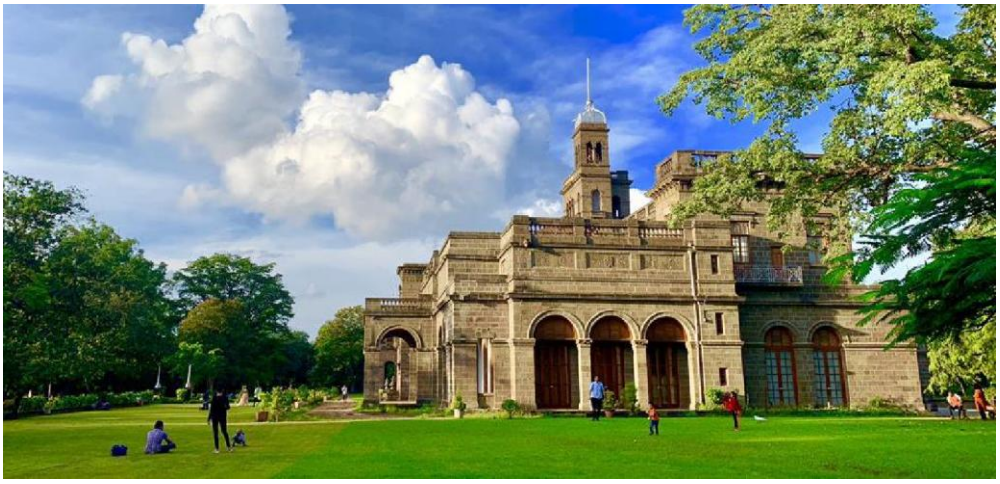
सावित्रीबाई फुले पुणे विद्यापीठ

Savitribai Phule Pune University Pune

Maharashtra, India

Faculty of Science and Technology



National Education Policy (NEP)-2020 Compliant Curriculum

Second Year B.Tech. Biotechnology

(2024 Pattern)

(With effect from Academic Year 2026-27)

DEPARTMENT OF BIOTECHNOLOGY

PROGRAMME SPECIFIC OBJECTIVES (PSO's):

PSO:

Gain interdisciplinary proficiency in biotechnology fields, like microbiology, molecular biology, bioprocess and analytical technology, to prepare for advanced education, industry roles, and entrepreneurial pursuits.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs):

The program educational objectives enable the students:

1. To develop industry ready trained human resources in various aspects of biotechnology by integration of biological sciences and engineering principles.
2. To impart knowledge through theory and practice of subjects of interdisciplinary nature and equip students with skills to pursue higher studies and research.
3. To nurture professional skills for employability and entrepreneurship like communication abilities, teamwork, and management of self-improvement in students.

Program Outcomes (PO's):

PO1: Engineering knowledge – Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis – Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions – Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations

PO4: Conduct investigations of complex problems – Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage – Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6: The Engineer and the World – Analyse and evaluate societal and environmental aspects while solving complex engineering problems, considering their impact on sustainability with reference to economy, health, safety, legal frameworks, culture, and the environment.

PO7: Ethics – Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO8: Individual and teamwork – Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO9: Communication – Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO10: Project management and finance – Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO11: Life-long learning – Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Reference: Self-Assessment Report (SAR) Format Undergraduate Engineering Programs Graduate Attributes and Professional Competencies Version 4.0 (GAPC V4.0) - (August 2024) Page 56.

PEO/ PO &PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO
PEO 1	√	√	√	√	√	√	√	√	√	√	√	√
PEO 2	√	√	√	√	√	√	√	√	√	√	√	√
PEO 3		√	√	√		√	√	√	√	√	√	√

General Rules and Guidelines

- Course Outcomes (CO): Course Outcomes are narrower statements that describe what students are expected to know, and are able to do at the end of each course. These relate to the skills, knowledge and behaviour that students acquire in their progress through the course.
- Assessment: Assessment is one or more processes, carried out by the institution, that identify, collect, and prepare data to evaluate the achievement of Program Educational Objectives and Program Outcomes.
- Evaluation: Evaluation is one or more processes, done by the Evaluation Team, for interpreting the data and evidence accumulated through assessment practices. Evaluation determines the extent to which Program Educational Objectives or Program Outcomes are being achieved, and results in decisions and actions to improve the program.

