intellectual property rights (IPR) issues, patent application procedure, copyright laws, transfer of copyrights, infringements, trademarks, objectives- rights and protection, biopiracy problems; effect of biotech foods on the food business of developing and developed countries.

**Unit 3 Microbial contamination and preservation 6 hours**

Sources and control of contamination in pharmaceutical environments. Spoilage of pharmaceutical products: tablets, capsules, injectables, syrups; Assessment of microbial contamination and spoilage. Preservation of pharmaceutical products using antimicrobial agents, Types of preservatives and their microbial inhibition mechanisms, evaluation of microbial stability of formulations. Microbial Limit Tests (IP, BP, USP standards); Microbiological Contamination: Product recalls; microbial limit standards; Type of Preservatives for microbiological products. The test methods for evaluation of formulations such as Preservative Efficacy Testing and Stability of Drugs & Stability Testing; Microbiological control: Risk Assessment, Principles and types: moist and dry heat, filtration, radiation, gas; Validation and biological indicators (D-value, Z-value, F-value); Disinfectants: classification, efficacy testing (phenol coefficient, use dilution); Aseptic techniques and cleanroom practices (Class 100/ISO 5); Concept of validation and quality assurance; Disinfectants: Factors in Choice and Use of Disinfectants. Qualification of Disinfectants Test Methods and Validation of disinfectants.

**Unit 4 Antibiotics, Vaccines, Biopharmaceuticals 10 hours**

Fermentation process for antibiotic production (penicillin, streptomycin), Mechanisms of action and resistance, Microbiological assay of antibiotics (agar diffusion, tube dilution); Methods for standardization of antibiotics, vitamins and amino acids. Assessment of a new antibiotic; Types: live attenuated, killed, toxoids, subunit, recombinant; Steps in vaccine production and quality control and storage; Introduction to monoclonal antibodies and biosimilars; Regulatory overview of vaccines (national immunization programs)

**Unit 5 Risk assessment and regulatory principles 8 hours**

Pharmaceutical products and contamination risks; Quality assurance and Quality control of microbial contaminants in pharmaceutical industries with respect to FDA and WHO (GMP and GLP). Their maintenance and requirement criteria as per Indian Pharmacopeia. Case studies; Good practices in food quality management, Introduction of Good laboratory practices (GLP) and its applications, Elements of GLP, OECD guidelines for GLP, National Accreditation Board for Testing and Calibration Laboratories (NABL); Regulatory authorities: WHO, FDA, CDSCO.

**Unit 6 Practical application of Food and Pharmaceutical Microbiology 30 hours**

1. Antibiotic sensitivity assay
2. Microbial examination of Non-sterile products
3. To determine the food quality and its deterioration by measuring the microbial population
4. Isolation of bacterial probiotics from curd and development of probiotics in vitro
5. To check the effect of preservative in different formulations
6. To check the effect of disinfectant

**Experiential Learning**

1. Quality Assessment and Analysis of food
2. To simulate the process of discovering and evaluating an antibiotic from soil microbes.

**Textbooks**


1. Sandle, T, *Pharmaceutical Microbiology*, (2016) Elsevier, 80 High Street, Sawston, Cambridge, CB22 3HJ, UK.
2. Hugo, WB and Russell, AD. *Pharmaceutical Microbiology*, (2003). Blackwell Science, Oxford, UK.
3. Adams, M. R., & Moss, M. O. (2024). Food microbiology (4th ed.). Royal Society of Chemistry.


**Reference Books**


1. Geoffrey Hanlon and Norman Hodges. *Essential Microbiology for pharmacy and pharmaceutical science.* (2013). Wiley Blackwell.
2. S. P. Vyas & V. K. Dixit. *Pharmaceutical Biotechnology*. (2003) CBS Publishers & Distributors, New Delhi.
3. Frazier, W. C., & Westhoff, D. C. (2008). Food microbiology (4th ed.). Tata McGraw-Hill.


**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| Weightage (%) | 10 | 20 | 20 | 50 |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | | | 3 | - | 3 | 2 | - | 3 | 3 |
| **CO2** | 3 | 3 | 3 | | | 3 | - | 3 | 2 | - | - | 3 |
| **CO3** | 3 | 3 | 3 | | | 3 | - | 3 | 2 | - | - | 3 |
| **CO4** | **3** | 3 | 3 | | | 3 | - | 3 | 2 | - | **3** | 3 |
| **CO5** | **3** | 3 | 3 | | | 3 | - | 3 | 2 | - | 3 | 3 |
| **Average** | 3 | 3 | 3 | | | 3 | - | 3 | 2 | - | 3 | 3 |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| MIB505 | Bioprocess Technology | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | 2.0 | **2** | **1** | **1** | **4** |
| **Pre-requisites/Exposure** | Basic knowledge of microbiology, microbial metabolism, and fermentation concepts. | | | | |
| **Co-requisites** | None | | | | |

**Course Objectives**

1. To understand the fundamental principles of bioprocess design and microbial growth kinetics.
2. To study upstream and downstream processing in industrial biotechnology.
3. To gain insights into sterilization, bioreactor types, and scale-up processes.
4. To develop practical skills in microbial fermentation, product recovery, and process optimization.
5. To promote interdisciplinary problem-solving in industrial microbiology and biochemistry.

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** the stages and components involved in a typical bioprocess.
CO2 : **Understand** microbial growth dynamics, fermentation principles, and bioreactor operation.
CO3 : **Apply** bioprocess engineering concepts to solve scale-up and process development problems.
CO4 : **Analyze** and optimize microbial production processes for value-added products.
CO5 : **Evaluate** bioprocess efficiency, cost-effectiveness, and industrial applicability.

**Catalogue Description**

The course provides theoretical and hands-on training in microbial bioprocesses used in pharmaceutical, food, and industrial applications. Topics include bioreactor design, sterilization, fermentation kinetics, and product recovery techniques, supported by practical fermentation experiments.

**Course Content**

**Unit 1 Introduction to Bioprocess Technology 9 hours**

Overview of bioprocesses: Upstream and downstream, Historical evolution of bioprocess technology, Components of a bioprocess system; Transport phenomena in fermentation: Gas-liquid exchange and mass transfer, oxygen transfer, heat transfer.

**Unit 2 Microbial Growth and Product Formation Kinetics 9 hours**

Batch, fed-batch, and continuous culture, Monod model, yield coefficients, Primary vs. secondary metabolite production.

**Unit 3 Bioreactors and Scale-Up 9 hours**

Types of bioreactors: Stirred tank, airlift, packed bed, Aeration, agitation, substrate utilization kinetics, substrate inhibition models, product formation kinetics; Scale-up criteria: Geometric, kLa, P/V.

**Unit 4 Upstream Processing** **9 hours**

Inoculum development and media design, Sterilization: Air, media, and equipment, Process monitoring and control; storage of cultures for repeated fermentations.

**Unit 5 Downstream Processing** **9 hours**

Cell separation: Filtration, centrifugation; Cell disintegration: Physical, chemical and enzymatic methods, Extraction: Solvent, distillation, two phase, liquid extraction; Product recovery and purification: Precipitation, extraction, chromatography, Formulation and packaging

**Unit 6 Lab Exercises in Bioprocess Technology** **30 hours**

a. Operation of a laboratory-scale stirred-tank bioreactor for microbial biomass production.
b. Monitoring growth kinetics: Dry weight, OD, and pH tracking.
c. Downstream recovery of metabolites (e.g., ethanol distillation or enzyme extraction).
d. Comparative studies of Ethanol production using different substrates.

**Experiential Learning**

1. Visit to any fermentation industry to observe process operation and optimization.

**Textbooks**


1. Casida, L.E. JR (2019). *Industrial Microbiology*, 2nd Edition, New Age International Publishers.
2. Okafor N & Okeke C (2018). *Modern Industrial Microbiology And Biotechnology, 2nd Edition*, CRC Press.
3. Stanbury, P.F., Whitaker, A., Hall, S. J (2016). *Principles of Fermentation Technology*, 3rd Edition, Butterworth-Heinemann.
4. Patel, A.H (2011). *Industrial Microbiology*, Laxmi Publications.


**Reference Books**


1. Beemagani, S., and Pittala, N (2025). Industrial Microbiology, SIP.
2. Doran, P.M. Bioprocess Engineering Principles, Academic Press.
3. Demain, A.L. & Davies, J.E. *Manual of Industrial Microbiology and Biotechnology*, ASM Press.
4. Harrison, R.G. et al. *Bioseparations Science and Engineering*, Oxford University Press.


**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| Weightage (%) | 10 | 20 | 20 | 50 |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| **CO2** | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| **CO3** | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| **CO4** | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| **CO5** | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| **Average** | **3** | **3** | **2** | **3** | **3** | | | **3** | | | **1** | **3** |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| MIB506 | Research Approaches in Environmental Toxicology | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | 1.0 | 2 | 0 | 0 | 2 |
| **Pre-requisites/Exposure** | Basic understanding of microbiology, biochemistry, and environmental science. | | | | |
| **Co-requisites** | None | | | | |

**Course Objectives**

1. To provide an overview of environmental pollutants and their toxic effects on microbial systems.
2. To understand modern research methodologies used to assess environmental toxicants.
3. To explore microbial bioindicators and biosensors in toxicity evaluation.
4. To evaluate the relevance of omics-based and bioinformatics tools in environmental toxicology research.
5. To promote critical thinking in designing toxicity-related microbiological investigations.

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** major environmental toxicants and their microbial targets.
CO2 : **Understand** mechanisms of toxicity at the cellular and molecular levels.
CO3 : **Apply** microbiological and molecular tools to assess toxicity.
CO4 : **Analyze** omics-based data for toxicity monitoring.
CO5 : **Evaluate** research methodologies in environmental toxicology and propose suitable experimental approaches.

**Catalogue Description**

This course introduces students to research-oriented approaches in environmental toxicology, focusing on microbial responses to pollutants. It covers modern techniques like biomonitoring, biosensors, omics analyses, and risk assessment strategies relevant to environmental microbiology.

**Course Content**

**Unit 1 Introduction to Environmental Toxicology 6 hours**

Principles of toxicology; Classification of environmental toxicants (organic, inorganic, emerging contaminants); Dose-response relationships and toxicity thresholds; Toxicity Testing, and ADME II (Absorption, Distribution, Metabolism and Excretion), ADME II (Toxicokinetics and Metabolism)

**Unit 2 Microbial Response to Environmental Toxicants 6 hours**

Toxicant-microbe interactions; Mechanisms of toxicity (oxidative stress, membrane damage, DNA/protein alterations); Detoxification and resistance mechanisms in microbes

**Unit 3 Microbial Bioassays and Biosensors 6 hours**

Concepts of microbial bioindicators; Whole-cell biosensors: reporter genes, luminescent and fluorescent markers; Bioassays for water, soil, and air toxicity

**Unit 4 Molecular and Omics Approaches 6 hours**

Metagenomics and transcriptomics in environmental samples; Proteomics and metabolomics for toxicity assessment; Use of RT-qPCR, microarrays, and sequencing for biomarker analysis

**Unit 5 Experimental Design and Toxicity Risk Assessment 6 hours**

Environmental benchmarks, Data sources for exposure risk characterization; Study design for toxicity testing; Microbial endpoints in ecotoxicology; Microbial risk assessment and standard protocols (EPA, OECD, USEPA)

**Experiential Learning**

1. Ecological and human health risk assessment-Case Studies
2. Neurotoxicological effects of environmental pollutants-Case Studies

**Textbooks**


1. Newman, M.C., Unger, M.A. *Fundamentals of Ecotoxicology*. 5th edition, CRC Press, 2019.
2. Casarett & Doull's Essentials of Toxicology. 4th edition, Klaassen CD, Watkins JB. McGraw Hill, 2022.
3. Reshi, M.S., Javaid, D., Qadri, S.S. *Environmental Toxicology: Concepts and Principles*. 1st edition, Jenny Stanford Publishing, 2025.
4. Awasthi, K.K., Yadav, C.S., Awasthi, G., Sankhla, M.S. Environmental Toxicology: Pollutants and Health Impacts. Shiv Shakti Book Traders, 2021.


**Reference Books**


1. Hayes' Principles and Methods of Toxicology, Hayes, A. W., Kruger, C.L., CRC Press, Taylor and Francis, 6th edition, 2014.
2. Principles of Ecotoxicology, Walker, C.H., Sibly, R.M., Hopkin, S.p., Peakall, D.B., CRC Press, 2012.
3. A Textbook of Modern Toxicology. E. Hodgson (Ed.). John Wiley & Sons, Inc. 4th Edition. 2010.
4. An Introduction to Environmental Toxicology, Michael H. Dong. Lash and Temple Publishing, 4th edition, 2018.


**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| Weightage (%) | 10 | 20 | 20 | 50 |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 1 | 2 | - | - | - | - | - | - | - |
| **CO2** | 3 | 2 | 3 | 2 | 2 | - | - | - | - | 1 | - | - |
| **CO3** | 2 | 2 | 3 | 3 | 2 | - | - | 1 | 2 | 1 | 2 | - |
| **CO4** | 2 | 2 | 3 | 3 | 2 | - | - | 1 | 2 | 2 | 3 | - |
| **CO5** | 2 | 3 | 3 | 2 | 3 | - | 2 | 1 | 1 | 2 | 3 | 1 |
| **Average** | 2.4 | 2.2 | 2.8 | 2.2 | 2.2 | - | 0.4 | 0.6 | 1 | 1.2 | 1.6 | 0.2 |

**1** : Weakly mapped
**2** : Moderately mapped
**3** : Strongly mapped

| MIB507 | Research Practices in Microbial Safety and Sustainability in Food Systems | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | **1.0** | **2** | **0** | **0** | **2** |
| **Pre-requisites/Exposure** | Basic knowledge of food microbiology | | | | |
| **Co-requisites** | None | | | | |

**Course Objectives**

1. To introduce current research practices in microbial food safety and sustainable food systems.
2. To analyze microbial risks in food chains, emerging pathogens, and antimicrobial resistance.
3. To understand the integration of microbial safety strategies with sustainability goals.
4. To review risk assessment, monitoring frameworks, and microbial interventions in food systems.
5. To critically evaluate contemporary research and global regulatory practices in food microbiology.

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** principles of microbial food safety and sustainability.
CO2 : **Understand** microbial hazards and sustainable control strategies in food systems.
CO3 : **Apply** concepts of microbial risk assessment and hazard identification in food chains.
CO4 : **Analyze** research approaches in monitoring and controlling pathogens in sustainable food systems.
CO5 : **Evaluate** food safety frameworks and research publications for effective intervention design.

**Catalogue Description**

This course explores advanced research approaches and global practices that ensure microbial safety while promoting sustainability in food production and distribution systems. It integrates food microbiology, public health, and environmental concerns.

**Course Content**

**Unit 1 Introduction to Microbial Safety and Sustainability in Food Systems 6 hours**
Definition and scope of microbial food safety; Sustainable development goals (SDGs) related to food systems; Link between food safety and environmental sustainability

**Unit 2 Microbial Hazards and Risk Assessment in Food Chains 6 hours**
Biological hazards: bacteria, viruses, fungi, toxins; Hazard Analysis and Critical Control Points (HACCP); Principles of risk analysis: risk assessment, management, communication

**Unit 3 Emerging Pathogens and Antimicrobial Resistance (AMR) 6 hours**
Foodborne transmission of AMR organisms; Novel and re-emerging microbial threats; Global One Health perspectives and AMR surveillance

**Unit 4 Sustainable Microbial Interventions and Practices 6 hours**

Bio-preservation, bacteriophages, probiotics; Eco-friendly packaging and green sanitation practices; Reduction of microbial load using non-thermal technologies

**Unit 5 Research Methodology and Global Frameworks in Food Safety 6 hours**

Literature review and data analysis in microbial safety research; Role of FAO, WHO, EFSA, FSSAI in food safety; National and international guidelines on sustainable food safety

**Experiential Learning**

1. Risk mapping activity for selected foodborne pathogens across supply chains
2. Group project: developing a sustainability-integrated microbial safety model
3. Seminar presentation on emerging trends in sustainable food microbiology

**Textbooks**


1. Arun Karnwal, Abdel Rahman Mohammad Said Al-Tawaha. Food Microbial Sustainability: Integration of Food Production and Food Safety, 2023, Springer.
2. James M. Jay, Martin J. Loessner, David A. Golden. Modern Food Microbiology, 7th edition, 2005, Springer.
3. International Commission on Microbiological Specifications for Foods. Microorganisms in Foods 7: Microbiological Testing in Food Safety Management, 2nd edition, 2018, Springer.
4. Anna McElhatton & Richard J. Marshall. Food Safety: A Practical and Case Study Approach (Integrating Safety and Environmental Knowledge Into, 2006, Springer.


**Reference Books**


1. William H. & Carol Anne. Food Safety for the 21st Century: Managing HACCP and Food Safety Throughout the Global Supply Chain, 2018, Wiley.
2. M Dillon. Auditing in the food industry: From safety and quality to environmental and other audits, 2001, CRC Press.


**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| Weightage (%) | 10 | 20 | 20 | 50 |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | - | - | - | - | - | - | 2 | - | 2 |
| **CO2** | 3 | 3 | 2 | 2 | - | - | - | - | - | 2 | - | 2 |
| **CO3** | 2 | 3 | 3 | 2 | 2 | 2 | 2 | - | - | 2 | - | 1 |
| **CO4** | 2 | 3 | 3 | 2 | 3 | 2 | 3 | - | - | 2 | 1 | 1 |
| **CO5** | 2 | 3 | 2 | 2 | 3 | 3 | 3 | 2 | 1 | 3 | 2 | 2 |
| **Average** | **2.4** | **2.8** | **2.2** | **1.6** | **1.6** | **1.4** | **1.6** | **0.4** | **0.2** | **2.2** | **0.6** | **1.6** |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| MIB508 | Critical Reading and Writing on Enzyme Technology | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | **1.0** | **2** | **0** | **0** | **2** |
| **Pre-requisites/Exposure** | Basic knowledge of microbiology and enzymology | | | | |
| **Co-requisites** | None | | | | |

**Course Objectives**

1. To understand enzyme structure, function, and catalytic mechanisms relevant to industrial processes.
2. To learn principles of enzyme kinetics, regulation, and immobilization.
3. To explore microbial sources, large-scale enzyme production, and downstream processing.
4. To study applications of enzymes in industrial biotechnology and emerging bioprocesses.
5. To appreciate recent trends in green bioengineering and catalysis

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** enzyme classification, structure, and catalysis.
CO2 : **Understand** kinetic and regulatory mechanisms.
CO3 : **Apply** enzyme engineering principles in bioprocess design.
CO4 : **Analyse** microbial enzyme production, purification, and immobilization.
CO5 : **Evaluate** literature on enzyme applications and emerging trends, and present written analyses.

**Catalogue Description**

This course introduces the principles and applications of enzymes in bioprocess technology. It covers enzyme structure, classification, catalysis, kinetics, and regulation, along with microbial production, purification, and immobilization techniques. Emphasis is placed on enzyme engineering for enhanced stability and activity, and their use in industrial sectors such as food, pharmaceuticals, detergents, textiles, and biofuels. Students explore contemporary trends including extremozymes, biosensors, and green catalysis through guided readings and analytical writing. The course integrates conceptual learning with experiential components to develop skills in process understanding, literature analysis, and critical evaluation of enzyme-based biotechnological innovations.

**Course Content**

**Unit 1 Fundamentals of Enzyme Catalysis** **3 hours**

Nature and classification of enzymes (IUB system), enzyme structure and active site, cofactors and coenzymes, mechanism of enzyme action, transition state theory, energy profile of enzyme-catalyzed reactions, factors affecting enzyme activity (pH, temperature, substrate concentration).

**Unit 2 Enzyme Kinetics and Regulation** **12 hours**

Michaelis–Menten kinetics and derivation, determination of kinetic parameters (Km, Vmax), Derivatives of Michaelis-Menten Kinetics (Eadie-Hofstee plot, Woolf-Hanes, Cornish-Bowden plots),

enzyme inhibition – competitive, non-competitive, uncompetitive, allosteric regulation, multi-substrate kinetics, isoenzymes, enzyme cooperativity; Bioinformatics in Kinetic analyses

**Unit 3 Enzyme Production and Purification** **6 hours**

Microbial sources of industrial enzymes (bacteria, fungi, actinomycetes), screening and strain improvement, recombinant enzyme production, fermentation strategies – submerged and solid-state, downstream processing – cell disruption, precipitation, dialysis, chromatography, case studies – amylases, proteases, cellulases.

**Unit 4 Enzyme Immobilisation and Engineering** **6 hours**

Need for enzyme immobilization, methods – adsorption, covalent bonding, entrapment, encapsulation, cross-linking, kinetic behavior of immobilized enzymes, enzyme engineering – site-directed mutagenesis, directed evolution, protein design, immobilized enzyme reactors – design and applications.

**Unit 5 Enzyme Applications and Emerging Trends** **3 hours**

Enzymes in industries, enzyme biosensors and diagnostics, extremozymes and metagenomic enzyme discovery, enzyme nanotechnology, green catalysis, recent literature-based studies on industrial enzyme applications, student review and report writing on selected research papers (≤5 years old).

**Experiential Learning**

1. Industrial Enzyme Case Study and Process Mapping
2. Research Paper Review and Analytical Summary

**Textbooks**

1. Trevor Palmer & Philip Bonner – *Enzymes: Biochemistry, Biotechnology and Clinical Chemistry*, 2nd Ed.
2. Nicholas C. Price & Lewis Stevens – *Fundamentals of Enzymology*.
3. H. Uhlig – *Industrial Enzymes and Their Applications*.

**Reference Books**

1. A. Pandey, C. Larroche & C.R. Soccol (Eds.) – *Current Developments in Biotechnology and Bioengineering: Production, Isolation and Purification of Industrial Products.*
2. J. E. Bailey & D. F. Ollis – *Biochemical Engineering Fundamentals.*

**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| Weightage (%) | 10 | 20 | 20 | 50 |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | - | - | - | - | - | - | 2 | - | 2 |
| **CO2** | 3 | 3 | 2 | 2 | - | - | - | - | - | 2 | - | 2 |
| **CO3** | 2 | 3 | 3 | 2 | 2 | 2 | 2 | - | - | 2 | - | 1 |
| **CO4** | 2 | 3 | 3 | 2 | 3 | 2 | 3 | - | - | 2 | 1 | 1 |
| **CO5** | 2 | 3 | 2 | 2 | 3 | 3 | 3 | 2 | 1 | 3 | 2 | 2 |
| **Average** | **2.4** | **2.8** | **2.2** | **1.6** | **1.6** | **1.4** | **1.6** | **0.4** | **0.2** | **2.2** | **0.6** | **1.6** |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| MIB509 | Internship | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | **2.0** | **0** | **0** | **2** | **2** |
| **Pre-requisites/Exposure** | Knowledge of microbiological and biochemical techniques | | | | |
| **Co-requisites** | | | | | |

**Course Objectives**

1. Provide students with hands-on exposure to industrial environments relevant to microbiology and biotechnology.
2. Bridge the gap between academic learning and real-world industrial applications, workflows, and quality standards.
3. Train students in the use of industry-specific instruments, laboratory practices, documentation systems, and safety protocols.
4. Build professional competencies including teamwork, communication, time management, and problem-solving in an industrial setting.
5. Enable students to document, present, and critically assess their internship experience through a structured report and presentation.

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** key microbiological and biochemical techniques, industrial workflows, safety norms, and standard operating procedures observed during the internship.

CO2 : **Understand** the principles behind industrial processes, instrumentation, quality control systems (GLP/GMP), and the relevance of classroom concepts in industrial settings.

CO3 : **Apply** microbiological and biochemical skills, analytical methods, and good laboratory practices to perform assigned tasks in wet lab and/or dry lab industrial environments.

CO4 : **Analyse** industrial data, workflows, troubleshooting strategies, and the differences between academic and industrial research practices.

CO5 : **Evaluate** their overall internship experience by assessing process efficiency, data quality, limitations, and industry–academia linkages through a structured report and presentation.

**Catalogue Description**

This course provides students with practical exposure to industrial settings through a structured internship. Students undergo training in wet lab and/or dry lab environments depending on the hosting organization, such as pharmaceutical companies, diagnostic laboratories, fermentation industries, food testing facilities, or biotechnology firms. During the internship, they experience real-world workflows, instrumentation, quality control processes, biosafety standards, and industrial documentation practices. Students are required to maintain a work log, prepare an internship report, and present their key learnings. The course aims to enhance employability, technical competence, and understanding of the interface between academia and industrial research.

**Modes of Evaluation**

| Components | Internship Report | End Term |
|---|---|---|
| Weightage (%) | 50 | 50 |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | - | 3 |
| CO2 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | - | 3 |
| CO3 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | - | 3 |
| CO4 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | - | 3 |
| CO5 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | - | 3 |
| Average | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | - | 3 |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| MIB516 | Dissertation Part I | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | **1.0** | **0** | **0** | **6** | **6** |
| **Pre-requisites/Exposure** | Completion of core courses in Microbiology and allied subjects | | | | |
| **Co-requisites** | Research Methodology, Biostatistics | | | | |

**Course Objectives**

1. To identify a focused research problem in microbiology based on literature gaps.
2. To develop research questions, hypotheses, and experimental design.
3. To train students in ethical research practices and biosafety compliance.
4. To initiate laboratory/field-based investigations using appropriate techniques.
5. To develop scientific writing and presentation skills.