Guidelines for Examination Scheme

1. Theory Examination: The theory examination shall be conducted in two different parts Comprehensive Continuous Evaluation (CCE) and End-Semester Examination (ESE).

2. Comprehensive Continuous Evaluation (CCE) of 40 marks based on all the Units of course syllabus to be scheduled and conducted at institute level. To design a Comprehensive Continuous Evaluation (CCE) scheme for a theory subject of 40 marks with the specified parameters, the allocation of marks and the structure can be detailed as follows:

Sr.	Parameters	Marks	Coverage of Units
1	Unit Test	15 Marks	Units 1 & Unit 2 (7/8Marks/Unit)
2	Assignments / Case Studies	15 Marks	Units 3 & Unit 4 (7/8 Marks/Unit)
3	Seminar Presentation / Open Book Test/ Quiz	10 Marks	Unit 5

3. CCE of 20 marks based on all the Units of course syllabus to be scheduled and conducted at institute level. To design a CCE scheme for a theory subject of 20 marks with the specified parameters, the allocation of marks and the structure can be detailed as follows:

Sr.	Parameters	Marks	Coverage of Units
1	Unit Test	10 Marks	Units 1 & Unit 2 (5 Marks/Unit)
2	Seminar Presentation / Open Book Test/ Assignments/ Case Studies	10 Marks	Units 3 & Unit 4 (5 Marks/Unit)

Format and Implementation of Comprehensive Continuous Evaluation

1. Unit Test

- **Format:** Questions designed as per Bloom's Taxonomy guidelines to assess various cognitive levels (Remember, Understand, Apply, Analyze, Evaluate, Create).
- **Implementation**: Schedule the test after completing Units 1 and 2. Ensure the question paper is balanced and covers key concepts and applications.

2. Sample Question Distribution

- Remembering (2 Marks): Define key terms related to [Topic from Units 1 and 2].
- Understanding (2 Marks): Explain the principle of [Concept] in [Context].
- Applying (2 Marks): Demonstrate how [Concept] can be used in [Scenario].
- Analyzing (3 Marks): Compare & contrast [Two related concepts] from Units 1 and 2.
- Evaluating (3 Marks): Evaluate the effectiveness of [Theory/Model] in [Situation].

3. **Assignments / Case Study**: Students should submit one assignment or one Case Study Report based on Unit 3 and one assignment or one Case Study Report based on Unit 4.
   - **Format:** Problem-solving tasks, theoretical questions, practical exercises, or case studies that require in-depth analysis and application of concepts.
   - **Implementation:** Distribute the assignments or case study after covering Units 3 and 4. Provide clear guidelines and a rubric for evaluation.

4. Seminar Presentation:

- **Format:** Oral presentation on a topic from Unit 5, followed by a Q&A session.
- **Deliverables:** Presentation slides, a summary report in 2 to 3 pages, and performance during the presentation.
- **Implementation:** Schedule the seminar presentations towards the end of the course. Provide students with ample time to prepare and offer guidance on presentation skills.

5. Open Book Test:

- **Format:** Analytical and application-based questions to assess depth of understanding.
- **Implementation:** Schedule the open book test towards the end of the course, ensuring it covers critical aspects of Unit 5.

6. Quiz/Puzzles:

- **Format:** Quizzes/Puzzles can help students to practice existing knowledge while stimulating interest in learning about new topic in that course. You can set your quizzes/puzzles to be completed individually or in small groups.
- **Implementation:** Online tools and softwares can be used to create quiz/puzzle. Each quiz is made up of a variety of question types including multiple choice, flashcards, cross words true or false etc.

- ## Example Timeline for conducting CCE:
  - Weeks 1-4 : Cover Units 1 and 2
  - Week 5 : Conduct Unit Test (15 marks)
  - Weeks 6-8 : Cover Units 3 and 4
  - Week 9 : Distribute and collect Assignments / Case Study (15 marks)
  - Weeks 10-12 : Cover Unit 5
  - Week 13 : Conduct Seminar Presentations or Open Book Test or Quiz (10 marks)

- **Evaluation and Feedback:**
  - **Unit Test:** Evaluate promptly and provide constructive feedback on strengths and areas for improvement.
  - **Assignments / Case Study:** Assess the quality of submissions based on the provided rubric. Offer feedback to help students to understand their performance.
  - **Seminar Presentation:** Evaluate based on content, delivery, and engagement during the Q&A session. Provide feedback on presentation skills and comprehension of the topic.
  - **Open Book Test**: Evaluate based on the depth of analysis and application of concepts. Provide feedback on critical thinking and problem-solving skills.

End-Semester Examination (ESE)

End-Semester Examination (ESE) of 60 marks written theory examination based on all the unit of course syllabus scheduled by university. Question papers will be sent by the University through QPD (Question Paper Delivery). University will schedule and conduct ESE at the end of the semester.

Format and Implementation:

- **Question Paper Design**: Below structure is to be followed to design an End-Semester Examination (ESE) for a theory subject of 60 marks on all 5 units of the syllabus with questions set as per Bloom's Taxonomy guidelines and 12 marks allocated per unit.

- **Balanced Coverage**: Ensure balanced coverage of all units with questions that assess different cognitive levels of Bloom's Taxonomy: Remember, Understand, Apply, Analyze, Evaluate, and Create. The questions should be structured to cover:

    * Remembering: Basic recall of facts and concepts.
    * Understanding: Explanation of ideas or concepts.
    * Applying: Use of information in new situations.
    * Analyzing: Drawing connections among ideas.
    * Evaluating: Justifying a decision or course of action.
    * Creating: Producing new or original work (if applicable).

- **Detailed Scheme for 60 Marks:** Unit-Wise Allocation (12 Marks per Unit): Each unit will have a combination of questions designed to assess different cognitive levels. By following this scheme, you can ensure a comprehensive and fair assessment of students' understanding and application of the course material, adhering to Bloom's Taxonomy guidelines for cognitive skills evaluation.

- **Detailed Scheme for 30 Marks:** Unit-Wise Allocation (06 Marks per Unit): Each unit will have a combination of questions designed to assess different cognitive levels. By following this scheme, you can ensure a comprehensive and fair assessment of students' understanding and application of the course material, adhering to Bloom's Taxonomy guidelines for cognitive skills evaluation.

NEP 2020 Compliant Curriculum Structure

Second Year Biotechnology (2024 Pattern)

Level 5.0

Semester III														
Course Code	**Type of Course**	**Course Title**	**Teaching Scheme**			**Examination Scheme**						**Credit**			
			L	**T**	**P**	**CCE**	**ESE**	**TW**	**PR**	**OR**	**Total**	**L**	**T**	**P**	**Total**
PCC-201-BIO	Major Course 1	Microbiology	3			40	60				100	3			3
PCC-202-BIO	Major Course 2	Fluid Flow and unit Operations	3			40	60				100	3			3
PCC-203-BIO	Major Course 3	Cell Biology & Tissue Culture	3			40	60				100	3			3
PCC-204-BIO	Practical Lab 1	Microbiology Lab			4			25	50		75			2	2
PCC-205-BIO	Practical Lab 1	Fluid Flow Unit Operations Lab			2			25		25	50			1	1
***OEL**	Open Elective	*Open Elective-1	2			20	30				50	2			2
MDM-221-BIO	Multidisciplinary Minor-1	Applied Biotechnology	2			40	60				100	2			2
VEC-231-BIO	Value Education Course	Universal Human Values & Professional Ethics	2			20	30				50	2			2
EEM-232-BIO	Entrepreneurship/Economics/ Management Course	Leadership & Personality Development		1	2			25			25		1	1	2
CEP-241-BIO	Community Engagement Project	Community Engagement Project			4			25		25	50			2	2
Total			**15**	**1**	**12**	**200**	**300**	**100**	**50**	**50**	**700**	**15**	**1**	**6**	**22**

***Note:**

Students can opt for Open Electives offered by different faculty like Arts, Science, Commerce, Management, Humanities or Inter-Disciplinary studies.