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** relevant theoretical concepts and prior research related to the selected problem.
CO2 : **Understand** experimental approaches, methodologies, and safety requirements.
CO3 : **Apply** microbiological, molecular, or analytical techniques to generate preliminary data.
CO4 : **Analyse** initial results and refine experimental strategies.
CO5 : **Evaluate** the feasibility and scientific merit of the research plan.

**Catalogue Description**

This course constitutes the first phase of the year-long postgraduate dissertation under the coursework-plus-research pattern. Students identify a research problem in microbiology, perform an in-depth literature review, and formulate clear objectives and hypotheses. Emphasis is placed on experimental design, biosafety, ethics, and methodological rigor. Students initiate laboratory or field investigations and generate preliminary data that form the foundation for extended research in the subsequent semester. The course develops independent thinking, critical analysis, and scientific communication skills essential for doctoral research and R&D careers.

**Modes of Evaluation**

| Components | Literature Review and Proposal | Presentation of Research Update | Total (End Semester) |
|---|---|---|---|
| **Weightage (%)** | **50** | **50** | **100** |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | - | 3 |
| **CO2** | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | - | 3 |
| **CO3** | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | - | 3 |
| **CO4** | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | - | 3 |
| **CO5** | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | - | 3 |
| **Average** | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | - | 3 |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| MIB510 | Bioethics and Intellectual Property Rights (IPR) | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | **1.0** | **3** | **1** | **0** | **4** |
| **Pre-requisites/Exposure** | Knowledge of scientific methods and techniques in the undergraduate level | | | | |
| **Co-requisites** | | | | | |

**Course Objectives**

1. To impart comprehensive knowledge of biosafety principles and regulatory frameworks governing biological research.
2. To familiarize students with different forms of Intellectual Property Rights and their applications in science and technology.
3. To enable students to understand legal procedures for patent filing and protection of innovations.
4. To explore the role of IPR in commercialization, research, and start-up development.
5. To provide insights into global IPR trends, WIPO initiatives, technological developments, and global innovation performance.

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** the principles of biosafety, biological risk management, and regulatory guidelines.
CO2 : **Understand** various types of Intellectual Property Rights and their significance in research, development, and entrepreneurship.
CO3 : **Apply** legal and procedural knowledge to protect innovations through patents, copyrights, trademarks, designs, and trade secrets.
CO4 : **Analyze** the role of IPR in technology transfer, commercialization, and start-up growth.
CO5 : **Evaluate** global IPR trends, WIPO initiatives, international treaties, and innovation rankings.

**Catalogue Description**

This course is designed for students from biotechnology, life sciences, engineering, and interdisciplinary domains, providing an integrated understanding of biosafety, IPR, and innovation management essential for research, entrepreneurship, and global competitiveness.

**Course Content**

**Unit 1 Biosafety and Regulatory Aspects 12 hours**

Principles of Biosafety and Biological Risk Assessment, Laboratory Biosafety Levels and Containment Measures, National and International Biosafety Guidelines (e.g., Cartagena Protocol), Institutional Biosafety Committees (IBSC) and Review Processes, Regulatory Frameworks for GMOs, Recombinant DNA Research, Biotechnology, and Clinical Trials.

**Unit 2 Intellectual Property Rights: Fundamentals and Global Perspective 12 hours**

Introduction and Evolution of IPR, Types of IPR: Patents, Copyrights, Trademarks, Industrial Designs, Geographical Indications, Trade Secrets. Need for IPR Protection and Impact on Economic Development,

Health, and Agriculture. Global IPR Systems: International Organizations, Treaties (WIPO, TRIPS, PCT). IPR Scenario in India: Growth, Challenges, and Case Studies.

**Unit 3 Patents and Legal Protection of Innovations 12 hours**

Patentable and Non-Patentable Inventions, Process and Product Patents, Patent of Addition, Legal Requirements and Patent Granting Procedures, Patent Search, Drafting, Filing (National and International), IP Asset Management, Portfolio Management, Assignment, Licensing, and Infringement.

**Unit 4 IPR in Practice: Copyright, Trademarks, Designs, and Traditional Knowledge 12 hours**

Copyrights: Rights, Registration Process, Infringement, and International Copyright Laws; Trademarks: Types, Purpose, Functions, Protection, and Registration; Industrial Designs and Protection Mechanisms; Geographical Indications (GI) and Traditional Knowledge Protection; Trade Secrets: Legal Aspects, Misappropriation, and Enforcement.

**Unit 5 Contemporary Trends, Global Innovation, and IPR for Start-ups 12 hours**

Technological Developments in IPR: Software, Databases, Biotechnology, and AI; World Intellectual Property Organization (WIPO) and Global IPR Governance; Global Innovation Index (GII): Parameters, Rankings, and India's Performance; Relevance of IPR for Start-ups, MSMEs, and Economic Growth; Data Privacy, Plagiarism, and Ethics in IPR; Public-Private Partnerships, Bilateral and Regional Agreements (WTO, TRIPS Implementation)

**Experiential Learning**

1. Patent Search using InPASS
2. Drafting Claims for Patent
3. Case Study on IP Infringement

**Textbooks**


1. Ganguli, P. (2001). *Intellectual Property Rights: Unleashing the Knowledge Economy*. Tata McGraw-Hill Publishing Company.
2. Singh, K. (2020). *Textbook on Biosafety and Bioethics*. Kalyani Publishers.
3. Bansal, K., & Bansal, P. (2012). *Fundamentals of Intellectual Property for Engineers*. BSP Books Pvt. Ltd.


**Reference Books and Review Articles**


1. WIPO. (2004). *WIPO Intellectual Property Handbook: Policy, Law and Use*. World Intellectual Property Organization.
2. Debroy, B., & Sanjeev, S. (2018). *Intellectual Property Rights in Developing Countries*. Academic Foundation.
3. Fleming, J. T. (2012). *Biosafety in the Laboratory: Practical Principles, Guidelines, and Techniques*. Cold Spring Harbor Laboratory Press.

**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| Weightage (%) | 10 | 20 | 20 | 50 |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 2 | 2 | 2 |
| CO2 | 3 | 3 | 1 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| CO3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 |
| CO4 | 2 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 3 | 3 | 3 | 2 |
| CO5 | 2 | 2 | 1 | 1 | 1 | 3 | 1 | 2 | 2 | 3 | 3 | 2 |
| Average | 3 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| MIB511 | Environmental Monitoring and Surveillance | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | **1.2** | **3** | **1** | **0** | **4** |
| **Pre-requisites/Exposure** | Environmental Microbiology, Ecology, Analytical Chemistry | | | | |
| **Co-requisites** | Toxicology, Molecular Biology, Biostatistics | | | | |

**Course Objectives**

1. To introduce key concepts and approaches in environmental monitoring and surveillance.
2. To equip students with practical tools for monitoring air, water, soil, and biological contaminants.
3. To understand biosensors, molecular, and microbial tools for environmental surveillance.
4. To assess environmental risks, pollution sources, and mitigation strategies.
5. To explore global and national policies on environmental health and public safety.

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** principles and frameworks for environmental monitoring and regulatory compliance.
CO2 : **Understand** physical, chemical, and biological tools for environmental sample analysis.
CO3 : **Apply** surveillance strategies for environmental pathogens and pollutants.
CO4 : **Analyse** environmental data and assess ecological/public health risks.
CO5 : **Evaluate** scientific monitoring with policy frameworks and community health strategies.

**Catalogue Description**

This course provides theoretical and practical exposure to environmental monitoring of air, water, soil, and biotic components using modern surveillance tools. Emphasis is laid on pollution assessment, risk evaluation, biosafety, and integration with public health decision-making.

**Course Content**

**Unit 1 Fundamentals of Environmental Monitoring** **10 hours**
Monitoring objectives, indicator selection, sample collection and handling. Environmental sampling strategies and standards (ISO, EPA, CPCB). Biosafety, transport, and data integrity.

**Unit 2 Water and Soil Quality Monitoring** **12 hours**
Parameters: pH, turbidity, BOD, COD, TDS, nitrate, phosphate, heavy metals. Microbiological testing for coliforms, *E. coli*, pathogens. Soil respiration, organic content, contamination indices.

**Unit 3 Air and Bioaerosol Monitoring** **14 hours**
Air quality indices, particulate matter, NOx, SOx, VOCs. Bioaerosol sampling, spore and pollen detection, airborne pathogens. Indoor and occupational air surveillance.

**Unit 4 Molecular and Microbial Biosurveillance Tools** **12 hours**
Use of biosensors, qPCR, metagenomics, remote sensing in environmental diagnostics. Detection of GMOs, ARGs, persistent pathogens. Microbial source tracking and biodegradation markers.

**Unit 5 Risk Analysis and Environmental Policy Frameworks 12 hours**

Ecological risk assessment, hazard identification, exposure modeling. Environmental epidemiology, One Health approach. Indian and global policy acts (EPA, CPCB, SDGs, Paris Agreement).

**Experiential Learning**

1. Field sampling of water, soil, or air followed by lab analysis.
2. Visit to an environmental surveillance or pollution control lab
3. Case study on environmental disease outbreak or contamination event.

**Textbooks**

1. Pepper, I.L., Gerba, C.P. *Environmental Microbiology*. Elsevier.
2. Arora, D.R., Arora, B. *Textbook of Environmental Studies*. Himalaya Publishing.
3. Mishra, P.C. *Environmental Pollution and Management*. APH Publishing.

**Reference Books**

1. APHA. *Standard Methods for the Examination of Water and Wastewater*.
2. CPCB and MoEFCC (India) regulations and manuals.

**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| Weightage (%) | 10 | 20 | 20 | 50 |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 |
| CO2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 |
| Average | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| MIB512 | Quality Management Systems | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | 1.0 | **3** | **1** | **0** | **4** |
| **Pre-requisites/Exposure** | Basic microbiology, biosafety, and laboratory operations knowledge. | | | | |
| **Co-requisites** | None | | | | |

**Course Objectives**

1. To introduce the principles and evolution of Quality Management Systems (QMS) in microbiology and biochemistry.
2. To explore international standards, laboratory practices, and risk assessment tools in QMS.
3. To train students in the preparation of SOPs and regulatory documentation.
4. To provide exposure to audit practices, CAPA, and data integrity systems.
5. To encourage hands-on learning and problem-solving through simulated QMS project design.

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** QMS fundamentals, terminologies, and regulatory authorities.
CO2 : **Understand** key QMS frameworks and laboratory compliance standards.
CO3 : **Apply** quality tools such as SOPs, FMEA, and CAPA to microbiological testing processes.
CO4 : **Analyze** audit findings, identify non-compliances, and recommend corrective actions.
CO5 : **Evaluate** and design a functional QMS model for microbiology/biochemistry laboratories.

**Catalogue Description**

This course equips students with theoretical and applied knowledge of Quality Management Systems relevant to microbiology labs. Topics include ISO standards, GLP/GMP, risk analysis, audits, documentation, and QMS software with project-based learning.

**Course Content**

**Unit 1 Introduction to QMS** **12 hours**
Definition, scope, and principles; Evolution of QMS in microbiology, QA vs. QC; regulatory bodies (FDA, WHO, EMA); QMS evolution in microbiology.

**Unit 2 Standards and Frameworks** **12 hours**
ISO 9001, ISO 17025, GMP, GLP; FDA case studies on microbiological non-compliance. Biosafety levels (BSL-1 to BSL-4); PPE and microbial waste management.

**Unit 3 Risk Management** **12 hours**
FMEA technique for microbial contamination risks; Root cause analysis, SOP preparation (sterility, endotoxin)

**Unit 4 Data Integrity and Documentation** **12 hours**
ALCOA+ principles; Use of ELNs and demo of QMS software tools.

**Unit 5 Audits and Continuous Improvement** **12 hours**

Types of audits; CAPA implementation; Guest lecture on audit readiness.

**Experiential Learning**

1. Group project: Design a QMS framework for a hypothetical microbiology/biochemistry lab.
2. Design and Validation of SOPs for Endotoxin Testing in a Pharmaceutical Microbiology Lab

**Textbooks**


1. Rosamund M. Baird, Norman A. Hodges & Stephen P. Denyer (2019). Handbook of Microbiological Quality Control in Pharmaceuticals and Medical Devices, Taylor and Francis.
2. Sharma, R (2010). *Good Laboratory Practices,* 3rd Edition, CBS Publishers.
3. Sandle, T (2015). *Pharmaceutical Microbiology: Essentials for Quality Assurance and Quality Control,* Woodhead Publishing.
4. Tim Sandle, Madhu Raju Saghee (2017). Cleanroom Management in Pharmaceuticals and Healthcare: 2nd Edition, Euromed Communications.
5. James O. Westgard (2014). Basic Quality Management Systems: Essentials for Analytical Quality Assurance, Westgard Quality Corporation.


**Reference Books**


1. ISO 17025:2017, ISO 15189, ISO 9001 manuals.
2. FDA Regulatory Guidance Documents.
3. USP and BIS standards for microbiological testing.
4. Jennifer Stepniowski (2016). ISO 9001:2015 Quality Management System Audit Checklist
5. Milton P. Dentch (2016). The ISO 9001:2015 Implementation Handbook: Using the Process Approach to Build a Quality


**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| Weightage (%) | 10 | 20 | 20 | 50 |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | - | - | - | - | - | 2 | 1 | 2 | - |
| **CO2** | 3 | 3 | 2 | 2 | - | - | - | - | 2 | 1 | 2 | - |
| **CO3** | 2 | 3 | 3 | 3 | 2 | 2 | - | - | 2 | - | - | - |
| **CO4** | 2 | 3 | 3 | 2 | 3 | 3 | - | - | 2 | - | - | - |
| **CO5** | 2 | 3 | 3 | 3 | 3 | 3 | - | 2 | 2 | 2 | 2 | 1 |
| **Average** | **2.4** | **2.8** | **2.6** | **2** | **1.6** | **1.6** | - | **0.4** | **2** | **0.8** | **1.2** | **0.2** |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| MIB513 | Process Plant and Bioreactor Design | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | **1.0** | **3** | **1** | **0** | **4** |
| **Pre-requisites/Exposure** | Basics of microbiology, biochemistry, fermentation principles, and instrumental techniques. | | | | |
| **Co-requisites** | None | | | | |

**Course Objectives**

1. To understand the fundamentals of bioreactor design and process flow in industrial biotechnology.
2. To impart knowledge on the types, components, and operations of bioreactors.
3. To train students in the design principles of upstream and downstream process equipment.
4. To develop practical skills for process scale-up, instrumentation, and control in fermentation.
5. To familiarize students with regulatory and safety considerations in bioprocess plant design.

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** the principles of bioreactor design and classification.
CO2 : **Understand** the components and operational parameters of various bioreactor systems.
CO3 : **Apply** design principles to construct process flow diagrams for industrial microbiology.
CO4 : **Analyze** scale-up challenges, control strategies, and mass/heat transfer considerations.
CO5 : **Evaluate** bioprocess plant layout, safety, and compliance factors.

**Catalogue Description**

This course integrates theoretical principles and practical applications of bioreactor and process plant design in industrial microbiology and biochemistry. Students learn about reactor types, components, instrumentation, and bioprocess control, along with hands-on training in lab-scale reactor systems and process simulations.

**Course Content**

**Unit 1 Introduction to Bioreactor Design** **12 hours**

Bottom line procedures of generalized bioprocess and design view, general design information; Possible milestones in a design project, process flow sheeting, review of mass and energy balance, Use of computer-aided process design and simulation packages.

**Unit 2 Bioreactor Components, Design and Functions** **12 hours**

Selection and basic concepts of design of heat exchangers used in bioprocess Industries, Agitators, spargers, baffles, seals, valves, sampling ports, sensors, temperature/pH/DO control; sterilization-in-place (SIP) and cleaning-in-place (CIP).

**Unit 3 Process Flow and Plant Layout** **12 hours**

Process flow diagrams (PFD), piping and instrumentation diagrams (P&ID), upstream and downstream integration, and facility planning for fermentation units, Materials of construction for bioprocess plants; piping details of size, length and type of valves and fittings, Mechanical design of process equipment.

**Unit 4 Scale-Up, Mass Transfer and Instrumentation** **12 hours**

Oxygen transfer (kLa), power input, heat transfer, mixing time, aeration; criteria for scale-up; shear stress and productivity considerations. Bioprocess monitoring systems; sensors, data acquisition systems; feedback, feed forward, and cascade control; control of foam, DO, pH, temperature.

**Unit 5 Regulatory and Safety Aspects** **12 hours**

GMP/GLP in plant design; biosafety levels; hazard analysis of products (HAZOP), pressure relief systems, safety protocols for microbial containment, Plant startup safety review, safety aspects of the plant shut down procedures. Gantt chart (time schedule) with each steps of standard procedure of shut down of the plant.

**Experiential Learning**

1. Visit to any fermentation industry to observe process operation and optimization.
2. Measurement of kLa and mixing time in a lab-scale bioreactor.

**Textbooks**


1. Casida, L.E. JR (2019). *Industrial Microbiology*, 2nd Edition, New Age International Publishers.
2. Okafor N & Okeke C (2018). *Modern Industrial Microbiology And Biotechnology, 2nd Edition*, CRC Press.
3. Stanbury, P.F., Whitaker, A., Hall, S. J (2016). *Principles of Fermentation Technology*, 3rd Edition, Butterworth-Heinemann.
4. Patel, A.H (2011). *Industrial Microbiology*, Laxmi Publications.


**Reference Books**


1. Beemagani, S & Pittala, N (2025). Industrial Microbiology, SIP.
2. Doran, P.M. Bioprocess Engineering Principles, Academic Press.
3. Demain, A.L. & Davies, J.E. *Manual of Industrial Microbiology and Biotechnology*, ASM Press.
4. Harrison, R.G. et al. *Bioseparations Science and Engineering*, Oxford University Press.


**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| Weightage (%) | 10 | 20 | 20 | 50 |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | | | | | | 1 | 1 | 2 | |
| **CO2** | 3 | 3 | 2 | 2 | 1 | | | | 1 | 1 | 2 | |
| **CO3** | 3 | 3 | 3 | 3 | 2 | 2 | | | 2 | 2 | 3 | 1 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 2 | | 1 | 2 | 2 | 3 | 1 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 2 | 3 | 2 |
| **Average** | **3** | **2.8** | **2.6** | **2.2** | **2** | **1.6** | **0.4** | **0.4** | **1.6** | **1.6** | **2.6** | **0.8** |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| MIB514 | Innovation and Entrepreneurship in Biotechnology | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | **1.0** | **2** | **0** | **0** | **2** |
| **Pre-requisites/Exposure** | Knowledge of scientific methods and techniques in the undergraduate level | | | | |
| **Co-requisites** | | | | | |

**Course Objectives**

1. To cultivate innovation and entrepreneurial mindset among students in biotechnology.
2. To develop the ability to translate scientific discoveries into viable bio-based solutions.
3. To understand the role of biotechnology in achieving sustainable development goals (SDGs).
4. To impart knowledge on venture creation, business models, and commercialization pathways.
5. To introduce funding mechanisms, start-up opportunities, and the evolving bio-economy landscape.

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : Explain the concepts of ideation, discovery, and innovation in the biotechnology sector.
CO2 : Illustrate the application of biotechnology innovations in addressing SDGs and global challenges.
CO3 : Design business models for biotech ventures using established tools like Business Model Canvas.
CO4 : Identify and explore grant opportunities, fellowships, and ecosystem support for biotech start-ups.
CO5 : Analyze the structure, trends, and socio-economic impact of the emerging bio-economy.

**Catalogue Description**

The course is designed to be sector-focused yet interdisciplinary, combining biotechnology, innovation management, and entrepreneurship development to create job-ready bio-innovators and start-up founders.

**Course Content**

**Unit 1 Ideation, Discovery, and Innovation in Biotechnology 12 hours**

Concept of Ideation, Discovery, Creativity, Invention, and Innovation; Techniques for Idea Generation in Biotechnology; Interdisciplinary Approaches and Collaboration in Bio-Innovation; Case Studies of Innovative Breakthroughs in Biotechnology

**Unit 2 Bio-Innovation and Sustainable Development Goals (SDGs) 12 hours**

Overview of SDGs and Global Development Challenges; Role of Biotechnology in Achieving SDGs (Health, Agriculture, Environment, Energy); Social Innovation and Inclusive Growth through Biotechnology; Success Stories of Bio-Innovations aligned with SDGs

**Unit 3 Venture Creation and Business Model Development 12 hours**

Overview of the Biotech Start-up Ecosystem; Elements of a Business Model: Value Proposition, Customer Segments, Revenue Streams; Business Model Canvas Framework Applied to Biotech Ventures; Intellectual Property Considerations for Biotech Entrepreneurs; Commercialization Pathways for Biotech Products and Services.

**Unit 4 Opportunities for Biotech Start-ups, Grants, Fellowships, and the Bio-Economy 12 hours**

Entrepreneurship Opportunities in the Indian and Global Biotech Sectors; Government and Private Sector Grants (e.g., BIRAC, DBT, MSME, Start-up India); National and International Fellowships for Bio-entrepreneurs; Prominent Biotech Start-ups, Case Studies, and their Impact; Role of Incubators, Accelerators, and Networking Platforms in Biotechnology

**Unit 5 Emerging Trends, Challenges, and the Future of Bio-Innovation 12 hours**

Global and Indian Bio-economy: Definition, Structure, and Emerging Opportunities; Role of Biotechnology in Circular Economy and Sustainable Development; Current Trends: Synthetic Biology, AI in Biotech, and Digital Health Solutions; Challenges in Scaling, Regulations, and Market Entry for Biotech Ventures; Future Outlook: Global Collaborations, Investment Trends, and Policy Support

**Experiential Learning**

1. Identification of Problem statement
2. Preparing Business Pitch
3. Creation of Business model canvas

**Textbooks**


1. Rathore, A. S., & Pathak, M. (2021). *Fundamentals of Biotechnology: Innovation and Commercialization*. Academic Press.
2. Ganguli, P. (2001). *Intellectual Property Rights: Unleashing the Knowledge Economy*. Tata McGraw-Hill.
3 Nicholas, P., & Steenkamp, J. (2021). *Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies*. Academic Press.


**Reference Books and Review Articles**


1. OECD. (2009). *The Bioeconomy to 2030: Designing a Policy Agenda*. Organisation for Economic Co-operation and Development.
2. Debroy, B., & Sanjeev, S. (2018). *Intellectual Property Rights in Developing Countries*. Academic Foundation.
3. European Commission. (2012). *Bioeconomy in Europe: State of Play and Future Potential*. Publications Office of the European Union.

**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| Weightage (%) | 10 | 20 | 20 | 50 |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 2 | 2 | 2 |
| CO2 | 3 | 3 | 1 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| CO3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 |
| CO4 | 2 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 3 | 3 | 3 | 2 |
| CO5 | 2 | 2 | 1 | 1 | 1 | 3 | 1 | 2 | 2 | 3 | 3 | 2 |
| Average | 3 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| MIB517 | Dissertation Part II | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | **2.0** | **0** | **0** | **12** | **12** |
| **Pre-requisites/Exposure** | Successful completion of Dissertation Part I | | | | |
| **Co-requisites** | | | | | |

**Course Objectives**

1. To complete experimental work addressing the defined research objectives.
2. To generate reproducible and statistically valid data.
3. To interpret results in the context of existing scientific literature.
4. To develop skills in thesis writing and scientific argumentation.
5. To prepare students for doctoral-level research and publication.

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** advanced concepts relevant to data interpretation and discussion.
CO2 : **Understand** relationships between experimental results and biological mechanisms.
CO3 : **Apply** advanced analytical, molecular, or computational techniques as required.
CO4 : **Analyse** and integrate results to draw scientifically sound conclusions.
CO5 : **Evaluate** the novelty, limitations, and future scope of the research work.

**Catalogue Description**

This course represents the culmination of the postgraduate dissertation initiated in the previous semester. Students complete experimental investigations, analyse and interpret data, and present their findings in the form of a structured dissertation. Emphasis is placed on critical evaluation of results, integration with published literature, and identification of future research directions. Students develop competence in scientific writing, data presentation, and oral defense. The course prepares graduates for doctoral research, industrial R&D, and evidence-based problem-solving in microbiology.

**Modes of Evaluation**

| Components | Thesis | Research Presentation | Total (End Semester) |
|---|---|---|---|
| **Weightage (%)** | **50** | **50** | **100** |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | - | 3 |
| **CO2** | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | - | 3 |
| **CO3** | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | - | 3 |
| **CO4** | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | - | 3 |
| **CO5** | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | - | 3 |
| **Average** | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | - | 3 |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

**Syllabus for 2nd Year**

**with**

***Research***

*Specialisations Offered* –

- **Toxicology**
- **Quality Management Systems**
- **Bioprocess Technology**

| MIB501 | Environmental Microbiology | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | **2.0** | **2** | **1** | **1** | **4** |
| **Pre-requisites/Exposure** | Knowledge of Bacteriology and Ecology | | | | |
| **Co-requisites** | Fundamental Biochemistry and Microbial Physiology | | | | |

**Course Objectives**

1. To provide a mechanistic understanding of microbial processes in soil, water, and air environments.
2. To explain microbial participation and metabolic regulation of biogeochemical cycles.
3. To analyse plant–microbe and microbe–microbe interactions shaping ecosystem function.
4. To apply environmental microbiology principles to waste management, bioremediation, and engineered systems.
5. To evaluate the role of microorganisms in sustainability and achievement of Sustainable Development Goals (SDGs).

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** microbial diversity and distribution across terrestrial, aquatic, and atmospheric environments.
CO2 : **Understand** metabolic pathways and regulatory mechanisms driving biogeochemical cycles.
CO3 : **Apply** microbiological tools to assess environmental quality and microbial function.
CO4 : **Analyse** environmental processes and pollution scenarios using microbial systems thinking.
CO5 : **Evaluate** microbial strategies for environmental sustainability, waste management, and SDG implementation.

**Catalogue Description**

This course provides an advanced understanding of microorganisms as regulators of environmental processes in soil, water, and air. Emphasis is placed on microbial diversity, metabolic pathways driving biogeochemical cycles, plant–microbe interactions, and microbial responses to environmental stress. The course bridges natural and engineered ecosystems, covering waste management, bioremediation, and microbial solutions for sustainability. Integrating mechanistic insights with applied perspectives, the course prepares students for doctoral research and careers in environmental biotechnology, policy, and allied industries, while highlighting the contribution of environmental microbiology to achieving Sustainable Development Goals.

**Course Content**

**Unit 1 Microbial Diversity in Ambient Environments 10 hours**

Microbial biogeography in terrestrial, aquatic, atmospheric and host-associated environments; drivers of microbial diversity; freshwater and marine microflora and nutrient cycling; microbial dispersal through air; applications of environmental microbiomes in agriculture, ecosystem services, and sustainability; introduction to metagenomics and amplicon sequencing (16S/18S/ITS); functional *vs* taxonomic profiling of environmental microbial communities; concept of microbial consortia and functional guilds.

**Unit 2 Microbial Diversity in Extreme Environments 8 hours**

Occurrence and diversity of oligotrophs, thermophiles, psychrophiles, barophiles, halophiles, acidophiles, alkaliphiles, metallophiles, solvent- and radiation-tolerant microorganisms; physicochemical constraints of extreme habitats; molecular and metabolic adaptations of enzymes, membranes, DNA repair systems, osmolytes, and redox metabolism; applications of extremophiles in industry, bioremediation.

**Unit 3 Soil Microbiology and Biogeochemical Cycling 12 hours**

Microbial interactions; rhizosphere, rhizoplane, endorhizosphere, and phyllosphere microbiology; composting, biofertilizers, and biological pest control; microbial mediation of biogeochemical cycles: Carbon cycle, soil carbon stabilization; Nitrogen, Phosphorus and sulphur cycles – mineralization, solubilization, redox transformations; Iron and manganese cycles – microbial redox processes, siderophores and soil structure

**Unit 4 Environmental Waste Management and Water Microbiology 8 hours**

Microbial processes in solid waste management: composting and sanitary landfills; sewage composition and strength (BOD, COD); microbial ecology of primary, secondary and tertiary wastewater treatment; drinking water and microbial safety; microbial indicators and risk-based assessment of potable water quality.

**Unit 5 Microbial Bioremediation and Sustainability 7 hours**

Principles of microbial bioremediation; degradation of pesticides and petroleum hydrocarbons; aerobic and anaerobic degradation pathways; microbial transformation and immobilization of metals; biosurfactants and pollutant bioavailability; bioleaching of copper, gold, and uranium; role of environmental microbiology in circular bioeconomy and achieving SDGs (clean water, soil health, climate action).

**Unit 6 Laboratory Exercises in Environmental Microbiology 30 hours**

Isolation of amylase-, protease-, urease-, and phosphatase-producing microorganisms
Presumptive, confirmed, and completed tests for coliforms
IMViC tests for differentiation of enteric bacteria
Enumeration of soil and water microorganisms by serial dilution and plate count
Isolation and characterization of phosphate-solubilizing and nitrogen-fixing microorganisms
Estimation of soil enzyme activities (dehydrogenase, phosphatase)
Microbial degradation of model organic pollutants
Assessment of drinking water microbiological quality

**Experiential Learning**

1. Case study: microbial failure and recovery in wastewater treatment plants
2. Field-based analysis of soil or water microbial quality
3. Research paper discussion on microbial biogeochemical cycling
4. SDG mapping exercise linking microbial processes to sustainability goals

**Textbooks**


1. Madigan, M.T., Bender, K.S., Buckley, D.H., Sattley, W.M., and Stahl, D.A. (2025). *Brock Biology of Microorganisms*. 16th Edition. Pearson.
2. Atlas, R.M. and Bartha, R. (2014). *Microbial Ecology: Fundamentals and Applications*. 4th Edition. Pearson.


**Reference Books**


1. Raina, M.M. (2013). *Environmental Microbiology*. Oxford & IBH Publishing.
2. Cappuccino, J.G. and Welsh, C.T. (2023). *Microbiology: A Laboratory Manual*. 11th Edition. Pearson Education.


**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| **Weightage (%)** | **10** | **20** | **20** | **50** |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 1 | 2 | 1 | 1 | 3 | 1 | – | 1 | – | 1 |
| **CO2** | 3 | 3 | 2 | 2 | 2 | 2 | 3 | – | – | 1 | – | 1 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | – | – | 2 | – | 1 |
| **CO4** | 3 | 3 | 3 | 2 | 2 | 3 | 2 | – | 1 | 2 | 1 | 2 |
| **CO5** | 2 | 3 | 2 | 2 | 2 | 3 | 2 | 1 | 2 | 3 | 3 | 3 |
| **Average** | 2.6 | 2.8 | 2.2 | 2.2 | 2.0 | 2.2 | 2.4 | 0.4 | 0.6 | 1.8 | 0.8 | 1.6 |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| MIB502 | Bioanalytical Techniques | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | 1.0 | **2** | **1** | **1** | **4** |
| **Pre-requisites/Exposure** | Basic knowledge of biomolecules, instrumentation, and quantitative analytical methods. | | | | |
| **Co-requisites** | None | | | | |

**Course Objectives**

1. To provide theoretical understanding of key bioanalytical techniques used in molecular biology, microbiology, and biochemistry.
2. To impart knowledge of qualitative and quantitative analysis of biological macromolecules.
3. To familiarize students with chromatography, electrophoresis, spectroscopy, and advanced techniques.
4. To provide hands-on experience in using bioanalytical tools in the lab.
5. To train students in interpreting data from modern analytical instrumentation.

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** the principles of major bioanalytical techniques.
CO2 : **Understand** the working and applications of spectroscopy, chromatography, and electrophoresis.
CO3 : **Apply** techniques for qualitative and quantitative analysis of biomolecules.
CO4 : **Analyze** experimental results and validate analytical methods.
CO5 : **Evaluate** appropriate analytical tools for different biological samples.

**Catalogue Description**

This course provides a comprehensive overview of qualitative and quantitative bioanalytical techniques such as chromatography, electrophoresis, spectroscopy, and immunoassays, supported by hands-on lab sessions to develop analytical competence.

**Course Content**

**Unit 1 Chromatographic Techniques** **9 hours**

Paper, Thin Layer Chromatography (TLC), Column, Ion Exchange, Gel Filtration, and Affinity Chromatography, HPLC and GC: Principles, detectors, and applications.

**Unit 2 Electrophoretic Techniques** **9 hours**

PAGE, SDS-PAGE, Native-PAGE, Agarose Gel Electrophoresis, 2D electrophoresis, Capillary electrophoresis, Immunoelectrophoresis.

**Unit 3 Spectroscopic Techniques** **9 hours**

UV-Vis spectroscopy, Fluorescence spectroscopy, Infrared (IR), Circular Dichroism (CD), Atomic Absorption Spectroscopy (AAS) and Mass Spectrometry basics.

**Unit 4 Immunoanalytical and Enzymatic Techniques** **9 hours**

ELISA (Direct, Indirect, Sandwich, Competitive), RIA, Western Blot, Lateral flow assay, Enzyme activity assays and applications in diagnostics

**Unit 5 Advanced Analytical Tools and Quality Control** **9 hours**

Flow Cytometry, Surface Plasmon Resonance (SPR), Microarrays; Instrument calibration and maintenance, Validation of analytical methods

**Unit 6 Lab Exercises in Bioanalytical Techniques** **30 hours**

Separation of amino acid mixture by Paper chromatography and TLC
Estimation of DNA and RNA of a bacterial cell.
Separation of DNA through Agarose Gel Electrophoresis
Separation of protein through SDS-PAGE electrophoresis
Determination of activity of amylase, protease

**Experiential Learning**

1. Separation of plant pigments using TLC and column chromatography.
2. Visit to a research institute to experience practical applications of Mass spectrometry, CD spectroscopy, etc.
3. To perform fluorescence spectroscopy for quenching study.

**Textbooks**


1. Hofmann, A. and Clokie Wilson, S (2018). *Wilson And Walker's Principles And Techniques Of Biochemistry And Molecular Biology*, Cambridge University Press.
2. Sheehan, D (2009). *Physical Biochemistry: Principles and Applications*, John Wiley & Sons Inc.
3. Robyt, J. F. (2015). *Biochemical Techniques: Theory and Practice*, CBS.
4. Allen, J. P. (2008). *Biophysical Chemistry* Wiley-Blackwell.


**Reference Books**


1. Atkins, P. and Paula, J (2011). *Physical Chemistry for the Life Sciences*, W.H. Freeman.
2. Kalidas, C. and Sangaranarayanan, M.V. (2023). *Biophysical Chemistry: Techniques and Applications*,
3. Dash, U. N (2006). *Textbook of Biophysical Chemistry*, Macmillan.
4. Upadhyay, A., Upadhyay, K. and Nath, N (2009). *Biophysical Chemistry: Principles and Techniques*, Himalaya Publishing House.


**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| Weightage (%) | 10 | 20 | 20 | 50 |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | 2 | 2 | – | 2 | – | – | – | 1 | – |
| **CO2** | 3 | 3 | 2 | 2 | 3 | – | 2 | – | – | – | 1 | – |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 2 | 3 | – | – | – | 1 | – |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 2 | 3 | – | 2 | – | 1 | – |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 2 |
| **Average** | 3 | 2.8 | 2.4 | 2.6 | 2.8 | 1.4 | 2.6 | 0.4 | 0.8 | 0.4 | 1 | 0.4 |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| MIB503 | Natural Product and Toxicology | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | **3.0** | **2** | **1** | **1** | **4** |
| **Pre-requisites/Exposure** | **Knowledge of Basic Biochemistry** | | | | |
| **Co-requisites** | | | | | |

**Course Objectives**

1. **Remember** the role of natural products in drug development, including chemical diversity and structure-based drug design.
2. **Understand** various extraction, isolation, and bioassay techniques used for identifying bioactive compounds from natural sources.
3. **Apply** analytical techniques for detecting toxicants and heavy metals in biological and food samples using chromatographic and spectroscopic methods.
4. **Analyze** the interaction between food, nutrients, and drugs, and the implications for pharmacokinetics and health outcomes.
5. **Evaluate** the toxicological risks associated with food, drugs, and natural toxins, including principles of dose-response and organ toxicity.

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** the significance of natural products and their structural diversity in guiding modern drug discovery, including real-world examples like statins and taxol.

CO2 : **Understand use of** extraction, purification, and bioassay-guided fractionation methods to isolate bioactive compounds.

CO3 : **Apply** analytical tests including chromatography, ELISA, and atomic spectroscopic techniques to detect and quantify toxicants and contaminants in food and drug samples.

CO4 : **Analyze** nutrient-drug interaction case studies to assess how diet influences drug absorption, metabolism, and effectiveness.

CO5 : **Evaluate** the toxicity and safety of various natural and synthetic substances by applying toxicological principles such as LD50, biotransformation, and organ-specific effects.

**Catalogue Description**

This course explores the role of natural products in drug discovery, focusing on plant-derived compounds, microbial metabolites, and their applications in modern medicine. It covers techniques for the extraction, isolation, and bioassay of natural substances, along with structure elucidation methods. Students will examine nutrient-drug interactions, the principles of toxicology, and the impact of food toxicants on health. Emphasis is placed on analytical toxicology, including chromatography and spectroscopic methods for detecting contaminants. Case studies and real-world examples provide a practical understanding of how natural products guide therapeutic development and toxicological assessment.

**Course Content**

**Unit 1 Natural Products in Drug Discovery 7 hours**

Approaches to modern drug development; Role of natural products in drug discovery; Plant-derived drugs and novel drug templates; Chemical diversity and structure-based drug design; Bioactive compounds from microorganisms (antibiotics, non-antibiotics, microbial phytotoxins); Structure elucidation of natural products using classical, spectroscopic, synthetic, and degradative methods; Case studies: Statins, Taxol, cardiac glycosides, vinca alkaloids, morphine, quinine, podophyllotoxin

**Unit 2 Extraction and Screening of Natural Compounds 10 hours**

Extraction, isolation, and purification techniques for bioactive compounds; Bioassay-guided fractionation of natural products; Disease conditions where natural products are preferred over synthetic drugs; Developments in adaptogens, immunomodulators, memory enhancers, anti-inflammatories, and antiparasitics; Screening methods for active compound isolation; Genetically engineered and biotechnology-derived natural products

**Unit 3 Nutraceuticals and Food-Drug Interactions 10 hours**

Food–drug and nutrient interactions affecting ADME (absorption, distribution, metabolism, excretion); Alcohol and nutrient deficiencies; Interactions of antidepressants and psychoactive drugs with nutrients; Effects of appetite changes, drug intake, and malnutrition on therapeutic outcomes; Overview of nutraceuticals, functional foods, and their biomedical significance

**Unit 4 Toxicology and Risk Assessment 10 hours**

Classification of food and environmental toxicants; Food laws, safety standards, and regulatory frameworks; Principles of toxicology: exposure, dose-response, biotransformation (Phase I & II); Carcinogenesis, mutagenesis, teratogenesis, and organ-specific toxicity; Natural toxins in food (plant origin, mushrooms, marine toxins, mycotoxins); Food adulteration, pesticide residues, and toxicants from food processing

**Unit 5 Analytical Toxicology and Instrumentation 8 hours**

Qualitative and quantitative assessment of toxicants; Toxicity exposure limits, LD50 and ED50 concepts; Chromatographic analysis of pesticides and contaminants; Spectrophotometric and atomic spectroscopy techniques: AAS, AES, ICP; Detection of drugs of abuse and environmental contaminants; Immunoassay techniques for genotoxicity: ELISA

**Unit 6 Laboratory Exercises 30 hours**

Determination of LD50 using model organisms or simulated calculations; Detection of heavy metals in food and water samples; Extraction and isolation of alkaloids and other bioactive compounds from plant material; Antibacterial activity testing of natural products; Antibiotic assay and microbial inhibition zone analysis; Case-based analysis of food-drug interactions and toxicity assessments

**Experiential Learning**

1. Chronic exposure linked to liver cancer and immunosuppression in tropical countries due to poor storage
2. Organophosphate poisoning in the Delhi Midday Meal tragedy
3. Rediscovery of *Artemisia annua* (sweet wormwood) leading to Nobel-winning antimalarial

4. Development of microtubule-targeting anticancer agents for breast and ovarian cancer

**Textbooks**


1. Barceloux, D.G. (2008). *Medical Toxicology of Natural Substances: Foods, Fungi, Medicinal Herbs, Plants, and Venomous Animals.* John Wiley & Sons, Inc. ISBN: 9780471727613.
2. Pelkonen, O., Duez, P., Vuorela, P.M., & Vuorela, H. (Eds.) (2019). *Toxicology of Herbal Products.* Springer. ISBN: 978-3319829159.


**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| **Weightage (%)** | **10** | **20** | **20** | **50** |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 2 | 1 | – | 2 | – | – | – | 1 | – |
| **CO2** | 3 | 3 | 2 | 2 | 3 | – | 2 | – | – | – | 1 | – |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 2 | 3 | – | – | – | 1 | – |
| **CO4** | 3 | 3 | 3 | 3 | 2 | 2 | 3 | – | 2 | – | 1 | – |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 2 |
| **Average** | 3 | 2.8 | 2.6 | 2.6 | 2.4 | 1.4 | 2.6 | 0.4 | 0.8 | 0.4 | 1 | 0.4 |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| MIB504 | Food and Pharmaceutical Microbiology | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | **2.0** | **2** | **1** | **1** | **4** |
| **Pre-requisites/Exposure** | Basic knowledge of microbiology and life science | | | | |
| **Co-requisites** | - | | | | |

**Course Objectives**

1. To provide a comprehensive understanding of synthesizing microbial food products and its applications.
2. To develop knowledge of food biotechnology and genetic engineering in food production with an in-depth understanding of food safety and pharmaceutical standards and regulatory frameworks
3. To enable the identification, control, and prevention of microbial contamination in food and pharmaceutical environments with technical knowledge of sterilization, disinfection, and aseptic processing.
4. To introduce the principles of vaccine development and biopharmaceutical production.

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** the role of microbiology in food production and pharmaceutical applications
CO2 : **Understand** sources of contamination and spoilage in food production and pharmaceutical environments.
CO3 : **Apply** process of sterilization, disinfection, and aseptic processing.
CO4 : **Analyse** microbial assays of antibiotics and sterility testing and examine the production, regulation, and quality control of vaccines and biopharmaceuticals.
CO5 : **Evaluate** pharmacopoeial standards and follow Good Manufacturing Practices (GMP).

**Catalogue Description**

This course provides a comprehensive overview of microbial applications in the food and pharmaceutical industries, with a focus on food safety, quality control, and biotechnology. Students will explore the production of microbial food products such as Single Cell Protein (SCP), probiotics, and edible mushrooms, as well as their nutritional and functional roles in human health. Key topics include food biotechnology, genetic modification, microbial contamination, sterilization, and disinfection processes, along with antibiotic production and vaccine development. The course emphasizes regulatory frameworks, quality assurance systems like HACCP and Good Laboratory Practices (GLP) and introduces intellectual property rights related to biotech products. Practical sessions offer hands-on training in microbial assays, probiotic development, preservative and disinfectant efficacy testing, and microbial quality assessment of food and pharmaceutical products. By the end of the course, students will gain essential skills for ensuring food and pharmaceutical safety and quality in compliance with global regulatory standards.

**Course Content**

**Unit 1 Microbial Food Products for Human Consumption 7 hours**

Microbial SCP production by bacteria, algae and mycoprotein from fungi for use as food and feed; SCP production process by using different substrates; properties and nutritional values; Industrially used SCP (Quoron, Pruteen); Advantage and disadvantages of SCP. Mushroom cultivation, harvesting and post harvesting; important edible mushroom species; Concept of probiotics, prebiotics, symbiotics and bioactive food; Production and composition of various probiotics; chemistry, metabolism and bioavailability of probiotics; Effect of probiotics on human health and potential application in risk reduction of diseases; genetically modified probiotics/prebiotics.

**Unit 2 Food Biotechnology, Food safety, Quality Control and Trade Regulation of Food Materials 14 hours**

Food safety objectives (FSO), Bacteriology of Water supplies, Sewage in waste treatment and disposal, Indicators of food microbial quality and safety, some indicators of product quality- Coliforms, Enterococci, Bifidobacterium, Coliphages; Microbiological quality standards of food, control and inspection, Enforcement and Govt. Regulatory practices and policies. FDA, EPA, HACCP,ISI; handling of recombinant product; Detection of various methods of food toxicity, Hazard analysis criteria control points (HACCP) system for food safety, HACCP principles, Application of HACCP principles; Introduction to food biotechnology; improvement of the food crops by genetic engineering; genetically modified plants and animals for enhanced food production; safety of GM food crops. Protein engineering in food technology: methods, applications of protein engineering to produce glucose isomerase, *Lactobacillus* betagalactosidase and peptide antibiotic nisin; Transgenic plant foods: golden rice, Btbrinjal, maize, tomato, potato, soyabean etc. Intellectual property rights (IPR) issues, patent application procedure, copyright laws, transfer of copyrights, infringements, trademarks, objectives- rights and protection, biopiracy problems; effect of biotech foods on the food business of developing and developed countries.

**Unit 3 Microbial contamination and preservation 6 hours**

Sources and control of contamination in pharmaceutical environments. Spoilage of pharmaceutical products: tablets, capsules, injectables, syrups; Assessment of microbial contamination and spoilage. Preservation of pharmaceutical products using antimicrobial agents, Types of preservatives and their microbial inhibition mechanisms, evaluation of microbial stability of formulations. Microbial Limit Tests (IP, BP, USP standards); Microbiological Contamination: Product recalls; microbial limit standards; Type of Preservatives for microbiological products. The test methods for evaluation of formulations such as Preservative Efficacy Testing and Stability of Drugs & Stability Testing; Microbiological control: Risk Assessment, Principles and types: moist and dry heat, filtration, radiation, gas; Validation and biological indicators (D-value, Z-value, F-value); Disinfectants: classification, efficacy testing (phenol coefficient, use dilution); Aseptic techniques and cleanroom practices (Class 100/ISO 5); Concept of validation and quality assurance; Disinfectants: Factors in Choice and Use of Disinfectants. Qualification of Disinfectants Test Methods and Validation of disinfectants.

**Unit 4 Antibiotics, Vaccines, Biopharmaceuticals 10 hours**

Fermentation process for antibiotic production (penicillin, streptomycin), Mechanisms of action and resistance, Microbiological assay of antibiotics (agar diffusion, tube dilution); Methods for standardization of antibiotics, vitamins and amino acids. Assessment of a new antibiotic; Types: live attenuated, killed, toxoids, subunit, recombinant; Steps in vaccine production and quality control and storage; Introduction to monoclonal antibodies and biosimilars; Regulatory overview of vaccines (national immunization programs)

**Unit 5 Risk assessment and regulatory principles 8 hours**

Pharmaceutical products and contamination risks; Quality assurance and Quality control of microbial contaminants in pharmaceutical industries with respect to FDA and WHO (GMP and GLP). Their maintenance and requirement criteria as per Indian Pharmacopeia. Case studies; Good practices in food quality management, Introduction of Good laboratory practices (GLP) and its applications, Elements of GLP, OECD guidelines for GLP, National Accreditation Board for Testing and Calibration Laboratories (NABL); Regulatory authorities: WHO, FDA, CDSCO.

**Unit 6 Practical application of Food and Pharmaceutical Microbiology 30 hours**

1. Antibiotic sensitivity assay
2. Microbial examination of Non-sterile products
3. To determine the food quality and its deterioration by measuring the microbial population
4. Isolation of bacterial probiotics from curd and development of probiotics in vitro
5. To check the effect of preservative in different formulations
6. To check the effect of disinfectant

**Experiential Learning**

1. Quality Assessment and Analysis of food
2. To simulate the process of discovering and evaluating an antibiotic from soil microbes.

**Textbooks**


1. Sandle, T, *Pharmaceutical Microbiology*, (2016) Elsevier, 80 High Street, Sawston, Cambridge, CB22 3HJ, UK.
2. Hugo, WB and Russell, AD. *Pharmaceutical Microbiology*, (2003). Blackwell Science, Oxford, UK.
3. Adams, M. R., & Moss, M. O. (2024). Food microbiology (4th ed.). Royal Society of Chemistry.


**Reference Books**


1. Geoffrey Hanlon and Norman Hodges. *Essential Microbiology for pharmacy and pharmaceutical science.* (2013). Wiley Blackwell.
2. S. P. Vyas & V. K. Dixit. *Pharmaceutical Biotechnology*. (2003) CBS Publishers & Distributors, New Delhi.
3. Frazier, W. C., & Westhoff, D. C. (2008). Food microbiology (4th ed.). Tata McGraw-Hill.


**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| Weightage (%) | 10 | 20 | 20 | 50 |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | | | 3 | - | 3 | 2 | - | 3 | 3 |
| **CO2** | 3 | 3 | 3 | | | 3 | - | 3 | 2 | - | - | 3 |
| **CO3** | 3 | 3 | 3 | | | 3 | - | 3 | 2 | - | - | 3 |
| **CO4** | **3** | 3 | 3 | | | 3 | - | 3 | 2 | - | **3** | 3 |
| **CO5** | **3** | 3 | 3 | | | 3 | - | 3 | 2 | - | 3 | 3 |
| **Average** | 3 | 3 | 3 | | | 3 | - | 3 | 2 | - | 3 | 3 |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| MIB505 | Bioprocess Technology | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | 2025-26 | **2** | **1** | **1** | **4** |
| **Pre-requisites/Exposure** | Basic knowledge of microbiology, microbial metabolism, and fermentation concepts. | | | | |
| **Co-requisites** | None | | | | |

**Course Objectives**

1. To understand the fundamental principles of bioprocess design and microbial growth kinetics.
2. To study upstream and downstream processing in industrial biotechnology.
3. To gain insights into sterilization, bioreactor types, and scale-up processes.
4. To develop practical skills in microbial fermentation, product recovery, and process optimization.
5. To promote interdisciplinary problem-solving in industrial microbiology and biochemistry.

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** the stages and components involved in a typical bioprocess.
CO2 : **Understand** microbial growth dynamics, fermentation principles, and bioreactor operation.
CO3 : **Apply** bioprocess engineering concepts to solve scale-up and process development problems.
CO4 : **Analyze** and optimize microbial production processes for value-added products.
CO5 : **Evaluate** bioprocess efficiency, cost-effectiveness, and industrial applicability.

**Catalogue Description**

The course provides theoretical and hands-on training in microbial bioprocesses used in pharmaceutical, food, and industrial applications. Topics include bioreactor design, sterilization, fermentation kinetics, and product recovery techniques, supported by practical fermentation experiments.

**Course Content**

**Unit 1 Introduction to Bioprocess Technology** **9 hours**

Overview of bioprocesses: Upstream and downstream, Historical evolution of bioprocess technology, Components of a bioprocess system; Transport phenomena in fermentation: Gas-liquid exchange and mass transfer, oxygen transfer, heat transfer.

**Unit 2 Microbial Growth and Product Formation Kinetics** **9 hours**

Batch, fed-batch, and continuous culture, Monod model, yield coefficients, Primary *vs*. secondary metabolite production.

**Unit 3 Bioreactors and Scale-Up** **9 hours**

Types of bioreactors: Stirred tank, airlift, packed bed, Aeration, agitation, substrate utilization kinetics, substrate inhibition models, product formation kinetics; Scale-up criteria: Geometric, kLa, P/V.

**Unit 4 Upstream Processing** **9 hours**

Inoculum development and media design, Sterilization: Air, media, and equipment, Process monitoring and control; storage of cultures for repeated fermentations.

**Unit 5 Downstream Processing** **9 hours**

Cell separation: Filtration, centrifugation; Cell disintegration: Physical, chemical and enzymatic methods, Extraction: Solvent, distillation, two phase, liquid extraction; Product recovery and purification: Precipitation, extraction, chromatography, Formulation and packaging

**Unit 6 Lab Exercises in Bioprocess Technology** **30 hours**

e. Operation of a laboratory-scale stirred-tank bioreactor for microbial biomass production.
f. Monitoring growth kinetics: Dry weight, OD, and pH tracking.
g. Downstream recovery of metabolites (e.g., ethanol distillation or enzyme extraction).
h. Comparative studies of Ethanol production using different substrates.

**Experiential Learning**

1. Visit to any fermentation industry to observe process operation and optimization.

**Textbooks**


1. Casida, L.E. JR (2019). *Industrial Microbiology*, 2nd Edition, New Age International Publishers.
2. Okafor N & Okeke C (2018). *Modern Industrial Microbiology And Biotechnology, 2nd Edition*, CRC Press.
3. Stanbury, P.F., Whitaker, A., Hall, S. J (2016). *Principles of Fermentation Technology*, 3rd Edition, Butterworth-Heinemann.
4. Patel, A.H (2011). *Industrial Microbiology*, Laxmi Publications.


**Reference Books**


1. Beemagani, S., and Pittala, N (2025). Industrial Microbiology, SIP.
2. Doran, P.M. Bioprocess Engineering Principles, Academic Press.
3. Demain, A.L. & Davies, J.E. *Manual of Industrial Microbiology and Biotechnology*, ASM Press.
4. Harrison, R.G. et al. *Bioseparations Science and Engineering*, Oxford University Press.


**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| Weightage (%) | 10 | 20 | 20 | 50 |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| **CO2** | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| **CO3** | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| **CO4** | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| **CO5** | 3 | 3 | 2 | 3 | 3 | - | - | 3 | - | - | 1 | 3 |
| **Average** | **3** | **3** | **2** | **3** | **3** | | | **3** | | | **1** | **3** |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| MIB506 | Research Approaches in Environmental Toxicology | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | 1.0 | 2 | 0 | 0 | 2 |
| **Pre-requisites/Exposure** | Basic understanding of microbiology, biochemistry, and environmental science. | | | | |
| **Co-requisites** | None | | | | |

**Course Objectives**

1. To provide an overview of environmental pollutants and their toxic effects on microbial systems.
2. To understand modern research methodologies used to assess environmental toxicants.
3. To explore microbial bioindicators and biosensors in toxicity evaluation.
4. To evaluate the relevance of omics-based and bioinformatics tools in environmental toxicology research.
5. To promote critical thinking in designing toxicity-related microbiological investigations.

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** major environmental toxicants and their microbial targets.
CO2 : **Understand** mechanisms of toxicity at the cellular and molecular levels.
CO3 : **Apply** microbiological and molecular tools to assess toxicity.
CO4 : **Analyze** omics-based data for toxicity monitoring.
CO5 : **Evaluate** research methodologies in environmental toxicology and propose suitable experimental approaches.

**Catalogue Description**

This course introduces students to research-oriented approaches in environmental toxicology, focusing on microbial responses to pollutants. It covers modern techniques like biomonitoring, biosensors, omics analyses, and risk assessment strategies relevant to environmental microbiology.

**Course Content**

**Unit 1 Introduction to Environmental Toxicology 6 hours**

Principles of toxicology; Classification of environmental toxicants (organic, inorganic, emerging contaminants); Dose-response relationships and toxicity thresholds; Toxicity Testing, and ADME II (Absorption, Distribution, Metabolism and Excretion), ADME II (Toxicokinetics and Metabolism)

**Unit 2 Microbial Response to Environmental Toxicants 6 hours**

Toxicant-microbe interactions; Mechanisms of toxicity (oxidative stress, membrane damage, DNA/protein alterations); Detoxification and resistance mechanisms in microbes

**Unit 3 Microbial Bioassays and Biosensors 6 hours**

Concepts of microbial bioindicators; Whole-cell biosensors: reporter genes, luminescent and fluorescent markers; Bioassays for water, soil, and air toxicity

**Unit 4 Molecular and Omics Approaches 6 hours**

Metagenomics and transcriptomics in environmental samples; Proteomics and metabolomics for toxicity assessment; Use of RT-qPCR, microarrays, and sequencing for biomarker analysis

**Unit 5 Experimental Design and Toxicity Risk Assessment 6 hours**

Environmental benchmarks, Data sources for exposure risk characterization; Study design for toxicity testing; Microbial endpoints in ecotoxicology; Microbial risk assessment and standard protocols (EPA, OECD, USEPA)

**Experiential Learning**

1. Ecological and human health risk assessment-Case Studies
2. Neurotoxicological effects of environmental pollutants-Case Studies

**Textbooks**


1. Newman, M.C., Unger, M.A. *Fundamentals of Ecotoxicology*. 5th edition, CRC Press, 2019.
2. Casarett & Doull's Essentials of Toxicology. 4th edition, Klaassen CD, Watkins JB. McGraw Hill, 2022.
3. Reshi, M.S., Javaid, D., Qadri, S.S. *Environmental Toxicology: Concepts and Principles*. 1st edition, Jenny Stanford Publishing, 2025.
4. Awasthi, K.K., Yadav, C.S., Awasthi, G., Sankhla, M.S. Environmental Toxicology: Pollutants and Health Impacts. Shiv Shakti Book Traders, 2021.


**Reference Books**


1. Hayes' Principles and Methods of Toxicology, Hayes, A. W., Kruger, C.L., CRC Press, Taylor and Francis, 6th edition, 2014.
2. Principles of Ecotoxicology, Walker, C.H., Sibly, R.M., Hopkin, S.p., Peakall, D.B., CRC Press, 2012.
3. A Textbook of Modern Toxicology. E. Hodgson (Ed.). John Wiley & Sons, Inc. 4th Edition. 2010.
4. An Introduction to Environmental Toxicology, Michael H. Dong. Lash and Temple Publishing, 4th edition, 2018.


**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| Weightage (%) | 10 | 20 | 20 | 50 |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 1 | 2 | | | | | | | |
| **CO2** | 3 | 2 | 3 | 2 | 2 | | | | | 1 | | |
| **CO3** | 2 | 2 | 3 | 3 | 2 | | | 1 | 2 | 1 | 2 | |
| **CO4** | 2 | 2 | 3 | 3 | 2 | | | 1 | 2 | 2 | 3 | |
| **CO5** | 2 | 3 | 3 | 2 | 3 | | 2 | 1 | 1 | 2 | 3 | 1 |
| **Average** | 2.4 | 2.2 | 2.8 | 2.2 | 2.2 | 0 | 0.4 | 0.6 | 1 | 1.2 | 1.6 | 0.2 |

**1** : Weakly mapped
**2** : Moderately mapped
**3** : Strongly mapped

| MIB507 | Research Practices in Microbial Safety and Sustainability in Food Systems | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | **1.0** | **2** | **0** | **0** | **2** |
| **Pre-requisites/Exposure** | Basic knowledge of food microbiology | | | | |
| **Co-requisites** | None | | | | |

**Course Objectives**

1. To introduce current research practices in microbial food safety and sustainable food systems.
2. To analyze microbial risks in food chains, emerging pathogens, and antimicrobial resistance.
3. To understand the integration of microbial safety strategies with sustainability goals.
4. To review risk assessment, monitoring frameworks, and microbial interventions in food systems.
5. To critically evaluate contemporary research and global regulatory practices in food microbiology.

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** principles of microbial food safety and sustainability.
CO2 : **Understand** microbial hazards and sustainable control strategies in food systems.
CO3 : **Apply** concepts of microbial risk assessment and hazard identification in food chains.
CO4 : **Analyze** research approaches in monitoring and controlling pathogens in sustainable food systems.
CO5 : **Evaluate** food safety frameworks and research publications for effective intervention design.

**Catalogue Description**

This course explores advanced research approaches and global practices that ensure microbial safety while promoting sustainability in food production and distribution systems. It integrates food microbiology, public health, and environmental concerns.

**Course Content**

**Unit 1 Introduction to Microbial Safety and Sustainability in Food Systems 6 hours**
Definition and scope of microbial food safety; Sustainable development goals (SDGs) related to food systems; Link between food safety and environmental sustainability

**Unit 2 Microbial Hazards and Risk Assessment in Food Chains 6 hours**
Biological hazards: bacteria, viruses, fungi, toxins; Hazard Analysis and Critical Control Points (HACCP); Principles of risk analysis: risk assessment, management, communication

**Unit 3 Emerging Pathogens and Antimicrobial Resistance (AMR) 6 hours**
Foodborne transmission of AMR organisms; Novel and re-emerging microbial threats; Global One Health perspectives and AMR surveillance

**Unit 4 Sustainable Microbial Interventions and Practices 6 hours**

Bio-preservation, bacteriophages, probiotics; Eco-friendly packaging and green sanitation practices; Reduction of microbial load using non-thermal technologies

**Unit 5 Research Methodology and Global Frameworks in Food Safety 6 hours**

Literature review and data analysis in microbial safety research; Role of FAO, WHO, EFSA, FSSAI in food safety; National and international guidelines on sustainable food safety

**Experiential Learning**

1. Risk mapping activity for selected foodborne pathogens across supply chains
2. Group project: developing a sustainability-integrated microbial safety model
3. Seminar presentation on emerging trends in sustainable food microbiology

**Textbooks**


1. Arun Karnwal, Abdel Rahman Mohammad Said Al-Tawaha. Food Microbial Sustainability: Integration of Food Production and Food Safety, 2023, Springer.
2. James M. Jay, Martin J. Loessner, David A. Golden. Modern Food Microbiology, 7th edition, 2005, Springer.
3. International Commission on Microbiological Specifications for Foods. Microorganisms in Foods 7: Microbiological Testing in Food Safety Management, 2nd edition, 2018, Springer.
4. Anna McElhatton & Richard J. Marshall. Food Safety: A Practical and Case Study Approach (Integrating Safety and Environmental Knowledge Into, 2006, Springer.


**Reference Books**


1. William H. & Carol Anne. Food Safety for the 21st Century: Managing HACCP and Food Safety Throughout the Global Supply Chain, 2018, Wiley.
2. M Dillon. Auditing in the food industry: From safety and quality to environmental and other audits, 2001, CRC Press.


**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| Weightage (%) | 10 | 20 | 20 | 50 |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | | | | | | | 2 | | 2 |
| **CO2** | 3 | 3 | 2 | 2 | | | | | | 2 | | 2 |
| **CO3** | 2 | 3 | 3 | 2 | 2 | 2 | 2 | | | 2 | | 1 |
| **CO4** | 2 | 3 | 3 | 2 | 3 | 2 | 3 | | | 2 | 1 | 1 |
| **CO5** | 2 | 3 | 2 | 2 | 3 | 3 | 3 | 2 | 1 | 3 | 2 | 2 |
| **Average** | **2.4** | **2.8** | **2.2** | **1.6** | **1.6** | **1.4** | **1.6** | **0.4** | **0.2** | **2.2** | **0.6** | **1.6** |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| MIB508 | Critical Reading and Writing on Enzyme Technology | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | **1.0** | **2** | **0** | **0** | **2** |
| **Pre-requisites/Exposure** | Basic knowledge of microbiology and enzymology | | | | |
| **Co-requisites** | None | | | | |

**Course Objectives**

1. To understand enzyme structure, function, and catalytic mechanisms relevant to industrial processes.
2. To learn principles of enzyme kinetics, regulation, and immobilization.
3. To explore microbial sources, large-scale enzyme production, and downstream processing.
4. To study applications of enzymes in industrial biotechnology and emerging bioprocesses.
5. To appreciate recent trends in green bioengineering and catalysis

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** enzyme classification, structure, and catalysis.
CO2 : **Understand** kinetic and regulatory mechanisms.
CO3 : **Apply** enzyme engineering principles in bioprocess design.
CO4 : **Analyse** microbial enzyme production, purification, and immobilization.
CO5 : **Evaluate** literature on enzyme applications and emerging trends, and present written analyses.

**Catalogue Description**

This course introduces the principles and applications of enzymes in bioprocess technology. It covers enzyme structure, classification, catalysis, kinetics, and regulation, along with microbial production, purification, and immobilization techniques. Emphasis is placed on enzyme engineering for enhanced stability and activity, and their use in industrial sectors such as food, pharmaceuticals, detergents, textiles, and biofuels. Students explore contemporary trends including extremozymes, biosensors, and green catalysis through guided readings and analytical writing. The course integrates conceptual learning with experiential components to develop skills in process understanding, literature analysis, and critical evaluation of enzyme-based biotechnological innovations.

**Course Content**

**Unit 1 Fundamentals of Enzyme Catalysis** **3 hours**

Nature and classification of enzymes (IUB system), enzyme structure and active site, cofactors and coenzymes, mechanism of enzyme action, transition state theory, energy profile of enzyme-catalyzed reactions, factors affecting enzyme activity (pH, temperature, substrate concentration).

**Unit 2 Enzyme Kinetics and Regulation** **12 hours**

Michaelis–Menten kinetics and derivation, determination of kinetic parameters (Km, Vmax), Derivatives of Michaelis-Menten Kinetics (Eadie-Hofstee plot, Woolf-Hanes, Cornish-Bowden plots),

enzyme inhibition – competitive, non-competitive, uncompetitive, allosteric regulation, multi-substrate kinetics, isoenzymes, enzyme cooperativity; Bioinformatics in Kinetic analyses

**Unit 3 Enzyme Production and Purification** **6 hours**

Microbial sources of industrial enzymes (bacteria, fungi, actinomycetes), screening and strain improvement, recombinant enzyme production, fermentation strategies – submerged and solid-state, downstream processing – cell disruption, precipitation, dialysis, chromatography, case studies – amylases, proteases, cellulases.

**Unit 4 Enzyme Immobilisation and Engineering** **6 hours**

Need for enzyme immobilization, methods – adsorption, covalent bonding, entrapment, encapsulation, cross-linking, kinetic behavior of immobilized enzymes, enzyme engineering – site-directed mutagenesis, directed evolution, protein design, immobilized enzyme reactors – design and applications.

**Unit 5 Enzyme Applications and Emerging Trends** **3 hours**

Enzymes in industries, enzyme biosensors and diagnostics, extremozymes and metagenomic enzyme discovery, enzyme nanotechnology, green catalysis, recent literature-based studies on industrial enzyme applications, student review and report writing on selected research papers (≤5 years old).

**Experiential Learning**

1. Industrial Enzyme Case Study and Process Mapping
2. Research Paper Review and Analytical Summary

**Textbooks**

1. Trevor Palmer & Philip Bonner – *Enzymes: Biochemistry, Biotechnology and Clinical Chemistry*, 2nd Ed.
2. Nicholas C. Price & Lewis Stevens – *Fundamentals of Enzymology*.
3. H. Uhlig – *Industrial Enzymes and Their Applications*.

**Reference Books**

1. A. Pandey, C. Larroche & C.R. Soccol (Eds.) – *Current Developments in Biotechnology and Bioengineering: Production, Isolation and Purification of Industrial Products.*
2. J. E. Bailey & D. F. Ollis – *Biochemical Engineering Fundamentals.*

**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| Weightage (%) | 10 | 20 | 20 | 50 |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | | | | | | | 2 | | 2 |
| **CO2** | 3 | 3 | 2 | 2 | | | | | | 2 | | 2 |
| **CO3** | 2 | 3 | 3 | 2 | 2 | 2 | 2 | | | 2 | | 1 |
| **CO4** | 2 | 3 | 3 | 2 | 3 | 2 | 3 | | | 2 | 1 | 1 |
| **CO5** | 2 | 3 | 2 | 2 | 3 | 3 | 3 | 2 | 1 | 3 | 2 | 2 |
| **Average** | **2.4** | **2.8** | **2.2** | **1.6** | **1.6** | **1.4** | **1.6** | **0.4** | **0.2** | **2.2** | **0.6** | **1.6** |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| MIB519 | Research Project Part I | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | **1.0** | **0** | **0** | **6** | **6** |
| **Pre-requisites/Exposure** | Completion of core courses in Microbiology and allied subjects | | | | |
| **Co-requisites** | Research Methodology, Biostatistics | | | | |

**Course Objectives**

1. To define an original research problem suitable for doctoral-level inquiry.
2. To conduct an exhaustive literature review and gap analysis.
3. To design robust experimental or theoretical frameworks.
4. To initiate systematic data generation.
5. To develop independence in research planning.

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** current advances relevant to the chosen research domain.
CO2 : **Understand** experimental approaches, methodologies, and safety requirements.
CO3 : **Apply** microbiological, molecular, or analytical techniques to generate preliminary data.
CO4 : **Analyse** initial results and refine experimental strategies.
CO5 : **Evaluate** the feasibility and scientific merit of the research plan.

**Catalogue Description**

This course marks the first phase of the research-only postgraduate project. Students identify a research problem, perform comprehensive literature analysis, and initiate advanced experimental or computational investigations. Emphasis is placed on originality, methodological rigor, and independent inquiry. The course prepares students for sustained, high-level research leading into the final project phase.

**Modes of Evaluation**

| Components | Literature Review and Proposal | Presentation of Research Update | Total (End Semester) |
|---|---|---|---|
| **Weightage (%)** | **50** | **50** | **100** |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | - | 3 |
| **CO2** | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | - | 3 |
| **CO3** | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | - | 3 |
| **CO4** | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | - | 3 |
| **CO5** | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | - | 3 |
| **Average** | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | - | 3 |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| MIB515 | Field Project in Microbiology | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | **2.0** | **0** | **0** | **2** | **2** |
| **Pre-requisites/Exposure** | Core courses in Microbiology | | | | |
| **Co-requisites** | Environmental and Industrial Microbiology | | | | |

**Course Objectives**

1. To expose students to real-world microbiological problems.
2. To develop skills in field sampling and observational studies.
3. To link laboratory microbiology with environmental or industrial contexts.
4. To introduce data collection under non-laboratory conditions.
5. To strengthen problem-solving and reporting skills.

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** principles relevant to field-based microbiological studies.
CO2 : **Understand** environmental, industrial, or clinical constraints on data collection.
CO3 : **Apply** sampling and basic analytical techniques in field settings.
CO4 : **Analyse** field data to identify trends and microbial processes.
CO5 : **Evaluate** practical challenges and propose evidence-based solutions.

**Catalogue Description**

This course provides hands-on exposure to field-based microbiology through projects conducted in environmental, industrial, agricultural, or public health settings. Students undertake supervised fieldwork involving sampling, preliminary analysis, and data interpretation. The course bridges theory and practice, emphasizing real-world constraints, ethics, and safety. It strengthens applied skills essential for research and complements laboratory-based dissertation work.

**Modes of Evaluation**

| Components | Field Work | Field Report | Total (End Semester) |
|---|---|---|---|
| **Weightage (%)** | **50** | **50** | **100** |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | - | 3 |
| **CO2** | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | - | 3 |
| **CO3** | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | - | 3 |
| **CO4** | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | - | 3 |
| **CO5** | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | - | 3 |
| **Average** | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | - | 3 |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| MIB520 | Research Project Part II | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | **1.0** | **0** | **0** | **20** | **20** |
| **Pre-requisites/Exposure** | Completion of Research Project Part I | | | | |
| **Co-requisites** | | | | | |

**Course Objectives**

1. To complete extensive research investigations.
2. To generate publishable-quality data.
3. To critically interpret findings within global scientific contexts.
4. To develop advanced scientific writing and presentation skills.
5. To prepare students for independent research careers.

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** advanced theoretical and methodological concepts.
CO2 : **Understand** complex biological systems and data relationships.
CO3 : **Apply** skills of data presentation and refinement.
CO4 : **Analyse** experimental observations through integrative perspectives.
CO5 : **Evaluate** the impact, scientific utility, limitations and translational impact of the research.

**Catalogue Description**

This course represents the final phase of the research project. Students complete in-depth investigations, analyse and interpret comprehensive datasets, and prepare a dissertation of doctoral-entry standard. Emphasis is placed on originality, critical thinking, and scientific rigor. The course equips students for research, competitive fellowships, and high-level R&D roles.

**Modes of Evaluation**

| Components | Thesis | Research Presentation | Total (End Semester) |
|---|---|---|---|
| **Weightage (%)** | **50** | **50** | **100** |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | - | 3 |
| **CO2** | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | - | 3 |
| **CO3** | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | - | 3 |
| **CO4** | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | - | 3 |
| **CO5** | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | - | 3 |
| **Average** | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | - | - | 3 |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

**Syllabi of Multi-disciplinary Electives offered by the Department of Biological Sciences**

| Semester | Course Code | Course Title | Contact Hours per Week | | | Credit |
|---|---|---|---|---|---|---|
| | | | L | T | P | |
| I | MIB469 | Biosafety and Bioethics | 3 | 1 | 0 | 4 |
| | BIC456 | Indian Traditional Medicine | 3 | 1 | 0 | 4 |
| II | MIB470 | Nanobiotechnology | 3 | 1 | 0 | 4 |
| III | MIB518 | Human Physiology and Nutrition | 3 | 1 | 0 | 4 |

| MIB459 | Biosafety and Bioethics | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | **1.2** | **3** | **1** | **0** | **4** |
| **Pre-requisites/Exposure** | UG level biology | | | | |
| **Co-requisites** | Basics of biology | | | | |

**Course Objectives**

1. To provide students the basic understanding and implementation of ethical policies in biology.
2. Understanding of basic principles of ethical issues in biomedical research.
3. Providing basic concept of biosafety, environmental, human ethics, and animal ethics..
4. In depth concept of IPR.
5. Understanding national and international regulatory frameworks governing bioethics and IPR

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** the fundamental concepts of bioethics
CO2 : **Understand** the implementation of bioethics in biomedical research
CO3 : **Apply** the concept of bioethics in matters with various ethical concerns
CO4 : **Analyze** the concept of IPR and Patenting
CO5 : **Evaluate** the frameworks for patent and copyright approval

**Catalogue Description**

This course introduces postgraduate students to ethical, legal, and social issues associated with microbiology and biotechnology. It covers fundamental principles of bioethics, ethical conduct of research involving humans, animals, and microorganisms, and issues of biosafety and biosecurity. The course also provides an overview of intellectual property rights, including patents and other forms of IPR, with special emphasis on microbiological and biotechnological inventions. National and international regulatory frameworks, technology transfer, and emerging ethical challenges are discussed to promote responsible research, innovation, and professional practice in microbiology.

**Course Content**

**Unit 1 Introduction to Bioethics** **12 hours**

Concept, scope, and historical development of bioethics, Core ethical principles: autonomy, beneficence, non-maleficence, justice, Ethics in biological and microbiological research; Biosafety, biosecurity, and responsible conduct of research, Ethical decision-making in laboratory practices

**Unit 2 Ethics in Biomedical and Microbiological Research** **12 hours**

Ethical issues in human and animal research, Informed consent, confidentiality, and risk–benefit analysis, Role and functioning of Institutional Ethics Committees, Ethical guidelines: ICMR and CPCSEA, Research misconduct: plagiarism, fabrication, falsification, and dual-use research concerns

**Unit 3 Introduction to Intellectual Property Rights** **12 hours**

Concept and importance of intellectual property, Forms of IPR: patents, copyrights, trademarks, industrial designs, geographical indications, Patents: criteria for patentability and types of patents, Patent application process and documentation, Overview of IPR laws relevant to life sciences

**Unit 4 IPR in Microbiology and Biotechnology** **12 hours**

Patenting of microorganisms, genes, enzymes, vaccines, and diagnostics, IPR issues in bioprocesses and biopharmaceuticals, International agreements: TRIPS and Convention on Biological Diversity (CBD), Traditional knowledge, access and benefit sharing, Technology transfer and commercialization

**Unit 5 Regulatory Frameworks and Emerging Ethical Issues** **12 hours**

National and international biosafety and regulatory frameworks, Ethical and legal issues related to GMOs and recombinant DNA technology, Ethical challenges in genetic engineering, synthetic biology, and microbiome research, Environmental and public health considerations, Case studies on ethical dilemmas and IPR disputes in microbiology

**Experiential Learning**

1. Case study: patenting for novel drug/ vaccine
2. Ethical concerns and resolution of gene editing
3. Cohort designing

**Textbooks**


1. Bansal, S., & Sharma, R. (2016). *Bioethics and Biosafety.* Oxford University Press India.
2. Ganguli, P. (2001). *Intellectual Property Rights: Unleashing the Knowledge Economy.* Tata McGraw-Hill.


**Reference Books**


1. Cornish, W.R., Llewelyn, D., & Aplin, T. (2019). *Intellectual Property: Patents, Copyright, Trade Marks and Allied Rights.* Sweet & Maxwell.
2. Shamoo, A.E., & Resnik, D.B. (2015). *Responsible Conduct of Research.* Oxford University Press.


**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| Weightage (%) | 10 | 20 | 20 | 50 |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 2 | 1 | 3 | 2 |
| **CO2** | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 1 | 3 | 2 | 3 | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 2 | 3 | 2 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 2 |
| **CO5** | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 |
| **Average** | 3 | 3 | 2 | 2.4 | 2.2 | 2.6 | 2.4 | 1.6 | 2.6 | 2.0 | 3 | 2.4 |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| BIC456 | Indian Traditional Medicine | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | **1.0** | **3** | **1** | **0** | **4** |
| **Pre-requisites/Exposure** | Basic Biochemistry and Physiology | | | | |
| **Co-requisites** | Elementary Plant Biology | | | | |

**Course Objectives**

1. To understand the scientific and philosophical basis of Indian traditional medical systems
2. To correlate traditional knowledge with modern biochemistry
3. To explore medicinal plants and their bioactive compounds
4. To develop skills in evaluation and validation of traditional remedies
5. To bridge the gap between traditional knowledge and modern biochemical understanding

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** key concepts, terminology, and principles of Indian traditional medicine systems such as Ayurveda, Siddha, and Unani
CO2 : **Understand** the fundamental principles (e.g., Tridosha, Panchamahabhuta) underlying traditional medicine
CO3 : **Apply** basic techniques for identification and documentation of medicinal plants
CO4 : **Analyze** the biochemical basis of selected herbal remedies
CO5 : **Evaluate** the efficacy and safety of traditional medicines using scientific criteria

**Catalogue Description**

This course explores the scientific and biochemical foundations of Indian traditional medicine systems including Ayurveda, Siddha, and Unani. It covers medicinal plant phytochemistry, herbal formulation, standardization, and pharmacokinetics. Students learn to evaluate traditional remedies using modern analytical techniques, bridging ancient wisdom with contemporary biochemistry. Practical sessions include plant identification, phytochemical screening, TLC, and antioxidant assays.

**Course Content**

**Unit 1 Fundamentals of Indian Traditional Systems 15 hours**

Historical development and global relevance of traditional medicine; Overview of major systems: Ayurveda,Siddha,Unani; Basic principles: Tridosha theory (Vata, Pitta, Kapha), Panchamahabhuta (five elements) Concept of health, disease, and diagnosis

**Unit 2 Medicinal Plants and Phytochemistry 15 hours**

Classification of medicinal plants used in traditional medicine; Active constituents: Alkaloids, flavonoids, glycosides, tannins, terpenoids; Examples of important medicinal plants and their biochemical roles; Extraction, isolation, and identification of phytochemicals; Role of antioxidants and nutraceuticals

**Unit 3 Herbal Drug Formulation and Standardisation 15 hours**

Types of formulations: decoctions, powders, oils, tablets; Methods of preparation in traditional systems: Standardization techniques: Physicochemical analysis, Chromatographic profiling, Quality control and assurance of herbal medicines, Adulteration and contamination issues

**Unit 4 Pharmacokinetics, Disease management and Regulatory Affairs 15 hours**

Mechanism of action of herbal drugs at molecular level; Pharmacokinetics and pharmacodynamics of plant-based compounds; Role in management of diseases: Diabetes, inflammation, cancer, infections; Herb-drug interactions; Safety, toxicity, and regulatory aspects

**Experiential Learning**

1. Field visits to herbal gardens and documentation of medicinal plants
2. Case studies linking traditional remedies with biochemical evidence
3. Mini-project on Scientific validation of a selected traditional medicine

**Textbooks**


1. Shah, B.N. and Seth, A.K. (2010). *Textbook of Pharmacognosy and Phytochemistry*. Elsevier.
2. Singh, M., Wal, A., Panchawat, S., Tiwari, V., & Vashishtha, T.K. (2025). *A Textbook for Herbal Drug Technology*. Shashwat Publication.


**Reference Books**


1. A Textbook of Pharmacognosy (AGPH publication)

**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| **Weightage (%)** | **10** | **20** | **20** | **50** |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | | | | | | | | | 1 |
| **CO2** | 3 | 3 | 2 | 1 | | | | | | 1 | | 2 |
| **CO3** | 2 | 3 | 3 | 2 | 2 | | | | 1 | 1 | | 2 |
| **CO4** | 2 | 3 | 2 | 3 | 2 | 1 | | | 1 | 2 | | 2 |
| **CO5** | 2 | 3 | 2 | 3 | 2 | 2 | 1 | 1 | 2 | 2 | 1 | 3 |
| **Average** | 2.4 | 2.8 | 2 | 1.8 | 1.6 | 0.6 | 0.2 | 0.8 | 1.2 | 1.2 | 0.2 | 2 |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| MIB470 | Nanobiotechnology | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | 2.0 | **3** | **1** | **0** | **4** |
| **Pre-requisites/Exposure** | UG level knowledge of Chemistry and Biology | | | | |
| **Co-requisites** | None | | | | |

**Course Objectives**

1. To introduce students to the fundamental concepts of nanoscience and its relevance in biological systems.
2. To explore various methods of synthesis and characterization of nanomaterials.
3. To understand the biological interface of nanomaterials including bio-nanomachines and bioconjugates.
4. To apply nanotechnology in diagnostics, therapeutics, and tissue engineering.
5. To assess the cellular interaction, uptake, and toxicity of nanomaterials in vitro.

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** the fundamental principles of nanoscience and nanotechnology in a biological context.
CO2 : **Understand** the methods of nanomaterial synthesis and characterization.
CO3 : **Apply** nanotechnology concepts to the design of nanobiomaterials for research and clinical use.
CO4 : **Analyze** the role of nanomaterials in diagnostics, therapeutics, and cellular systems.
CO5 : **Evaluate** the safety, cellular uptake, and biological activity of nanomaterials.

**Catalogue Description**

This course provides interdisciplinary insight into nanoscience and nanotechnology with a strong emphasis on biological systems. It integrates theoretical understanding with hands-on experience in nanomaterial synthesis, characterization, and application in diagnostics and therapeutics.

**Course Content**

**Unit 1 Fundamentals of Nanobiotechnology** **12 hours**
Introduction to nanoscience and nanotechnology, Cellular nanostructures, Nano-biomimetics, Physical, chemical, and green synthesis of nanomaterials

**Unit 2 Characterization of Nanomaterials** **12 hours**
Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM), Dynamic Light Scattering (DLS), X-ray Diffraction (XRD), Fourier Transform Infrared Spectroscopy (FTIR), UV-Vis Spectroscopy

**Unit 3 Bio-inspired and Carbon-based Nanostructures** **12 hours**
DNA nanotechnology, Protein & Glyco nanotechnology, Lipid nanotechnology, Bio-nanomachines, Carbon nanotubes, fullerenes, carbon dots, dendrimers and their biomedical applications

**Unit 4 Nanobiotechnology in Medicine and Tissue Engineering 12 hours**

Nanomaterials for cancer diagnosis and therapy, Nanotechnology in tissue engineering and regenerative medicine, Nano artificial cells and organ printing

**Unit 5 Nanodiagnostics, Targeted Delivery, and Safety 12 hours**

Nanotechnology in point-of-care diagnostics, Nanopharmacology and targeted drug delivery, Cellular uptake of nanomaterials, In vitro antibacterial and anticancer assays, Nanotoxicology

**Experiential Learning**

1. Visit a research laboratory to visualize nanomaterial characterization through SEM/TEM/DLS/ FTIR, and other methods.
2. Preparation of an SOP for Nanomaterial Handling.

**Textbooks**


1. C.M. Niemeyer & C.A. Mirkin (2007). *Nanobiotechnology II: More Concepts and Applications*, Wiley-VCH.
2. Rajesh Singh Tomar, Anurag Jyoti, and Shuchi Kaushik (2020). Nanobiotechnology: Concepts and Applications in Health, Agriculture and Environment, Apple Academic Press.
3. R.S. Khandpur (2004). *Biomedical Instrumentation: Technology and Applications*, McGraw Hill
4. Tuan Vo-Dinh (2019). *Nanotechnology in Biology and Medicine*, CRC Press.


**Reference Books**


1. Ajeet Kaushik, Sesha S. Srinivasan, Yogendra Kumar Mishra (2023). Analytical Techniques for Biomedical Nanotechnology, IOP.
2. Prasad, P.N (2012). *Introduction to Nanomedicine and Nanobioengineering*, Wiley.
3. Cassandra Callmann (2025). Biomedical Nanotechnology, Humana Pr Inc.
4. Sarah Hurst Petrosko, Emily S. Day (2017). Biomedical Nanotechnology: Methods and Protocols, Humana Press.


**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| Weightage (%) | 10 | 20 | 20 | 50 |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | | | 2 | | | | | | | | |
| **CO2** | 3 | 3 | 2 | 2 | | | | | | | | |
| **CO3** | 2 | 3 | 3 | 3 | 2 | 2 | | | 1 | | | |
| **CO4** | 2 | 3 | 3 | 3 | 2 | 3 | 2 | | | 2 | | 1 |
| **CO5** | 2 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 1 | 2 | 2 | 2 |
| **Average** | **2.4** | **2.2** | **2** | **2.6** | **1.2** | **1.6** | **0.8** | **0.4** | **0.4** | **0.8** | **0.4** | **0.6** |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped

| MIB518 | Human Physiology and Nutrition | L | T | P | C |
|---|---|---|---|---|---|
| **Version** | **1.0** | **3** | **1** | **0** | **4** |
| **Pre-requisites/Exposure** | Knowledge of biology at UG level | | | | |
| **Co-requisites** | | | | | |

**Course Objectives**

1. To provide an integrated understanding of human physiological systems and their regulation.
2. To explain neuroendocrine coordination and reproductive physiology in health and adaptation.
3. To develop mechanistic insight into gastrointestinal, renal, and metabolic physiology.
4. To relate physiological principles to extreme environments, sports, and occupational biology.
5. To understand nutritional requirements, energy metabolism, and nutritional disorders relevant to human health.

**Course Outcomes**

On completion of the course, the students will be able to

CO1 : **Recall** the structure and basic functions of major human physiological systems.
CO2 : **Understand** regulatory mechanisms governing cardiovascular, neuroendocrine, renal, and digestive physiology.
CO3 : **Apply** physiological and nutritional concepts to assess health, performance, and metabolic needs.
CO4 : **Analyse** physiological adaptations under stress conditions, extreme environments, and nutritional imbalance.
CO5 : **Evaluate** nutritional status, dietary requirements, and health risks associated with malnutrition and food toxicants.

**Catalogue Description**

This course provides a comprehensive understanding of human physiological systems with an integrative emphasis on nutrition, metabolism, and adaptation to stress. It covers cardiovascular, pulmonary, musculoskeletal, neuroendocrine, reproductive, gastrointestinal, and renal physiology, highlighting regulatory and homeostatic mechanisms. Special attention is given to physiological responses during yogic practices, sports, aviation, and deep-sea diving. The nutrition component addresses energy metabolism, dietary requirements, malnutrition, and food toxicants. The course equips postgraduate microbiology students with foundational knowledge essential for biomedical research, public health, nutrition science, and interdisciplinary applications linking physiology with lifestyle and environmental factors.

**Course Content**

**Unit 1 Cardiovascular, Pulmonary and Musculoskeletal Physiology 14 hours**

Cardiac cycle and regulation; blood pressure and haemodynamics; respiratory mechanics and gas exchange; oxygen transport; muscle contraction mechanisms; skeletal muscle physiology; exercise physiology basics.

**Unit 2 Neuroendocrine and Reproductive Physiology 14 hours**

Neuronal signaling; synaptic transmission; Endocrine glands and hormones; H-P-A and H-P-G axes; male and female reproductive physiology; menstrual cycle; hormonal regulation of reproduction.

**Unit 3 Gastrointestinal and Renal Physiology 10 hours**

Digestion and absorption of nutrients; gastrointestinal motility and secretions; liver physiology; renal filtration, reabsorption, secretion; acid–base balance; water and electrolyte homeostasis.

**Unit 4 Yoga, Sports, Aviation and Deep-Sea Diving Physiology 10 hours**

Physiology of yogic practices and exercise; high-altitude physiology; hypoxia and hyperbaric conditions; decompression sickness; physiological stress and adaptation mechanisms; Physiological well-being, lifestyle interventions (yoga), and occupational health in relation to SDG 3 (Good Health and Well-being).

**Unit 5 Nutrition and Human Health 14 hours**

Defining nutrition; role of nutrients; units and measurement of energy; physiological fuel value; SDA; energy expenditure and BMR; RNI and RDA for different age groups; digestion and absorption; macronutrients and vitamins; diagnosis of malnutrition in children; food toxicants; Nutrition and public health in the context of Sustainable Development Goals (SDGs).

**Experiential Learning**

1. Observation of selected yogic postures (asanas), breathing techniques (pranayama), and meditation, followed by analysis of their effects on cardiovascular, respiratory, and neuroendocrine parameters.
2. Dietary assessment and calculation of energy expenditure, BMR, and nutrient adequacy using RDA/RNI guidelines.
3. Case-study–based analysis of physiological adaptations to exercise, hypoxia, and hyperbaric conditions.

**Textbooks**


1. Guyton, Arthur C. and Hall, John E. (2000). *Textbook of Medical Physiology*. 10th Edition. Elsevier.
2. Ganong, William F. (2005). *Review of Medical Physiology*. 27th Edition. McGraw-Hill.
3. Harper, H.A., Rodwell, V.W., Mayes, P.A. and Murray, R.K. (2009). *Harper's Illustrated Biochemistry*. 28th Edition. McGraw-Hill.


**Reference Books**


1. Waugh, Anne and Grant, Allison. (2010). *Ross and Wilson Anatomy and Physiology in Health and Illness*. Elsevier.
2. Widmaier, Eric P., Raff, Hershel and Strang, Kevin T. (2008). *Vander's Human Physiology*. 11th Edition. McGraw Hill International Publications, New York.

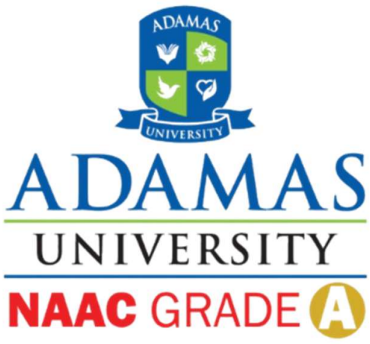
**Modes of Evaluation**

| Components | Class Assessment (including lab) | | Mid Term | End Term |
|---|---|---|---|---|
| | Experiential Learning | Regular Evaluation | | |
| Weightage (%) | 10 | 20 | 20 | 50 |

**Relationship between Course Outcomes (CO) and Program Outcomes (PO)**

| CO Number | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 1 |
| CO2 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 |
| CO3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 2 | 3 |
| CO5 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 |
| Average | 3.0 | 2.8 | 2.4 | 2.4 | 2.0 | 2.4 | 2.4 | 1.6 | 2.0 | 2.2 | 2.2 | 2.2 |

1 : Weakly mapped
2 : Moderately mapped
3 : Strongly mapped




# INTEGRATED POST-GRADUATE SYLLABUS

# OF SOFT SKILL AND APTITUDE

# OF YEAR 2026 ONWARDS

## ACKNOWLEDGEMENT

The successful development and implementation of the university-wide framework and syllabus for **Communicative English, Soft Skills and Aptitude at Adamas University** has been a result of collective vision, academic excellence, institutional support, and unwavering commitment from numerous leaders, academicians, and professionals. This endeavor reflects the University's dedication to preparing students for academic success, professional competence, and lifelong learning.

At the outset, I express my deepest gratitude to the **Hon'ble Chancellor of Adamas University** for providing visionary leadership and fostering an academic environment that encourages innovation, excellence, and industry relevance. His commitment to holistic education has been a guiding force behind initiatives aimed at enhancing student employability and professional growth.

I extend my sincere thanks to the **Vice Chancellor** for his constant encouragement and steadfast support throughout the conceptualization and development of this framework. His emphasis on academic rigor, interdisciplinary collaboration, and outcome-based education greatly influenced the direction and structure of the syllabus.

I am equally grateful to the **Pro Vice Chancellor** for offering valuable guidance and insightful suggestions during various stages of the curriculum development process. His proactive involvement and commitment to academic quality helped ensure that the framework remains contemporary, practical, and aligned with emerging educational and industry requirements.

My heartfelt appreciation goes to the **Dean of Academics**, whose academic expertise and constructive feedback played a pivotal role in refining the curriculum structure. The Dean's continuous support helped maintain the highest standards of curriculum design while ensuring alignment with institutional learning outcomes.

I would also like to acknowledge the invaluable contributions of the **Deans of all Schools of Adamas University**. Their diverse perspectives, academic insights, and recommendations enabled the development of a curriculum that caters to the varied needs of students across disciplines. Their active participation ensured that the framework remained relevant, inclusive, and responsive to the expectations of different academic domains.

Special thanks are extended to the **Heads of Departments of all Schools**, whose practical suggestions and discipline-specific inputs significantly enriched the syllabus. Their understanding of student needs, industry expectations, and subject-specific competencies helped create a robust and application-oriented framework that can effectively support learners from diverse academic backgrounds.

I express my profound gratitude to **Professor Abhijit Giri, Senior Vice President of the Career Development Cell (CDC)**, and all the members of CDC for their invaluable guidance and unwavering support. Their extensive experience in student development, employability enhancement, and placement readiness provided critical insights that helped shape the aptitude and professional skill development components of the curriculum. Prof. Giri's vision and commitment to preparing students for successful careers have been instrumental in strengthening the framework.

I would like to convey my sincere appreciation to Mr. Siladitya Basuray, the **Honorary Advisor of the Centre for Lifelong Learning (CLL)** for his strategic guidance and expert advice throughout the development process. His deep understanding of industry expectations and emerging workforce requirements helped ensure that the curriculum remains professionally relevant and future focused.

A special note of gratitude is due to the Co-ordinator of CLL, **Ms. Arpita Biswas,** for her relentless efforts, dedication, and meticulous attention to detail throughout the project. Her tireless coordination, consistent follow-ups, and commitment to excellence significantly contributed to the successful completion of this initiative. Her perseverance and hard work were instrumental in transforming ideas and discussions into a structured and comprehensive curriculum framework.

I also extend my heartfelt thanks to the **faculty members of the Centre for Lifelong Learning (CLL)** for their enthusiastic participation, collaborative spirit, and valuable contributions. Their collective expertise, thoughtful suggestions, and continuous engagement in curriculum planning, content development, and academic discussions enriched every stage of the process. Their dedication to student learning and professional development played a crucial role in shaping meaningful and impactful syllabus.

Finally, I acknowledge all academic leaders, faculty members, industry experts, and stakeholders whose encouragement, feedback, and support contributed to the successful development of this framework. Their collective wisdom and commitment have enabled the creation of a comprehensive curriculum that integrates communication competence, professional skills, aptitude development, and industry readiness.

This syllabus stands as a testament to what can be achieved when visionary leadership, academic expertise, institutional collaboration, and shared commitment come together with a common objective—to empower students of Adamas University with the knowledge, skills, and confidence required to excel in their academic, professional, and personal journeys.

Saswati Ghosh Bose

(Academic Head of CLL)

## COURSE SUMMARY

| Programme | Semester I | Semester II | Semester III | Semester IV |
|---|---|---|---|---|
| **B.Ed. Program** | Advance Soft Skills and Aptitude – I (EDN51243) | Advance Soft Skills and Aptitude – II (EDN51246) | Not Applicable | Advance Soft Skills and Aptitude – IV (EDN52224) |
| **MBA Program** | Advanced Soft Skills & Aptitude – I (CLL101) | Advanced Soft Skills & Aptitude – II (CLL102) | Advanced Soft Skills & Aptitude – III (CLL103) | Advanced Soft Skills & Aptitude – IV (CLL104) |
| **All M.A. and M.Sc. programs** | Advanced Soft Skills & Aptitude – I (CLL551) | Advanced Soft Skills & Aptitude – II (CLL552) | Advanced Soft Skills & Aptitude – III (CLL651) | Not Applicable |
| **M. Tech program** | Advanced Soft Skills & Aptitude – I (CLL11109) | Advanced Soft Skills & Aptitude – II (CLL11110) | Advanced Soft Skills & Aptitude – III (CLL11111) | Not Applicable |
| **M. Pharm, MCA, M. Com programs** | Advanced Soft Skills & Aptitude – I (CLL751) | Advanced Soft Skills & Aptitude – II (CLL752) | Advanced Soft Skills & Aptitude – III (CLL851) | Not Applicable |
| **LL.M Program** | Communicative English for Professionals – I (LWJ21201)<br>Communicative Aptitude for Professionals – I (LWJ21205) | Communicative English for Professionals – II (LWJ21202)<br>Communicative Aptitude for Professionals – II (LWJ21206) | Communicative English for Professionals – III (LWJ21203)<br>Communicative Aptitude for Professionals – III (LWJ21207) | Not Applicable |

# ADVANCED SOFT SKILLS & APTITUDE FOR M. PHARM, M. COM AND MCA PROGRAMS

**SEMESTER I: Advanced Soft Skills & Aptitude – I** **Course Code: CLL751**

**Contact Hours: 30 Hours**

**SOFT SKILL**

Module 1: Advanced Scientific Communication & Professional Writing (5 Hours)

1. Academic and scientific communication fundamentals
2. Technical writing for scientific disciplines
3. Research abstract and synopsis writing
4. Scientific presentation and seminar communication
5. Professional communication in research and laboratory environments

Module 2: Professional Effectiveness & Research Readiness (5 Hours)

1. Self-leadership and professional accountability
2. Research ethics and academic integrity
3. Time management for researchers and professionals
4. Professional behaviour in academic and laboratory environments
5. Adaptability and interdisciplinary collaboration

Module 3: Scientific Collaboration & Analytical Thinking (5 Hours)

1. Teamwork in research and scientific projects
2. Critical thinking and evidence-based reasoning
3. Scientific problem-solving approaches
4. Decision-making in laboratory and research environments
5. Professional networking and collaborative research culture

**Course Outcomes-**

CO1: Demonstrate effective scientific communication, technical writing and presentation skills in academic, research and professional environments.

CO2: Apply professional ethics, self-management, collaboration and research-oriented workplace competencies effectively.

CO3: Develop critical thinking, scientific problem-solving and interdisciplinary teamwork skills required for higher education and industry.

**APTITUDE**

Module 1: Quantitative Aptitude Foundations (5 Hours)

1. Numerical reasoning and quantitative interpretation
2. Percentages, ratios and proportional reasoning
3. Scientific and research-based calculations
4. Quantitative comparison techniques
5. Structured problem-solving methodologies

Module 2: Logical Reasoning & Data Interpretation (5 Hours)

1. Analytical reasoning techniques
2. Series and pattern analysis
3. Graphical and tabular data interpretation
4. Logical deduction methodologies
5. Research-oriented analytical reasoning

Module 3: Research Aptitude Foundations (5 Hours)

1. Critical analysis of information
2. Observation and interpretation techniques
3. Evidence-based reasoning approaches
4. Structured decision-making methodologies
5. Introduction to research aptitude and analytical assessment

**Course Outcomes -**

CO1: Apply quantitative aptitude and numerical reasoning techniques to solve academic and research-oriented analytical problems.

CO2: Demonstrate logical reasoning, data interpretation and analytical decision-making abilities.

CO3: Develop research aptitude, critical evaluation and evidence-based reasoning skills.

**SEMESTER II: Advanced Soft Skills & Aptitude – II** **Course Code: CLL752**

**Contact Hours: 30 Hours**

**SOFT SKILLS**

Module 1: Advanced Professional Communication (5 Hours)

1. Scientific presentations and conference communication
2. Research paper communication techniques
3. Technical discussions and professional articulation
4. Scientific documentation practices
5. Digital communication in academic and professional settings

Module 2: Leadership & Professional Competencies (5 Hours)

1. Leadership in research and professional teams
2. Conflict resolution and stakeholder management
3. Professional decision-making
4. Workplace professionalism and ethics
5. Cross-functional collaboration and coordination

Module 3: Innovation, Creativity & Research Management (5 Hours)

1. Innovation mindset development
2. Research project coordination
3. Problem-solving in multidisciplinary environments
4. Design thinking and innovation approaches
5. Research productivity enhancement

**Course Outcomes -**

CO1: Demonstrate advanced professional communication and scientific documentation competencies.

CO2: Apply leadership, workplace professionalism, conflict management and collaborative decision-making skills.

CO3: Develop innovation, creativity and research management capabilities for multidisciplinary professional environments.

**APTITUDE**

Module 1: Intermediate Quantitative Aptitude (5 Hours)

1. Algebraic reasoning
2. Averages and analytical calculations
3. Probability fundamentals
4. Quantitative comparison techniques
5. Applied problem-solving methodologies

Module 2: Advanced Logical Reasoning (5 Hours)

1. Critical reasoning
2. Logical deduction
3. Analytical decision-making
4. Data sufficiency concepts
5. Structured interpretation methodologies

Module 3: Scientific Data Analysis Aptitude (5 Hours)

1. Statistical interpretation
2. Research data evaluation
3. Scientific data interpretation
4. Analytical assessment techniques
5. Evidence-based reasoning

**Course Outcomes**

CO1: Apply intermediate quantitative and analytical reasoning techniques to solve complex problems.

CO2: Demonstrate logical deduction, statistical interpretation and data analysis capabilities.

CO3: Develop evidence-based analytical reasoning for academic, research and professional applications.

**SEMESTER III: Advanced Soft Skills & Aptitude – III** **Course Code:CLL851**

**Contact Hours: 30 Hours**

**SOFT SKILLS**

Module 1: Research Communication & Professional Visibility (5 Hours)

1. Research proposal communication
2. Publication-oriented writing practices
3. Scientific interviewing and professional interactions
4. Academic networking and professional branding
5. Research dissemination strategies

Module 2: Strategic Professional Skills (5 Hours)

1. Executive communication skills
2. Professional leadership and influence
3. Strategic decision-making
4. Organizational effectiveness
5. Career planning and lifelong learning strategies

Module 3: Industry & Research Readiness (5 Hours)

1. Industry-academia collaboration awareness
2. Research commercialization fundamentals
3. Innovation and entrepreneurship orientation
4. Professional adaptability in emerging sectors
5. Advanced workplace readiness

**Course Outcomes -**

CO1: Demonstrate advanced research communication and professional visibility competencies.

CO2: Apply strategic leadership, executive communication and organizational effectiveness skills.

CO3: Develop industry readiness, innovation orientation and professional adaptability for advanced careers.

**APTITUDE**

Module 1: Advanced Quantitative Aptitude (5 Hours)

1. Advanced numerical reasoning
2. Statistical reasoning techniques
3. Applied quantitative analysis
4. Research-oriented quantitative interpretation
5. Strategic analytical problem-solving

Module 2: Advanced Analytical & Critical Reasoning (5 Hours)

1. Complex reasoning techniques
2. Analytical evaluation approaches
3. Decision-making under uncertainty
4. Logical assessment methodologies
5. Advanced critical thinking

Module 3: Placement & Competitive Aptitude Readiness (5 Hours)

1. Research entrance examination aptitude
2. Fellowship and competitive examination readiness
3. Placement-oriented aptitude assessment
4. Interview-linked analytical reasoning
5. Professional analytical effectiveness

**Course Outcomes -**

CO1: Apply advanced quantitative and analytical reasoning techniques in research and professional environments.

CO2: Demonstrate critical evaluation, strategic decision-making and advanced logical reasoning competencies.

CO3: Develop placement, fellowship and competitive examination readiness through structured aptitude preparation.

# ADVANCED SOFT SKILLS & APTITUDE FOR ALL M.A. AND M.SC PROGRAMS

**SEMESTER I: Advanced Soft Skills & Aptitude – I** **Course Code: CLL551**

**Contact Hours: 30 Hours**

**SOFT SKILLS**

**Module 1: Academic, Technical & Professional Communication (5 Hours)**

1. Academic, technical and professional communication fundamentals
2. Scholarly and technical writing practices
3. Critical reading and information analysis
4. Academic presentations and technical demonstrations
5. Professional documentation and referencing practices

**Module 2: Personal Effectiveness & Professional Identity (5 Hours)**

1. Self-awareness and professional growth
2. Goal setting and career planning
3. Academic ethics and professional integrity
4. Time management and productivity enhancement
5. Professional conduct in academic and workplace environments

**Module 3: Critical Thinking & Collaborative Learning (5 Hours)**

1. Critical thinking and analytical reasoning
2. Evidence-based argumentation
3. Interdisciplinary teamwork and collaboration
4. Problem-solving in professional and social contexts
5. Professional networking and stakeholder engagement

**Course Outcomes -**

**CO1:** Demonstrate effective academic, technical and professional communication skills in higher education and workplace environments.

**CO2:** Apply professional ethics, self-management and career development strategies effectively.

**CO3:** Develop critical thinking, teamwork and collaborative problem-solving competencies.

**APTITUDE**

**Module 1: Quantitative & Analytical Foundations (5 Hours)**

1. Numerical reasoning fundamentals
2. Percentages, ratios and proportional reasoning
3. Quantitative comparison techniques
4. Data interpretation basics
5. Analytical problem-solving approaches

**Module 2: Logical Reasoning Fundamentals (5 Hours)**

1. Verbal reasoning techniques
2. Analytical reasoning methods
3. Logical deduction approaches
4. Pattern recognition and series analysis
5. Decision-making fundamentals

**Module 3: Research Aptitude Foundations (5 Hours)**

1. Observation and interpretation techniques
2. Critical evaluation of information
3. Evidence-based reasoning
4. Research-oriented analytical thinking
5. Academic aptitude fundamentals

**Course Outcomes -**

**CO1:** Apply quantitative and analytical reasoning techniques to solve academic and workplace problems.

**CO2:** Demonstrate logical reasoning and structured decision-making abilities.

**CO3:** Develop foundational research aptitude and analytical thinking skills.

**SEMESTER II: Advanced Soft Skills & Aptitude – II** **Course Code: CLL552**

**Contact Hours: 30 Hours**

**SOFT SKILLS**

**Module 1: Professional, Institutional & Technical Communication (5 Hours)**

1. Professional communication in organizational environments
2. Technical and project documentation practices
3. Professional report and proposal writing
4. Presentation and stakeholder communication
5. Communication in institutional and technology-driven workplaces

**Module 2: Leadership & Professional Competencies (5 Hours)**

1. Leadership and team management
2. Stakeholder engagement and relationship management
3. Conflict resolution and negotiation skills
4. Ethical decision-making and professional responsibility
5. Cross-functional collaboration and coordination

**Module 3: Research, Innovation & Project Management (5 Hours)**

1. Research project planning and execution
2. Innovation and design thinking
3. Project management fundamentals
4. Interdisciplinary collaboration techniques
5. Professional project implementation strategies

**Course Outcomes -**

**CO1:** Demonstrate effective communication in institutional, organizational and technical contexts.

**CO2:** Apply leadership, negotiation and stakeholder management skills in professional settings.

**CO3:** Develop research, innovation and project management competencies.

**APTITUDE**

**Module 1: Intermediate Quantitative Aptitude** **(5 Hours)**

1. Applied quantitative reasoning
2. Averages and analytical calculations
3. Quantitative data interpretation
4. Statistical reasoning fundamentals
5. Applied problem-solving techniques

**Module 2: Advanced Logical Reasoning** **(5 Hours)**

1. Critical reasoning approaches
2. Logical deduction techniques
3. Analytical decision-making
4. Data sufficiency concepts
5. Structured interpretation methodologies

**Module 3: Applied Research Aptitude** **(5 Hours)**

1. Research methodology aptitude
2. Analytical interpretation techniques
3. Case analysis and evaluation
4. Evidence-based decision-making
5. Applied research reasoning

**Course Outcomes -**

**CO1:** Apply intermediate quantitative and analytical reasoning techniques to solve complex problems.

**CO2:** Demonstrate advanced logical and critical reasoning abilities.

**CO3:** Develop applied research aptitude for academic and professional contexts.

**SEMESTER III: Advanced Soft Skills & Aptitude – III** **Course Code: CLL651**

**Contact Hours -30 Hours**

**SOFT SKILLS**

**Module 1: Advanced Academic, Technical & Professional Communication (5 Hours)**

1. Research publication and scholarly writing
2. Conference, seminar and professional presentations
3. Academic and professional networking
4. Professional branding and digital visibility
5. Advanced communication for leadership roles

**Module 2: Strategic Leadership, Innovation & Organizational Effectiveness (5 Hours)**

1. Strategic leadership and influence
2. Organizational communication and effectiveness
3. Innovation and change management
4. Institutional development strategies
5. Career advancement and professional growth

**Module 3: Research, Innovation & Professional Readiness (5 Hours)**

1. NET/SET/JRF and higher education readiness
2. Research communication and publication practices
3. Industry and organizational readiness
4. Innovation, consultancy and entrepreneurship
5. Lifelong learning and professional development

**Course Outcomes -**

**CO1:** Demonstrate advanced academic, technical and professional communication competencies.

**CO2:** Apply strategic leadership, innovation and organizational effectiveness skills.

**CO3:** Develop readiness for higher education, research, entrepreneurship and professional careers.

**APTITUDE**

**Module 1: Advanced Quantitative Aptitude** **(5 Hours)**

1. Advanced numerical reasoning
2. Statistical interpretation techniques
3. Quantitative data evaluation
4. Strategic quantitative decision-making
5. Advanced analytical problem-solving

**Module 2: Advanced Analytical & Critical Reasoning** **(5 Hours)**

1. Complex reasoning techniques
2. Critical evaluation methodologies
3. Decision-making under uncertainty
4. Policy and organizational analysis
5. Strategic analytical thinking

**Module 3: Competitive, Placement & Research Aptitude Readiness** **(5 Hours)**

1. Competitive examination aptitude
2. Research aptitude enhancement
3. Placement-oriented aptitude preparation
4. Interview-linked analytical reasoning
5. Professional assessment readiness

**Course Outcomes -**

**CO1:** Apply advanced quantitative and analytical reasoning skills in academic and professional environments.

**CO2:** Demonstrate critical evaluation, strategic thinking and decision-making competencies.

**CO3:** Develop readiness for competitive examinations, research, placement and professional advancement.

**ADVANCED SOFT SKILLS & APTITUDE SYALLABUS FOR MBA PROGRAMMES**

**SEMESTER I: Advanced Soft Skills & Aptitude – I** **Course Code: CLL101**

**Contact Hours - 30 Hours**

**SOFT SKILLS**

**Module 1: Professional Communication Fundamentals (5 Hours)**

1. Business communication essentials
2. Professional email and corporate correspondence
3. Workplace etiquette and communication protocols
4. Professional presentation fundamentals
5. Active listening and effective questioning

**Module 2: Self-Management & Professional Effectiveness (5 Hours)**

1. Self-awareness and professional identity
2. Time and priority management
3. Goal setting and performance orientation
4. Professional ethics and accountability
5. Adaptability and growth mindset

**Module 3: Teamwork & Workplace Collaboration (5 Hours)**

1. Team dynamics and collaboration
2. Interpersonal communication
3. Conflict management basics
4. Networking fundamentals
5. Professional relationship building

**Course Outcomes -**

**CO1:** Demonstrate effective professional communication in business environments.

**CO2:** Apply self-management and professional effectiveness techniques.

**CO3:** Develop teamwork and workplace collaboration competencies.

**APTITUDE**

**Module 1: Quantitative Aptitude Foundations** **(5 Hours)**

1. Percentages and ratios
2. Profit and loss
3. Averages and partnerships
4. Business arithmetic
5. Numerical reasoning

**Module 2: Logical Reasoning Foundations** **(5 Hours)**

1. Analytical reasoning
2. Coding-decoding
3. Series and patterns
4. Logical deduction
5. Decision-making basics

**Module 3: Business Aptitude Fundamentals** **(5 Hours)**

1. Data interpretation basics
2. Business problem solving
3. Quantitative comparison
4. Numerical decision making
5. Basic analytical aptitude

**Course Outcomes -**

**CO1:** Apply quantitative reasoning in business scenarios.

**CO2:** Demonstrate logical and analytical thinking abilities.

**CO3:** Develop foundational aptitude for management decision-making.

**SEMESTER II: Advanced Soft Skills & Aptitude – II** **Course Code: CLL102**

**Contact Hours - 30 Hours**

**SOFT SKILLS**

**Module 1: Corporate Communication & Business Writing** **(5 Hours)**

1. Business reports and executive summaries
2. Proposal and business document writing
3. Stakeholder communication
4. Professional presentation techniques
5. Corporate communication practices

**Module 2: Leadership & Team Management** **(5 Hours)**

1. Leadership fundamentals
2. Team motivation and engagement
3. Conflict resolution strategies
4. Negotiation techniques
5. Workplace influence and collaboration

**Module 3: Business Problem Solving & Decision Making** **(5 Hours)**

1. Critical thinking in management
2. Business decision-making models
3. Structured problem-solving approaches
4. Strategic thinking fundamentals
5. Organizational effectiveness

**Course Outcomes -**

**CO1:** Demonstrate professional business communication and documentation skills.

**CO2:** Apply leadership and team management principles effectively.

**CO3:** Develop structured business problem-solving and decision-making competencies.

**APTITUDE**

**Module 1: Intermediate Quantitative Aptitude** **(5 Hours)**

1. Time and work
2. Time, speed and distance
3. Business mathematics
4. Data sufficiency
5. Quantitative analysis

**Module 2: Advanced Reasoning** **(5 Hours)**

1. Critical reasoning
2. Logical analysis
3. Seating arrangements
4. Analytical puzzles
5. Business logic scenarios

**Module 3: Data Interpretation & Business Analytics Aptitude** **(5 Hours)**

1. Tables and charts
2. Business dashboards
3. Graph interpretation
4. Trend analysis
5. Data-driven decision making

**Course Outcomes -**

**CO1:** Apply intermediate quantitative aptitude in managerial contexts.

**CO2:** Demonstrate advanced reasoning and analytical thinking abilities.

**CO3:** Interpret business data for informed decision-making.

**SEMESTER III: Advanced Soft Skills & Aptitude – III** **Course Code: CLL103**

**Contact Hours - 30 Hours**

**SOFT SKILLS**

**Module 1: Strategic Business Communication** **(5 Hours)**

1. Executive communication
2. Boardroom presentations
3. Business storytelling
4. Corporate branding communication
5. Professional influence and persuasion

**Module 2: Managerial Leadership & Organizational Behaviour** **(5 Hours)**

1. Strategic leadership
2. Organizational behaviour applications
3. Change management
4. Stakeholder management
5. Cross-functional collaboration

**Module 3: Innovation & Business Excellence** **(5 Hours)**

1. Design thinking
2. Innovation management
3. Business model thinking
4. Entrepreneurial mindset
5. Strategic business execution

**Course Outcomes -**

**CO1:** Demonstrate strategic business communication and influence skills.

**CO2:** Apply leadership and organizational effectiveness principles.

**CO3:** Develop innovation and business excellence competencies.

**APTITUDE**

**Module 1: Advanced Quantitative Aptitude** **(5 Hours)**

1. Probability
2. Business statistics
3. Quantitative modelling basics
4. Numerical optimization
5. Analytical calculations

**Module 2: Advanced Analytical Reasoning** **(5 Hours)**

1. Critical reasoning
2. Case-based reasoning
3. Strategic decision analysis
4. Complex business scenarios
5. Advanced logical thinking

**Module 3: Business Analytics Aptitude** **(5 Hours)**

1. Data analysis
2. Business intelligence interpretation
3. KPI evaluation
4. Analytical reporting
5. Evidence-based business decisions

**Course Outcomes (Aptitude)**

**CO1:** Apply advanced quantitative and statistical reasoning skills.

**CO2:** Demonstrate strategic analytical thinking and problem-solving abilities.

**CO3:** Interpret business analytics for managerial decision-making.

**SEMESTER IV: Advanced Soft Skills & Aptitude – IV** **Course Code: CLL104**

**Contact Hours - 30 Hours**

**SOFT SKILLS**

**Module 1: Executive Presence & Corporate Readiness** **(5 Hours)**

1. Executive presence and professional image
2. Leadership communication
3. Corporate networking strategies
4. Personal branding
5. Workplace professionalism

**Module 2: Career Management & Employability Skills** **(5 Hours)**

1. Interview mastery
2. Group discussion excellence
3. Assessment centre readiness
4. Career planning strategies
5. Workplace adaptability

**Module 3: Business Leadership & Global Competence** **(5 Hours)**

1. Global business communication
2. Cross-cultural management
3. Strategic leadership readiness
4. Corporate governance awareness
5. Lifelong professional development

**Course Outcomes (Soft Skills)**

**CO1:** Demonstrate executive communication and professional branding competencies.

**CO2:** Apply employability and career management skills effectively.

**CO3:** Develop global business leadership and workplace readiness capabilities.

**APTITUDE**

**Module 1: Placement Aptitude Mastery** **(5 Hours)**

1. Advanced quantitative aptitude
2. Corporate aptitude test strategies
3. Business case calculations
4. Data interpretation mastery
5. Quantitative decision making

**Module 2: Advanced Business Reasoning** **(5 Hours)**

1. Corporate analytical reasoning
2. Strategic problem solving
3. Business case analysis
4. Critical decision making
5. Executive reasoning skills

**Module 3: Placement & Assessment Readiness** **(5 Hours)**

1. Company-specific aptitude preparation
2. Assessment centre aptitude
3. Interview-linked analytical reasoning
4. Business simulation exercises
5. Placement readiness diagnostics

**Course Outcomes -**

**CO1:** Apply advanced aptitude skills in placement and corporate assessment contexts.

**CO2:** Demonstrate executive-level analytical and reasoning abilities.

**CO3:** Develop comprehensive placement readiness and managerial problem-solving competencies.

**ADVANCED SOFT SKILLS & APTITUDE M. TECH PROGRAMMES**

**SEMESTER I: Advanced Soft Skills & Aptitude – I** **Course Code: CLL11109**

**Contact Hours - 30 Hours**

**SOFT SKILLS**

**Module 1: Technical Communication & Research Writing (5 Hours)**

1. Advanced technical and professional communication
2. Research paper and literature review writing
3. Technical report and documentation practices
4. Research proposal and abstract writing
5. Scholarly communication and publication ethics

**Module 2: Professional Excellence & Research Ethics (5 Hours)**

1. Professional ethics in engineering and technology
2. Research integrity and responsible innovation
3. Time and project management for researchers
4. Professional accountability and workplace conduct
5. Adaptability in multidisciplinary environments

**Module 3: Innovation, Collaboration & Problem Solving (5 Hours)**

1. Design thinking and innovation mindset
2. Collaborative research and interdisciplinary teamwork
3. Engineering problem-solving approaches
4. Critical thinking and analytical decision-making
5. Professional networking and industry-academia interaction

**Course Outcomes -**

**CO1:** Demonstrate advanced technical communication, research writing and professional documentation skills.

**CO2:** Apply ethical, professional and project management practices in engineering and research environments.

**CO3:** Develop innovation, collaboration and critical problem-solving competencies for industry and academia.

**APTITUDE**

**Module 1: Quantitative & Engineering Aptitude Foundations (5 Hours)**

1. Quantitative reasoning and numerical analysis
2. Engineering mathematics fundamentals
3. Data interpretation and analytical calculations
4. Quantitative decision-making techniques
5. Applied problem-solving methodologies

**Module 2: Logical & Analytical Reasoning (5 Hours)**

1. Logical reasoning techniques
2. Critical analytical thinking
3. Pattern recognition and logical deduction
4. Decision-making models
5. Structured reasoning approaches

**Module 3: Research Aptitude & Analytical Assessment (5 Hours)**

1. Research aptitude fundamentals
2. Data interpretation and inference
3. Evidence-based analysis
4. Experimental reasoning
5. Analytical evaluation techniques

**Course Outcomes -**

**CO1:** Apply quantitative and engineering aptitude skills to solve technical and research-oriented problems.

**CO2:** Demonstrate logical reasoning and analytical decision-making abilities.

**CO3:** Develop research aptitude and evidence-based analytical thinking competencies.

**SEMESTER II: Advanced Soft Skills & Aptitude – II** **Course Code: CLL11110**

**Contact Hours – 30 Hours**

**SOFT SKILLS**

**Module 1: Technical Leadership & Professional Communication (5 Hours)**

1. Technical presentations and professional speaking
2. Engineering project communication
3. Stakeholder and client communication
4. Technical proposal and project report writing
5. Communication in global engineering environments

**Module 2: Project Management & Industry Collaboration (5 Hours)**

1. Engineering project planning
2. Team leadership and coordination
3. Industry-academia collaboration
4. Risk assessment and decision-making
5. Professional responsibility and compliance

**Module 3: Innovation, Entrepreneurship & Technology Management (5 Hours)**

1. Innovation management principles
2. Technology commercialization awareness
3. Entrepreneurship and startup fundamentals
4. Design-driven innovation approaches
5. Emerging technology adaptation

**Course Outcomes -**

**CO1:** Demonstrate effective technical leadership and project communication skills.

**CO2:** Apply project management and collaborative professional practices in engineering environments.

**CO3:** Develop innovation, entrepreneurship and technology management competencies.

**APTITUDE**

**Module 1: Intermediate Quantitative Aptitude** **(5 Hours)**

1. Advanced quantitative reasoning
2. Statistical interpretation
3. Numerical optimization concepts
4. Engineering analytical calculations
5. Applied quantitative problem-solving

**Module 2: Advanced Logical Reasoning** **(5 Hours)**

1. Critical reasoning
2. Analytical decision-making
3. Data sufficiency techniques
4. Complex logical deduction
5. Strategic reasoning approaches

**Module 3: Technical & Research Aptitude** **(5 Hours)**

1. Research methodology aptitude
2. Analytical interpretation
3. Engineering case analysis
4. Experimental problem-solving
5. Technical reasoning assessment

**Course Outcomes**

**CO1:** Apply intermediate quantitative and technical aptitude skills in engineering contexts.

**CO2:** Demonstrate advanced analytical and logical reasoning abilities.

**CO3:** Develop technical and research aptitude for innovation and problem-solving.

**SEMESTER III: Advanced Soft Skills & Aptitude – III** **Course Code: CLL11111**

**Contact Hours- 30 Hours**

**SOFT SKILLS**

**Module 1: Research Publication & Technical Visibility** **(5 Hours)**

1. Research publication and journal communication
2. Conference presentation skills
3. Patent and intellectual property communication
4. Academic and professional networking
5. Research dissemination strategies

**Module 2: Strategic Leadership & Organizational Effectiveness** **(5 Hours)**

1. Strategic leadership in technology sectors
2. Organizational communication
3. Innovation leadership
4. Change management and organizational effectiveness
5. Professional advancement strategies

**Module 3: Industry 4.0, Research & Career Readiness** **(5 Hours)**

1. Industry 4.0 and digital transformation awareness
2. Emerging technology trends
3. Advanced workplace readiness
4. Consultancy and professional practice
5. Lifelong learning and career progression

**Course Outcomes -**

**CO1:** Demonstrate advanced research communication and publication-oriented competencies.

**CO2:** Apply strategic leadership and organizational effectiveness skills in engineering and technology domains.

**CO3:** Develop industry readiness, innovation orientation and professional advancement capabilities.

**APTITUDE**

**Module 1: Advanced Quantitative Aptitude** **(5 Hours)**

1. Advanced numerical reasoning
2. Statistical and analytical evaluation
3. Quantitative modelling concepts
4. Strategic quantitative decision-making
5. Complex problem-solving techniques

**Module 2: Advanced Analytical & Critical Reasoning** **(5 Hours)**

1. Systems thinking
2. Complex analytical reasoning
3. Critical evaluation techniques
4. Decision-making under uncertainty
5. Strategic problem analysis

**Module 3: Placement, Competitive & Research Aptitude Readiness** **(5 Hours)**

1. GATE-oriented aptitude enhancement
2. Research entrance and fellowship aptitude
3. Technical placement aptitude preparation
4. Interview-linked analytical reasoning
5. Professional assessment readiness

**Course Outcome -**

**CO1:** Apply advanced quantitative and analytical reasoning techniques in research and industrial contexts.

**CO2:** Demonstrate strategic thinking, critical evaluation and complex problem-solving abilities.

**CO3:** Develop readiness for research careers, technical placements, higher studies and professional advancement.

# COMMUNICATIVE ENGLISH FOR PROFESSIONALS FOR LL.M. PROGRAM

**Semester 1: Communicative English for Professionals – I** **Course Code: LWJ21201**

**Contact Hours – 15 hours**

**Module 1: Foundational Legal Communication** **5 hours**

1. Advanced verbal and non-verbal communication in legal environments
2. Grammar refinement and structured legal articulation
3. Professional legal vocabulary enhancement
4. Reading comprehension and interpretation of legal and policy documents
5. Listening and analytical interpretation during legal interaction

**Module 2: Academic & Legal Writing** **5 hours**

1. Professional email drafting and legal correspondence
2. Paragraph and analytical legal writing techniques
3. Formal communication in academic and institutional environments
4. Structured legal explanation and articulation
5. Communication ethics in legal and institutional ecosystems

**Module 3: Professional Legal Interaction** **5 hours**

1. Professional self-introduction and courtroom articulation
2. Public speaking and confidence development
3. Communication during seminars and legal discussions
4. Professional etiquette in legal institutions
5. Collaborative communication in academic legal environments

**Course Outcomes (COs)**

CO1: Demonstrate competencies aligned with communicative english for professionals – I (entry level) requirements.

CO2: Apply advanced legal communication, analytical articulation, and professional interaction techniques effectively.

CO3: Develop industry-oriented legal professionalism, advocacy communication, and executive leadership competencies.

**Semester 1 – Communicative Aptitude for Professionals I** **Course Code – LWJ21205**
**Contact Hours – 15 hours**

**Module 1: Foundational Legal Reasoning & Analytical Skills** **5 hours**

1. Foundational logical reasoning and analytical interpretation
2. Analogy, classification, and structured legal association techniques
3. Basic legal-data interpretation and quantitative reasoning
4. Analytical observation and structured problem-solving approaches
5. Foundational decision-making techniques in legal environments

**Module 2: Quantitative & Logical Interpretation** **5 hours**

1. Basic numerical reasoning and legal data evaluation
2. Percentage, ratio, proportion, and structured interpretation
3. Logical sequencing and reasoning accuracy
4. Critical thinking and analytical deduction fundamentals
5. Interpretation of institutional and policy-oriented information

**Module 3: Professional Aptitude & Legal Workplace Readiness** **5 hours**

1. Professional adaptability in legal environments
2. Analytical response management during legal interaction
3. Problem-solving approaches in institutional settings
4. Professional accountability and operational discipline
5. Foundational workplace reasoning and collaborative professionalism

**Course Outcomes (COs)**

CO1: Demonstrate legal aptitude, analytical reasoning, and structured interpretation competencies effectively.

CO2: Apply strategic legal reasoning, decision-making, and professional analytical techniques professionally.

CO3: Develop placement-oriented legal aptitude, executive analytical leadership, and professional sustainability competencies.

**Semester 2: Communicative English for Professionals – II** **Course Code: LWJ21202**

**Contact Hours – 15 hours**

**Module 1: Legal Drafting & Professional Articulation** **5 hours**

1. Legal drafting communication and structured explanation techniques
2. Professional articulation during client consultation and mediation
3. Case interpretation and analytical legal communication
4. Presentation communication in legal environments
5. Communication during arbitration and dispute-resolution interaction

**Module 2: Corporate & Judicial Communication** **5 hours**

1. Corporate legal communication practices
2. Professional communication during judicial and institutional interaction
3. Stakeholder-oriented communication techniques
4. Professional diplomacy and legal professionalism
5. Communication during legal documentation and reporting

**Module 3: Research Communication & Legal Presentation** **5 hours**

1. Research-oriented legal writing techniques
2. Presentation communication during legal research interaction
3. Analytical reporting and scholarly articulation
4. Professional networking and institutional communication
5. Workplace adaptability in multidisciplinary legal environments

**Course Outcomes (COs)**

CO1: Demonstrate competencies aligned with communicative english for professionals – ii (intermediate level) requirements.

CO2: Apply advanced legal communication, analytical articulation, and professional interaction techniques effectively.

CO3: Develop industry-oriented legal professionalism, advocacy communication, and executive leadership competencies.

**Semester 2 – Communicative Aptitude for Professionals II** **Course Code – LWJ21206**
Contact Hours – 15 hours

**Module 1: Intermediate Legal Analytical Interpretation** **5 hours**

1. Structured interpretation of legal and policy frameworks
2. Critical legal reasoning and analytical comparison techniques
3. Logical deduction and institutional reasoning
4. Analytical interpretation during legal operations
5. Strategic problem-solving in legal environments

**Module 2: Quantitative Analysis & Decision-Making** **5 hours**

1. Quantitative comparison and analytical evaluation methods
2. Data interpretation and legal analytical reasoning
3. Structured reasoning during institutional coordination
4. Decision-making and operational analytical approaches
5. Professional analytical effectiveness under time constraints

**Module 3: Legal Operations & Professional Aptitude** **5 hours**

1. Operational reasoning in legal and corporate environments
2. Professional coordination and stakeholder interaction
3. Analytical adaptability in multidisciplinary ecosystems
4. Problem-solving during legal workflow management
5. Professional resilience and institutional effectiveness

**Course Outcomes (COs)**

CO1: Demonstrate legal aptitude, analytical reasoning, and structured interpretation competencies effectively.

CO2: Apply strategic legal reasoning, decision-making, and professional analytical techniques professionally.

CO3: Develop placement-oriented legal aptitude, executive analytical leadership, and professional sustainability competencies.

**Semester 3: Communicative English for Professionals – III** **Course Code: LWJ21203**

**Contact Hours – 15 hours**

**Module 1: Executive Legal Communication & Leadership** **5 hours**

1. Executive communication in legal and corporate environments
2. Leadership articulation during strategic legal operations
3. Advanced advocacy communication techniques
4. Professional communication during high-pressure legal situations
5. Leadership interaction in multidisciplinary legal ecosystems

**Module 2: Global Legal Communication & Policy Interaction** **5 hours**

1. Global workplace communication and cross-cultural legal interaction
2. Policy-oriented communication and institutional articulation
3. Communication during international legal and corporate interaction
4. Professional interaction in evolving legal ecosystems
5. Strategic communication during organizational transformation

**Module 3: Career Sustainability & Professional Excellence** **5 hours**

1. Interview mastery and executive professionalism
2. Professional networking and stakeholder relationship management
3. Strategic presentation and advocacy communication
4. Professional readiness for judiciary, litigation, and corporate legal sectors
5. Career sustainability and continuous professional upskilling communication

**Course Outcomes (COs)**

CO1: Demonstrate competencies aligned with communicative english for professionals – iii (advanced level) requirements.

CO2: Apply advanced legal communication, analytical articulation, and professional interaction techniques effectively.

CO3: Develop industry-oriented legal professionalism, advocacy communication, and executive leadership competencies.

**Semester 3 – Communicative Aptitude for Professionals III** **Course Code – LWJ21207**
**Contact Hours – 15 hours**

**Module 1: Advanced Legal Reasoning & Strategic Interpretation** **5 hours**

1. Advanced legal reasoning and analytical deduction

2. Strategic legal risk analysis and interpretation

3. Complex institutional problem-solving methodologies

4. Operational reasoning during legal and organizational coordination

5. Advanced analytical leadership techniques

**Module 2: Executive Aptitude & Professional Decision-Making** **5 hours**

1. Executive-level reasoning and strategic decision-making

2. Analytical interpretation during crisis and conflict situations

3. Professional adaptability in evolving legal ecosystems

4. Leadership-oriented reasoning and stakeholder coordination

5. Strategic operational effectiveness in legal environments

**Module 3: Career Sustainability & Advanced Professional Aptitude** **5 hours**

1. Advanced placement-oriented aptitude and analytical readiness

2. Professional analytical communication under pressure environments

3. Career sustainability and professional growth strategies

4. Professional readiness for judiciary, litigation, and corporate legal sectors

5. Long-term executive legal professionalism and analytical excellence

**Course Outcomes (COs)**

CO1: Demonstrate legal aptitude, analytical reasoning, and structured interpretation competencies effectively.

CO2: Apply strategic legal reasoning, decision-making, and professional analytical techniques professionally.

CO3: Develop placement-oriented legal aptitude, executive analytical leadership, and professional sustainability competencies.

| | CLL Foreign Language French PG Semester 1 | L | T | P | C |
|---|---|---|---|---|---|
| **Version 1.0** | **Contact Hours - 30** | 2 | 0 | 0 | 2 |
| **Course Codes** | AEC408 (2 credits), CLL10001 (Non-Credit), CLL12002N (Non-Credit) | | | | |
| **Pre-requisites/Exposure** | - | | | | |
| **Co-requisites** | - | | | | |
| **Academic Year** | 2026-2027 | | | | |

**Programme Educational Objectives (PEO)**

The French Programme aims to equip students with fundamental linguistic, cultural and communicative competencies for practical applications. The educational objectives are:

PEO1 – Equip students with essential French language skills for basic communication in everyday contexts
PEO2 – Strengthen linguistic competence through a structured progression of vocabulary, grammar and writing skills
PEO3 – Foster an appreciation of Francophone cultures, enhancing intercultural sensitivity and global perspectives

**Course Description**

This beginner-level course is designed to introduce students to the fundamentals of the French language while fostering an appreciation for Francophone culture. Through a communicative and immersive approach, students will develop essential skills in listening, speaking, reading and writing, along with a foundational understanding of French grammar and cultural nuances.

**Course Content**

**Module 1 : Bonjour, World! — Your First Peek into the Land of the French [2 hours]**

- Overview of the Indo-European Family of Languages
- Concept of Germanic, Romance and Slavic Languages
- Countries where French is spoken: Canada, Monaco, Belgium, Switzerland, Luxembourg etc.
- French Colonies in India: Chandernagor, Pondicherry

**Module 2 : A-B-C, Très Fancy! — The Alphabet That Wears Accents [2 hours]**

- Alphabet Adventures – Once upon a Letter….
  - A Fun Intro to French Letters
- The five special French characters – accents ( é,è,ô,ç,ë ) and their significance
- French Pronunciation Rules
  Activities: Pronouncing unknown French words
  Reading unknown French texts with correct pronunciation

**Module 3: Colours, Cousins & Croissants — Everyday French Words Made Fun! [4 hours]**

- Noir, Rouge & everything in between – A Colourful Dive into French!
  - Making colours fun
- From Père to Oncle – Who's Who in the Family Tree?
  -Navigating Family Vocabulary
- From Kitchen to Chambre– A Tour of Your House in French
  -Essential Home Vocabulary
- Food menu in French: From Breakfast to Dinner
  Petit-Déjuener, Déjuener, Pain, Chocolat, Croissant

**Module 4 : Salut & Smiles — French Greetings for Every Mood [2 hours]**

- Basic expressions of greetings, expressions of politeness:
  - Bonjour, Salut, Comment allez-vous?, Comment ça va?, Je vais bien, Merci, Au revoir

**Module 5: Un, Deux, Trois… Voilà! — Counting the French Way [3 hours]**

- High-Five to French!

  -Un, Deux, Trois of French numbers: counting from 1 to 100

- Telling the time in French
  Activities: Listening Exercises on Numbers
  Telling the time by looking at pictures of clocks

**Module 6: Speak Up, Mon Ami! Your First Steps into French Conversations [2 Hours]**

- Self-introduction (First Name, Surname, Age, Nationality, Profession etc)
- Introducing someone else (talk about your friend, brother, mother, father etc.)

**Module 7 : Grammar Glamour — Chic Rules for Speaking Like a Parisian: [7 hours]**

- Definite and Indefinite Articles
- Common Nouns & Adjectives
- Singular and Plural Forms of Nouns
- Subject Pronouns
- Regular Verbs: ER & IR group
- Irregular Verbs: RE Group
- Construction of Negative Sentences

**Module 6: Cheese, Culture & Oh Là Là— A French Lifestyle Tour [6 hours]**

- French Gastronomy: French cheese and wines
  Roquefort, Camembert, Brie, Vin Rouge, Vin Blanc etc.
- Famous French perfumes:
  Dior, Chanel etc.
- French cities and tourist places:
  Paris, Lyon, Lille etc.
- Francophone countries
  La Belgique, La Suisse, Le Canada etc.
- Renowned French personalities:
  Jeanne d'Arc, Marie Curie, Molière etc.
- Significance of the French Flag and Currency

**Module 9: Compréhension des écrits — Honing Your Reading Skills [2 hours]**

Activity: Students will read short and simple unseen texts and answer questions based on these texts

**Course Outcomes (CO):**

On completion of this first-semester course, the students will be able to

CO1 - Understand the historical and linguistic background of French within the Indo-European language family
CO2 - Master basic pronunciation rules and apply them to pronounce French words
CO3 - Build essential vocabulary for colours, family, colours, parts of the house and food items
CO4 - Learn basic French greetings and expressions and practice speaking
CO5 - Learn to count and tell time in French
CO6 - Introduce themselves and others in French
CO7 - Develop a foundation in elementary French grammar, in articles, personal Pronouns and verbs
CO8 - Gain insights into French cultural norms, traditions and etiquette, helping them blend into native conversations
CO9 - Read simple, unseen French texts and answer questions

**Programme Outcomes (PO):**

Upon successful completion of this two-semester programme, students will develop the following competencies:

PO1 - Know about the origin of the French language vis-à-vis other European languages
PO2 - Develop French pronunciation skills
PO3 - Learn to count and tell time in French
PO4 - Understand and apply elementary French Grammar
PO5 - Speak in basic French
PO6 - Demonstrate familiarity with French culture
PO7 - Fill up Forms in French and write short French sentences and messages
PO8 - Gain knowledge of basic French vocabulary

**Programme Specific Outcomes (PSO):**

PSO1 – Learn about French as a Germanic language and its place in the Indo-European School of Languages
PSO2 – Recognize French diphthongs, accents, sounds and phonetic patterns for accurate pronunciation.
PSO3 – Understand formal and informal time and cardinal and ordinal numbers in French
PSO4 – Grasp key grammatical concepts involving definite and indefinite articles, subject pronouns, adjectives, regular, irregular and pronomial verbs, interrogative adjectives and prepositions
PSO5 – Speak and respond confidently in daily communication scenarios and understand and apply common greetings, expressions and conversational starters
PSO6 – Get acquainted with aspects of French culture, like food and dining etiquette, festivals and media
PSO7 – Fill up forms in French by providing personal information and communicate in French through short e-mails and messages and use conventional French salutations and valedictions
PSO8 – Acquire knowledge of vocabulary related to areas like colours, family, parts of the house, food and drinks, public places, transport, weather and clothes

**Correlation Matrix between CO and PO and CO and PSO:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 | PSO 7 | PSO 8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | | | | | | | | 3 | | | | | | | |
| CO2 | | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 |
| CO3 | | 2 | | | 2 | | 2 | 3 | | 2 | | | 2 | | 2 | 3 |
| CO4 | | 2 | | | 3 | | | 1 | | 2 | | | 3 | | | 1 |
| CO5 | | | 3 | | | | | | | | 3 | | | | | |
| CO6 | | 2 | | 2 | 3 | | | 1 | | 2 | | 2 | 3 | | | 1 |
| CO7 | | | | 3 | 2 | | 2 | | | | | 3 | 2 | | 2 | |
| CO8 | | | | | | 3 | | | | | | | | 3 | | |
| CO9 | | 2 | | 2 | | | 3 | 2 | | 2 | | 2 | | | 3 | 2 |

Degree of Correlation: 1 – low, 2 – medium, 3 – high

| | CLL Foreign Language French PG Semester 2 | L | T | P | C |
|---|---|---|---|---|---|
| **Version 1.0** | **Contact Hours - 30** | 2 | 0 | 0 | 2 |
| **Course Codes** | AEC503 (2 credits), CLL10004 (Non-Credit), CLL22002N (Non-Credit) | | | | |
| **Pre-requisites/Exposure** | - | | | | |
| **Co-requisites** | - | | | | |
| **Academic Year** | 2026-2027 | | | | |

**Programme Educational Objectives (PEO)**

The French Programme aims to equip students with fundamental linguistic, cultural and communicative competencies for practical applications. The educational objectives are:

PEO1 – Equip students with essential French language skills for basic communication in everyday contexts
PEO2 – Strengthen linguistic competence through a structured progression of vocabulary, grammar and writing skills
PEO3 – Foster an appreciation of Francophone cultures, enhancing intercultural sensitivity and global perspectives

**Course Description**

This second-semester course builds upon foundational knowledge to deepen students' linguistic competence in the French language and awareness of French culture. Designed for learners with prior exposure to elementary French, the course reinforces everyday communication, introduces nuanced grammatical structures and expands students' confidence in both oral and written expression.

**Module 1: French on the Go: Talk, Order, Buy, Repeat! [6 hours]**

- The Art of Introducing Yourself in French
  Speaking Topics: Personal / Family / Studies / Food / Hobbies and Spare Time/Discussing phone numbers
  Activity: Pair Work - Students pair up for casual dialogues and switch partners every 3 minutes
- Visualising someone's daily life
  Activity: Students speak about their daily life
- Ordering Food at a Restaurant
  Activity: Students practice ordering different items using a mock menu
- Buying items & asking Price
  Activity: Simulated Shopping - "Customer and Store Attendant" practice

**Module 2: From "Chat" to "Château": Your French Word Treasures [4 hours]**

- Different Public Places:
  École, Église , Gare etc.
- Transport:
  Bus, Train, Vélo, Voiture
- The Weather:
  Il fait beau, Il fait Mauvais, Il fait chaud, Il fait froid etc.
- Food & Drinks:
  Baguette, Pain , Chocolat, Poulet, Poisson, Vin, Lait, Café, Thé etc.
- Clothes:
  T-shirt, Pantalon, Jupe, Robe etc.
- Family Members:
  Père, Mère, Parents etc.

**Module 3: Unlocking the Grammar Vault of 'la Belle Langue' [10 hours]**

- How to frame Interrogative Sentences
- Near future
- Recent past
- Possessive adjectives
- Pronominal verbs
- Everyday verbs in present tense:
  Regular -er ending verbs (Porter, Manger, Acheter, Jouer, Donner, Commencer etc.)
  Irregular verbs: Faire, Venir, Boire, Pouvoir, Vouloir
- Prepositions before Countries & Places
- Quizzes and Worksheets

**Module 4: Pen, Paper, Paris: Writing the French Way [5 hours]**

- Writing brief e-mails or messages comprising of 20-25 words:
  - Greetings and Salutations: Salut/ Cher/ Chère
  - Valedictory Address: Au Revoir / À Bientôt
  Activity: Students write a short email based on a given scenario like a Birthday Invitation.
- Passage on seen topic
  Activity: Students read the passage and they will answer questions
- How to fill a form in French
  Activity: Students fill different forms in French

**Module 5: The Art of "Joie de Vivre": Celebrating French Culture [3 hours]**

- French Greetings on Occasions and Holidays:
  Joyeux Noël , Bonne Année etc.
- French Festivals:
  Noël , Le 14 Juillet etc.
- French Newspapers and Magazine:
  Newspapers – Le Monde, 20 Minutes, Le Figaro , Les Echos , Le Matin, L'Express etc.
  Magazines – Lire , Le Point , Paris Match, Numérique, Biba, Elle, Vogue etc.
- French Television Channels :
  TV5 Monde, Canal+, M6, France 2, France 3, France 4, France 5, Arte etc.

**Module 6: Communication en Action — Speak with Confidence [2 hours]**

- Monologue Practice
  – Describing daily life, likes and dislikes, best friends, the university etc.
  Activity: Role-play & speaking activities

**Course Outcomes (CO):**

On completion of this second-semester course, the students will be able to

CO1 - Introduce themselves, express personal preferences and participate in casual dialogues
CO2 - Order food and handle shopping interactions in French
CO3 - Get acquainted with basic French vocabulary for public places, transport, weather, food and drinks, clothes and family members
CO4 - Understand and apply French grammatical structures, including possessive adjectives, pronominal verbs, interrogative adverbs, near future and recent past
CO5 - Fill out forms in French and compose short messages and emails, using appropriate salutations and valedictions
CO6 - Evaluate aspects of French culture such as common French greetings, festivals and media
CO7 - Demonstrate basic oral communication skills in French by delivering short monologues

**Programme Outcomes (PO):**

Upon successful completion of this two-semester programme, students will develop the following competencies:

PO1 - Know about the origin of the French language vis-à-vis other European languages
PO2 - Develop French pronunciation skills
PO3 - Learn to count and tell time in French
PO4 - Understand and apply elementary French Grammar
PO5 - Speak in basic French
PO6 - Demonstrate familiarity with French culture
PO7 - Fill up Forms in French and write short French sentences and messages
PO8 - Gain knowledge of basic French vocabulary

**Programme Specific Outcomes (PSO):**

PSO1 – Learn about French as a Germanic language and its place in the Indo-European School of Languages
PSO2 – Recognize French diphthongs, accents, sounds and phonetic patterns for accurate pronunciation.
PSO3 – Understand formal and informal time and cardinal and ordinal numbers in French
PSO4 – Grasp key grammatical concepts involving definite and indefinite articles, subject pronouns, adjectives, regular, irregular and pronomial verbs, interrogative adjectives and prepositions
PSO5 – Speak and respond confidently in daily communication scenarios and understand and apply common greetings, expressions and conversational starters
PSO6 – Get acquainted with aspects of French culture, like food and dining etiquette, festivals and media
PSO7 – Fill up forms in French by providing personal information and communicate in French through short e-mails and messages and use conventional French salutations and valedictions
PSO8 – Acquire knowledge of vocabulary related to areas like colours, family, parts of the house, food and drinks, public places, transport, weather and clothes

**Correlation Matrix between CO and PO and CO and PSO:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 | PSO 7 | PSO 8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | 2 | | 2 | 3 | | | | | 2 | | 2 | 3 | | | |
| CO2 | | 2 | | 2 | 3 | 1 | | | | 2 | | 2 | 3 | 1 | | |
| CO3 | | 2 | | | 2 | | 3 | 3 | | 2 | | | 2 | | 3 | 3 |
| CO4 | | | | 3 | 3 | | 3 | | | | | 3 | 3 | | 3 | |
| CO5 | | | | 3 | | | 3 | 2 | | | | 3 | | | 3 | 2 |
| CO6 | | | | | 2 | 3 | | | | | | | 2 | 3 | | |
| CO7 | | 2 | | 2 | 3 | | | 2 | | 2 | | 2 | 3 | | | 2 |

Degree of Correlation: 1 – low, 2 – medium, 3 – high

| | CLL Foreign Language German PG Semester 1 | L | T | P | C |
|---|---|---|---|---|---|
| **Version 1.0** | **Contact Hours - 30** | 2 | 0 | 0 | 2 |
| **Course Codes** | AEC409 (2 credits), CLL10002 (Non-Credit), CLL12003N (Non-Credit) | | | | |
| **Pre-requisites/Exposure** | - | | | | |
| **Co-requisites** | - | | | | |
| **Academic Year** | 2026-2027 | | | | |

**Programme Educational Objectives (PEO)**

The German Programme aims to equip students with fundamental linguistic, cultural and communicative competencies for practical applications. The educational objectives are:

PEO1 – Develop foundational skills in speaking, reading, writing, and listening, enabling effective communication in German
PEO2 – Gain insight into German cultural practices, traditions and social etiquette
PEO3 – Acquire the ability to use German in real-life contexts, such as introducing oneself, in restaurant interactions, in supermarkets, in commuting and in formal writing
PEO4 – Develop competence in German grammar, understanding articles, pronouns, conjunctions, verb conjugations and sentence structures

**Course Description**

This beginner-friendly first-semester course is designed to introduce students to the fundamentals of German while immersing them in the rich cultural and linguistic landscape of German-speaking countries. This course will lay a strong foundation for communication, comprehension and cultural knowledge. Through interactive lessons, pronunciation drills, vocabulary-building exercises and cultural insights, students will gain the confidence to speak, listen and understand the basics of German in everyday scenarios.

**Course Content**

**Module 1: Introduction [2 hours]**

- Overview of the Indo-European Family of Languages
- Concept of Germanic, Romance and Slavic Languages
- European Countries where German is spoken:
  Germany, Austria, Switzerland, Luxembourg, Lichtenstein et. al.
- Variation of German accents across Germany, Austria and Switzerland
  Hochdeutsch, Österreichisches Deutsch and Schweizerdeutsch

**Module 2: The German Alphabet [2 hours]**

- Letter by Letter – Building Blocks of a New Language
  - A Fun Intro to German Letters
- The four special German characters – ä, ö, ü, ß and their significance
  Activity: Pronounce the Letters shown

**Module 3: Pronunciation Rules (From Bahnhof to Brötchen – Speaking Like a Local) [8 hours]**

- Rules for Vowels: a, o, e
- Rules for Special characters: ä, ö, ü
- Rules for Diphthongs: ie, ei, ai, au, aü, eu
- Rules for Consonants: b/d/g, h, j, r, s, v, y, z
- Rules for Consonant Clusters: ch, sch, tsch, chs, sp/st, pf, ck, tz, ng
- Rule for ig
  Activities: Pronouncing unknown German words from a Word Montage
  Reading elementary, unknown German texts with correct pronunciation

**Module 4: German Numbers (Cardinal, Ordinal, Fractions) [3 hours]**

- High-Five to German!
  - The eins, zwei, drei of German numbers: counting from 1 to 100
- Ordinal Numbers
- Fractions
  Activity: Listening Exercises on Numbers

**Module 5: Reading the Clock like a Native German – Tick-Tock auf Deutsch [3 hours]**

Wie spät ist es? /Wie viel Uhr ist es?

- Formal Time
- Informal Time
- Exercise: Telling the time by looking at pictures of clocks

**Module 6: Speaking German – Basic German Greetings and Expressions: [3 hours]**

- Hallo or Guten Tag?
  Navigating the Art of First Impressions - Mastering German Greetings
- From Tschüss to Bis Bald! – Saying Goodbye
  Farewell in German
- Wie Geht's? – How are you?
  Conversational Starters
- Danke, Bitte, Entschuldigung – The Magic Words You'll Use Every Day
  Essential German Politeness
- Ja, Nein, Vielleicht – Yes, No, Perhaps
  Common Responses & Reactions
- Jawohl! Ach So! – Expressions That Make You Sound Like a Local
  Authentic German Exclamations
  Activity: Role Play - Students exchange greetings

**Module 7: German Culture [3 hours]**

- Why Germans Love Punctuality – And How to Never Be 'Zu Spät!' Again!
  (Understanding Social Etiquette)
- Dining Etiquette: How to say "Guten Appetit!" and "Prost!" correctly
- The 'Feierabend' Philosophy – How Germans Unwind After Work
  Work-Life Balance & Leisure Culture
- "Kuchen und Kaffee" – What Germans eat and drink
  Traditional German Food and Everyday Eating Habits
- Karneval , Oktoberfest, Ostern, Christmas Markets & Silvester
  German Festivals and Seasonal Events

**Module 8: Grammar - Mission: Grammatik Possible [2 hours]**

- Definite and Indefinite Articles in the Nominativ
- Personal Pronouns in the Nominativ
  Activities: Students become Grammar Detectives and solve the Case by adding der/die/das in front of Nouns shown on Flashcards
  Students identify themselves and others by using Personal Pronouns

**Module 9: Elementary Vocabulary [4 hours]**

- From Montag Blues to Winter Views
  - Weekdays, Months, and Seasons in German
- Schwarz, Weiss & everything in between – A Colourful Dive into German!
  - Making colours fun
- From Oma to Onkel – Who's Who in the Family Tree?
  -Navigating Family Vocabulary
- From Küche to Keller – A Tour of Your House in German
  -Essential Home Vocabulary
- Hop On, Hop Off – Mastering German Transport Without Missing Your Bus
  - Understanding Transport Terms
  Activities: Audio Comprehensions
  Identification of Objects from Pictures shown

**Course Outcomes (CO):**

On completion of this first-semester course, the students will be able to

CO1 - Understand the historical and linguistic background of German within the Indo-European language family
CO2 - Master basic pronunciation rules and apply them to pronounce German words
CO3 - Learn to count and tell time in German
CO4 – Learn basic German greetings and expressions and practice speaking
CO5 - Gain insights into German cultural norms, traditions and etiquette, helping them blend into native conversations
CO6 - Develop a foundation in elementary German grammar, in articles and personal pronouns
CO7 - Build essential vocabulary for greetings, family, colours, transport and daily interactions

**Programme Outcomes (PO):**

Upon successful completion of this two-semester programme, students will develop the following competencies:

PO1 - Know about the origin of the German language vis-à-vis other European languages
PO2 - Develop German pronunciation skills
PO3 - Learn to count and tell time in German
PO4 - Understand and apply elementary German Grammar
PO5 - Speak in basic German
PO6 - Demonstrate familiarity with German culture
PO7 - Fill up Forms in German and write short German sentences and messages
PO8 - Gain knowledge of basic German vocabulary and answer questions based on unseen German texts

**Programme Specific Outcomes (PSO):**

PSO1 – Learn about German as a Germanic language and its place in the Indo-European School of Languages

PSO2 – Recognize German diphthongs, consonant clusters, sounds and phonetic patterns for accurate pronunciation.

PSO3 – Understand formal and informal time and cardinal numbers, ordinal numbers and fractions in German

PSO4 – Grasp key grammatical concepts involving main verbs, modal verbs, conjunctions and articles and personal pronouns as subjects and direct objects

PSO5 – Speak and respond confidently in daily communication scenarios and understand and apply common greetings, expressions and conversational starters

PSO6 – Get acquainted with aspects of German culture, like food and dining etiquette, punctuality, festivals, media, football craze and cars

PSO7 – Fill up forms in German by providing personal information and communicate in German through short e-mails and messages and use conventional German salutations and valedictions

PSO8 – Acquire knowledge of vocabulary related to areas like colours, family, home, clothes, transport, cities, weather and parts of the body and read simple, unseen German texts and answer questions based on these texts

**Correlation Matrix between CO and PO and CO and PSO:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 | PSO 7 | PSO 8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | | | | | | | | 3 | | | | | | | |
| CO2 | | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| CO3 | | | 3 | | | | | | | | 3 | | | | | |
| CO4 | | | | | 3 | 2 | 1 | | | | | | 3 | 2 | 1 | |
| CO5 | | | | | | 3 | | 2 | | | | | | 3 | | 2 |
| CO6 | | | | 3 | 3 | | 3 | 3 | | | | 3 | 3 | | 3 | 3 |
| CO7 | | | 1 | | 2 | 2 | 3 | 3 | | | 1 | | 2 | 2 | 3 | 3 |

Degree of Correlation: 1 – low, 2 – medium, 3 – high

| | CLL Foreign Language German PG Semester 2 | L | T | P | C |
|---|---|---|---|---|---|
| **Version 1.0** | **Contact Hours - 30** | 2 | 0 | 0 | 2 |
| **Course Codes** | AEC504 (2 credits), CLL10005 (Non-Credit), CLL22003N (Non-Credit) | | | | |
| **Pre-requisites/Exposure** | - | | | | |
| **Co-requisites** | - | | | | |
| **Academic Year** | 2026-2027 | | | | |

**Programme Educational Objectives (PEO)**

The German Programme aims to equip students with fundamental linguistic, cultural and communicative competencies for practical applications. The educational objectives are:

PEO1 – Develop foundational skills in speaking, reading, writing, and listening, enabling effective communication in German
PEO2 – Gain insight into German cultural practices, traditions and social etiquette
PEO3 – Acquire the ability to use German in real-life contexts, such as introducing oneself, in restaurant interactions, in supermarkets, in commuting and in formal writing
PEO4 – Develop competence in German grammar, understanding articles, pronouns, conjunctions, verb conjugations and sentence structures

**Course Description**

The Second Semester of the German Language Course is designed to equip students with fundamental grammar, vocabulary, conversational skills and cultural insights essential for effective communication. Students will gain practical exposure to real-life scenarios, including introductions, ordering food, shopping and navigating public transport. Through structured activities such as role-playing, writing exercises and interactive simulations, learners will develop confidence in expressing themselves in German while understanding key aspects of German culture.

**Course Content**

**Module 1: Grammar - Mission: Grammatik Possible [9 hours]**

- Everyday Verbs in the Present Tense
  Verbs of type: kaufen / antworten / fahren / essen / geben / lesen / haben / sein and similar verbs
- The Power of German Modal Verbs - From “Ich kann nicht!” to “Ich muss doch!”
  Modal Verbs: sollen / wollen / können / dürfen / mögen / müssen / möchten
- Hast du eine Frage?--Make interrogative sentence using the verb.
- Coordinate Conjunctions: und / oder / aber / sondern / denn
- Quizzes and Worksheets

**Module 2: Speaking German – Real Life Scenarios in Germany: [8 hours]**

- Wie alt bist du?—W-Frage (Wie, Wer, Woher, Wo, Was, Wann, Was)
- The Art of Introducing Yourself in German - "Ich heiße... und du?”
  Speaking Topics: Personal / Family / Studies / Food / Hobbies and Spare Time
  Activity: Pair Work -
  Students pair up for casual dialogues and switch partners every 3 minutes
- Essential Ordering Phrases in a German Restaurant
  " Von Schnitzel bis Erdbeerkuchen mit Sahne”
  Activity: Restaurant Simulation -

Students practice ordering different items using a mock menu

- Lost in the Aisles? Navigating a German Supermarkt Without Panic
  Shopping Conversations: Prices, Discounts, Preferences
  Activity: Simulated Shopping - "Customer and Store Attendant / Cashier" practice
- Asking for Directions and using Public Transport
  Navigating bus stops and train stations
  Buying tickets and asking about timetables
  Activity: Role Play -
  Students ask for directions to famous places in Germany
  Students buy train tickets at a railway station

**Module 3: German Culture** **[2 hours]**

- Mastering German Greetings on Occasions and Holidays:
  Alles Gute!
  Gesundheit!
  Herzlichen Glückwunsch zum Geburtstag! / zur Hochzeit!
  Alles Gute zum Jahrestag!
  Viel Glück für die Zukunft!
  Frohe / Fröhliche Weihnachten!
  Frohes neues Jahr! / Prosit Neujahr! / Guten Rutsch ins neue Jahr!
  Frohe Ostern!
- German Media: Brief Overview
  Newspapers – Die Zeit / Frankfurter Allgemeine / Süddeutsche Zeitung / Bild
  Magazines: Spiegel / Stern / Focus / Kicker
  Television: Deutsche Welle (DW) / ZDF / ARD / RTL
  Popular talk shows (Markus Lanz, Anne Will)
- Tor! German Football: Snapshot
  Bundesliga – The top-tier football league
  German Football Clubs – FC Bayern München, Borussia Dortmund, RB Leipzig, Bayer 04 Leverkusen
- German Car Industry: Brief Overview
  Brands – Mercedes Benz, Audi, BMW, Volkswagen, Porsche

**Module 4: Writing Skills** **[3 hours]**

- Fill out a form with detailed personal information in German.
  - Vorname, Nachname, Alter…..
- Writing 20-25 word brief e-mails or messages on instant messaging apps
  Formal e-mails -
  Greetings and Salutations: Sehr geehrte / Sehr geehrter
  Valedictory Address: Mit freundlichen Grüßen / Mit freundlichem Gruß
  Informal e-mails -
  Greetings and Salutations: Hallo / Liebe / Lieber
  Valedictory Address: Tschüss / Bis bald!
  Activity: Students write a short email / message based on a given scenario like fixing up or cancelling an appointment, then peer-review each other's work

**Module 5: Elementary Vocabulary** **[4 hours]**

- Surviving in a German City Without Getting Lost
  Urban Vocabulary for Everyday Use: From Bahnhof to Brücke
- Dressing the German Way
  Essential Clothing Vocabulary: From Mantel to Mütze
- Talking About the Weather Like a True German
  Mastering Weather Terms: Regen oder Schnee?
- Learning about parts of the body without losing your head
  Requisite Vocabulary for Anatomy: Von Kopf bis Fuß
- Audio Comprehensions

**Module 6: Advanced Grammar** **[2 hours]**

- Akkusativ: Definite and Indefinite Articles
- Ich liebe dich!—Personal Pronouns in the Akkusativ

**Module 7: Reading Ability: Unseen Comprehension** **[2 hours]**

Activity: Students will read short and simple unseen texts and answer questions based on these texts
Comprehension Gym – a workout for the brain, lifting sentences instead of weights.

**Course Outcomes (CO):**

On completion of this second-semester course, the students will be able to

CO1 - Use essential verbs, modal verbs and conjunctions to form sentences and question words to frame questions and answer them. Acquaint themselves with the Akkusativ.
CO2 - Introduce themselves, express personal preferences and participate in casual dialogues
CO3 - Order food, handle shopping interactions and ask for directions in German
CO4 - Learn common German greetings, football culture and about German media and German car brands
CO5– Fill out forms in German and compose short messages and emails, using appropriate salutations and valedictions
CO6 - Recognize essential words for urban navigation, clothing, weather and parts of the body
CO7 – Read simple, unseen German texts and answer questions

**Programme Outcomes (PO):**

Upon successful completion of this two-semester programme, students will develop the following competencies:

PO1 - Know about the origin of the German language vis-à-vis other European languages
PO2 - Develop German pronunciation skills
PO3 - Learn to count and tell time in German
PO4 - Understand and apply elementary German Grammar
PO5 - Speak in basic German
PO6 - Demonstrate familiarity with German culture
PO7 - Write short German sentences and messages
PO8 - Gain knowledge of basic German vocabulary

**Programme Specific Outcomes (PSO):**

PSO1 – Learn about German as a Germanic language and its place in the Indo-European School of Languages

PSO2 – Recognize German diphthongs, consonant clusters, sounds and phonetic patterns for accurate pronunciation

PSO3 – Understand formal and informal time and cardinal numbers in German

PSO4 – Grasp key grammatical concepts involving main verbs, modal verbs, conjunctions and articles and personal pronouns as subjects and direct objects

PSO5 – Speak and respond confidently in daily communication scenarios and understand and apply common greetings, expressions and conversational starters

PSO6 – Get acquainted with aspects of German culture, like food and dining etiquette, punctuality, festivals, media, football craze and cars

PSO7 – Communicate in German through short e-mails and messages and use conventional German salutations and valedictions.

PSO8 – Acquire knowledge of vocabulary related to areas like colours, family, home, clothes, transport, cities, weather and parts of the body

**Correlation Matrix between CO and PO and CO and PSO:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 | PSO 7 | PSO 8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | 3 | 3 | | 3 | 2 | | | | 3 | 3 | | 3 | 2 |
| CO2 | | 2 | | 3 | 3 | | | 2 | | 2 | | 3 | 3 | | | 2 |
| CO3 | | 2 | | 3 | 3 | | | 1 | | 2 | | 3 | 3 | | | 1 |
| CO4 | | 2 | | | 1 | 3 | | | | 2 | | | 1 | 3 | | |
| CO5 | | 1 | | 2 | 1 | | 3 | 2 | | 1 | | 2 | 1 | | 3 | 2 |
| CO6 | | | | | 2 | 1 | 2 | 3 | | | | | 2 | 1 | 2 | 3 |
| C07 | | 1 | | 3 | | | | 3 | | 1 | | 3 | | | | 3 |

Degree of Correlation: 1 – low, 2 – medium, 3 – high

| | CLL Foreign Language Spanish PG Semester 1 | L | T | P | C |
|---|---|---|---|---|---|
| **Version 1.0** | **Contact Hours - 30** | 2 | 0 | 0 | 2 |
| **Course Codes** | AEC410 (2 credits), CLL10003 (Non-Credit), CLL12004N (Non-Credit) | | | | |
| **Pre-requisites/Exposure** | - | | | | |
| **Co-requisites** | - | | | | |
| **Academic Year** | 2026-2027 | | | | |

**Programme Educational Objectives (PEO)**

The Spanish Programme aims to equip students with fundamental linguistic, cultural and communicative competencies for practical applications. The educational objectives are:

PEO1 – Equip students with the ability to communicate effectively in basic spoken and written Spanish in familiar contexts
PEO2 – Provide a strong foundation in Spanish grammar, vocabulary and pronunciation
PEO3 – Develop cross-cultural awareness and appreciation of Hispanic cultures and global diversity
PEO4 – Enable students to engage in real-life situations using Spanish through listening, speaking, reading and writing practice

**Course Description**

This first-semester course offers a lively introduction to the Spanish language. Beginning with the Spanish alphabet and fundamental pronunciation, students will explore practical expressions used in greetings, introductions and everyday conversations. With a blend of situational vocabulary and grammar, learners will acquire useful words related to daily life—covering topics such as food, travel, time and the classroom. Simultaneously, students will master basic grammar concepts including verb conjugation, personal pronouns and articles.

**Course Content**

**Module 1: Introduction [2 hours]**

- Overview of the Indo-European Family of Languages
- Concept of Germanic, Romance and Slavic Languages
- Countries where Spanish is spoken: Spain, Latin America (Mexico, Colombia, Argentina, Peru, Chile) and others
- Spanish Colonies: Territories formerly controlled by Spain in Latin America, Asia and Africa
- Español vis-à-vis Catalán and Euskera

**Module 2: From A to Ñ –A Flamenco of Spanish Letters and Sounds [4 hours]**

- Alphabet and Pronunciation
- Understanding special alphabets like ll and ch
- Key consonant sounds: h (silent), j, r/rr, c (before e/i), g (before e/i), ñ
  Activity: Reading short Spanish texts with correct pronunciation

**Module 3: Uno, Dos, Cha-Cha-Cha! – Dancing with Spanish Numbers [3 hours]**

- Counting from 1 to 100
- Basic arithmetic expressions like mas y menos
  Activity on numbers: (saying phone numbers and age)

**Module 4: From Taco to Techo: Everyday Spanish Words you'll use: [4 hours]**

- Colours and Shapes
- Food and Drinks
- Travel and Directions
- Classroom and University
  Activity**:** Audio Comprehensions

**Module 5: Grammar Fiesta [7 hours]**

- Regular verb conjugations in the present tense (ar, er, ir)
- Verb "ser" and nationalities
- Verb "estar" and location
- Personal Pronouns
- Articles (Definite / Indefinite)

**Module 6: Gramática avanzada - Advanced Spanish Grammar [2 hours]**

- Prepositions: en — (in, on, at), a — (to, at), o — (or), con — (with), sin — (without), de — (of, from), para — (for), por — (by, through, because of)

**Module 7: Saludos y Despedidas – The art of first impressions [3 hours]**

- Hola, buenos días, buenas tardes, buenas noches
- Farewell expressions: Adiós, hasta luego, nos vemos
- Introducing yourself: name, nationality, profession
- Introductions: Me llamo…, soy de…, estudio
  Activity**:** Rotating Pair Dialogues (Switch Partners every 3 minutes)

**Module 8: Tick-Tock en Español – ¿Qué hora es? [3 hours]**

- Telling time
- Reading clocks and expressing dates
- Days, months and seasons
  Activity**:** Identify time using images of clocks, telling date of birth and favourite seasons.

**Module 9: Hispanic Culture [2 hours]**

- Spanish and Latin American food culture: Paella, Tapas, Mate, Tortillas, Empanadas
- Everyday lifestyle: Siesta, Meal Schedules (Comida, Tapas, Meriendas, Sobremesa), "Mi casa es tu casa"
- Major festivals: La Tomatina (Buñol), Día de los Muertos, San Fermín (Pamplona), La Feria de Abril (Seville), Fallas de Valencia, La Mercè (Barcelona)

**Course Outcomes (CO):**

On completion of this first-semester course, the students will be able to

CO1 - Understand the historical and linguistic background of Spanish within the Indo-European language family
CO2 - Master the Spanish alphabet and build a foundation in pronunciation
CO3 - Count in Spanish, tell time and express dates, days, months and seasons
CO4 - Identify and use common vocabulary related to colours, food, directions and classroom settings to support communication in relevant contexts
CO5 - Demonstrate understanding of elementary grammar, including personal pronouns, articles and present tense conjugation of regular and essential irregular verbs.
Acquaint themselves with a bit of advanced grammer in the form of prepositions
CO6 - Use basic expressions to greet others and introduce themselves
CO7 - Gain insights into Spanish cultural norms, traditions and etiquette, helping them blend into native conversations

**Programme Outcomes (PO):**

Upon successful completion of this two-semester programme, students will develop the following competencies:

PO1 – Know about the origin and global spread of the Spanish language across continents
PO2 – Develop accurate Spanish pronunciation skills
PO3 – Learn to count and tell time in Spanish
PO4 – Understand and apply elementary Spanish grammar
PO5 – Speak in basic Spanish in everyday situations
PO6 – Demonstrate familiarity with Spanish and Latin American cultures
PO7 – Write short Spanish sentences and messages
PO8 – Gain knowledge of basic Spanish vocabulary across everyday themes

**Programme Specific Outcomes (PSO):**

PSO1 – Learn about Spanish as a Romance language and its place in the Indo-European School of Languages
PSO2 – Recognize Spanish vowel sounds, diphthongs, consonant combinations and phonetic patterns for accurate pronunciation
PSO3 – Understand formal and informal time, numbers and basic quantifiers in Spanish
PSO4 – Grasp key grammatical concepts involving regular and irregular verbs, modal verbs, conjunctions, articles, personal pronouns, reflexive verbs and object pronouns
PSO5 – Speak and respond confidently in everyday communication scenarios using greetings, expressions and conversational starters
PSO6 – Get acquainted with Hispanic cultural elements such as food habits, dining etiquette, festivals, media, football culture and traditions across Spain & Latin America
PSO7 – Communicate in Spanish through short emails and messages using conventional Spanish salutations and valediction. Fill up forms in Spanish.
PSO8 – Acquire vocabulary related to areas such as colours and shapes, food and drinks, travel and direction, classroom and university, family members, navigating a city, clothing and accessories, expressions related to weather weather and parts of the body

**Correlation Matrix between CO and PO and CO and PSO:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 | PSO 7 | PSO 8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | | | | | | | | 3 | | | | | | | |
| CO2 | | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 |
| CO3 | | | 3 | | 1 | | 1 | | | | 3 | | 1 | | 1 | |
| CO4 | | | | | 2 | 2 | 3 | 3 | | | | | 2 | 2 | 3 | 3 |
| CO5 | | | | 3 | 3 | | 3 | | | | | 3 | 3 | | 3 | |
| CO6 | | 2 | | | 3 | 2 | 1 | | | 2 | | | 3 | 2 | 1 | |
| CO7 | | | | | 2 | 3 | | 1 | | | | | 2 | 3 | | 1 |

Degree of Correlation: 1 – low, 2 – medium, 3 – high

| | CLL Foreign Language Spanish PG Semester 2 | L | T | P | C |
|---|---|---|---|---|---|
| **Version 1.0** | **Contact Hours - 30** | 2 | 0 | 0 | 2 |
| **Course Codes** | AEC505 (2 credits), CLL10006 (Non-Credit), CLL22004N (Non-Credit) | | | | |
| **Pre-requisites/Exposure** | - | | | | |
| **Co-requisites** | - | | | | |
| **Academic Year** | 2026-2027 | | | | |

**Programme Educational Objectives (PEO)**

The Spanish Programme aims to equip learners with essential linguistic, cultural and communicative abilities for practical everyday use.

**PEO1** – Develop foundational speaking, reading, writing and listening skills for effective communication in Spanish
**PEO2** – Understand key aspects of Hispanic cultures, traditions and social behaviour
**PEO3** – Use Spanish confidently in real-life contexts such as introductions, shopping, directions and restaurant conversations
**PEO4** – Build accuracy in Spanish grammar: verbs, pronouns, articles, possessives, reflexives and everyday sentence structures

**Course Description**

The Second Semester of the Spanish Language Course enhances students' linguistic competence by introducing practical grammar, thematic vocabulary and conversational fluency. Learners engage with real-life scenarios such as dining in a restaurant, shopping, asking for directions and describing daily routines. Through pair-work, simulations, audio–visual inputs and presentations, students build confidence in expressing themselves effectively in Spanish. Cultural elements from Spain and Latin America—festivals, food, media and traditions—are woven into classroom activities to enrich intercultural understanding.

**Course Content**

**Module 1: Grammar - Misión: Gramática Posible** **[10 hours]**

- Everyday Spanish Verbs in the Present Tense:
  - Verbs like hablar, vivir, comer, escribir, comprar
  - Irregular Verbs: ser, estar, tener, ir, hacer, poner, decir
  - Stem - changing Verbs: pensar, pedir, poder, jugar
  - Reflexive Verbs with reflexive pronoun: levantarse, ducharse, ponerse, vestirse, acostarse
  - Vocabulary: Routines
- Conjunctions:
  y / o / pero / porque / aunque
- Introduction to indirect object pronouns: me, te, le, nos, os, les
- Structure of gustar: me gusta / me gustan / te gusta / le gusta
- Using emphasis: A mí me gusta…, A ella le gusta…

Activities: Grammar Quizzes, Gap-fill Worksheets, Verb conjugation challenges

**Module 2: Elementary Vocabulary [4 hours]**

- Family Members: padre, madre, hijo, hija, Hermano, hermana, primo, prima, tio, tia, abuelo, Abuela etc.
- Navigating a City: aeropuerto, estación, calle, farmacia, banco etc.
- Clothing & Accessories: camisa, camiseta, pantalón o pantalones, falda, zapatos, gorro etc.
- Weather Expressions: hace frío, hace sol, hace Viento etc.
- Parts of the Body: cabeza, pierna, corazón, ojo, oreja, mano etc.
  Activity: Audio Comprehension

**Module 3: Speaking Spanish – Real Life Situations in the Hispanic World: [8 hours]**

- Talking about likes and preferences for food, hobbies, people, activities
  Activities: Pair conversation: "¿Qué te gusta hacer?"
  Students create 5 sentences about their likes/dislikes or quick class survey using gustar (food, sports, music)

- Shopping Without Panic – Spanish Markets
  Useful phrases: ¿Cuánto cuesta?, ¿Tiene otra …..(talla)?, Busco…
  Numbers from 100 - 1000
  Activity: Market Roleplay – "Cliente y dependiente"

- Public Transport & Asking for Basic Directions
  Phrases for bus stops, metro stations and travel
  Expresiones: ¿Dónde está…?, ¿Cómo llego a…?
  Activities: Role Play – Asking for directions to famous cities/landmarks
  Buying tickets at a metro station

**Module 4: Writing Skills and Form Filling in Spanish [3 hours]**

- Essential form vocabulary:
  nombre, apellido, dirección, fecha de nacimiento, correo electrónico, número de teléfono, firma
  Activity: Fill a brief personal information form or complete a short hotel/registration form based on a given scenario.
- Writing short (20–25 word) E-mails or messages
  Informal: Greetings- Hola / Querido / Querida and Closings- Un abrazo / Nos vemos pronto
  Activity: Students write a short message or email based on a given scenario

**Module 5: Spanish Culture [3 hours]**

- Mastering Greetings for Festivals & Social Occasions:
  ¡Feliz cumpleaños! / ¡Buena suerte! / ¡Felices fiestas! / ¡Feliz Año Nuevo!

- Spanish & Latin American Media:
  Newspapers: El País, La Vanguardia
  TV/Channels: RTVE, Univisión, Telemundo
  Popular Spanish podcasts

- Football Fever – A Spanish Passion
  La Liga Overview
  Famous Clubs: FC Barcelona, Real Madrid, Atlético de Madrid

**Module 6: Reading Comprehension and Translation [2 Hours]**

Activity: Students will read short and simple unseen texts and answer questions based on these texts
Comprehension Gym – a workout for the brain, lifting sentences instead of weights.

**Course Outcomes (CO):**
By the end of the course, students will be able to:

CO1 – Use essential Spanish regular verbs, irregular verbs, conjunctions and indirect object pronouns to form meaningful sentences.
CO2 – Recognize essential Spanish vocabulary related to family members, city navigation, clothing, weather and parts of the body
CO3 – Introduce themselves, express personal preferences (including gustar) and participate in casual dialogues and use numbers from 100 – 1000.
CO4 – Order food, handle shopping interactions and ask for directions in Spanish.
CO5 – Compose short messages or emails using appropriate Spanish salutations, understand and formulate dialogues and fillup forms in Spanish.
CO6 – Learn common Spanish greetings and gain insight into Hispanic festivals, football culture and Spanish/Latin American media.
CO7 – Read simple, unseen Spanish texts and answer questions

**Programme Outcomes (PO):**

Upon successful completion of this two-semester programme, students will develop the following competencies:

PO1 – Know about the origin and global spread of the Spanish language across continents
PO2 – Develop accurate Spanish pronunciation skills
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| CO2 | | 2 | | | 2 | | 2 | 3 | | 2 | | | 2 | | 2 | 3 |
| CO3 | | 2 | 3 | 2 | 2 | | | | | 2 | 3 | 2 | 2 | | | |
| CO4 | | 2 | | 3 | 3 | | | | | 2 | | 3 | 3 | | | |
| CO5 | | | | 2 | | | 3 | 2 | | | | 2 | | | 3 | 2 |
| CO6 | | | | 2 | 1 | 3 | | | | | | 2 | 1 | 3 | | |
| CO7 | | 2 | | 3 | | | 3 | 2 | | 2 | | 3 | | | 3 | 2 |

Degree of Correlation: 1 – low, 2 – medium, 3 – high