Example –

Open Elective 1 – Scope of Microbiology, Grains to Beer, Wine Technology, Dairy Technology

Open Elective 2 – Chemical and Biological Techniques for Synthesis of Nanomaterials, Basic Characterization Techniques, Nanoscience and Nanotechnology in Daily Life, Project Management

NEP 2020 Compliant Curriculum Structure

Second Year Biotechnology (2024 Pattern)

Level 5.0

Semester IV															
Course Code	**Type of Course**	**Course Title**	**Teaching Scheme**			**Examination Scheme**						**Credit**			
			L	**T**	**P**	**CCE**	**ESE**	**TW**	**PR**	**OR**	**Total**	**L**	**T**	**P**	**Total**
PCC-251-BIO	Major Course 4	Biochemistry	3			40	60				100	3			3
PCC-252-BIO	Major Course 5	Genetics & Molecular Biology	3			40	60				100	3			3
PCC-253-BIO	Major Course 6	Material Balance & Stoichiometry	2			40	60				100	2			2
PCC-254-BIO	Practical Lab 1	Biochemistry Lab			2			25	25		50			1	1
PCC-255-BIO	Practical Lab 2	Genetics & Molecular Biology Lab			2					25	25			1	1
***OEL**	Open Elective	*Open Elective-2	2			20	30				50	2			2
MDM-271-BIO	Multidisciplinary Minor-2	Biodiversity	2			40	60				100	2			2
MDM-272-BIO	Multidisciplinary Minor-2	Lifestyle and Nutrition	2			40	60				100	2			2
VSEC-281-BIO	Vocational Skill Enhancement Course	Lab Practices & Data Analysis			4			25	25		50			2	2
AEC-282-BIO	Ability Enhancement Course	Modern Indian Language: (Marathi/ Hindi)		1	2			50			50		1	1	2
EEM-283-BIO	Entrepreneurship/Economics/ Management Course	Entrepreneurship		1	2			25			25		1	1	2
VEC-284-BIO	Value Education Course	Environmental Studies	2			20	30				50	2			2
Total			**14**	**2**	**12**	**200**	**300**	**125**	**50**	**25**	**700**	**14**	**2**	**6**	**22**

Savitribai Phule Pune University, Pune Second Year of B.Tech. Biotechnology (2024 Course) Course Code: PCC-201-BIO Course Name: Microbiology		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Theory: 3 Hours/Week	**03**	**CCE (Theory): 40 Marks ESE (Theory): 60 Marks Total: 100 Marks**

Prerequisite Courses, if any: Biology

Course Objectives:

1. To understand fundamental microbiology concepts, including microbial history, classification, cell ultrastructure, and demonstrate the role of microscopy and staining in microbial studies.
2. To classify microorganisms based on their nutritional and environmental requirements, and apply isolation, culturing, and preservation techniques.
3. To analyze bacterial growth dynamics and demonstrate appropriate enumeration methods for microbial quantification.
4. To assess physical, chemical, and biological microbial control methods and justify their applications across various fields.
5. To examine microbial interactions within ecosystems and evaluate their roles in industrial, medical, and environmental contexts.

Course Outcomes: On completion of the course, learner will be able to –

CO1: Explain fundamental concepts in microbiology, including microbial diversity, cell structure, and microscopy techniques.

CO2: Classify microorganisms based on nutritional requirements and demonstrate isolation, culturing, and preservation techniques.

CO3: Analyze bacterial growth characteristics and apply appropriate enumeration methods.

CO4: Evaluate different microbial control methods and justify their applications in clinical, industrial, and environmental settings.

CO5: Assess microbial interactions with the environment and analyze their significance in biogeochemical cycles, biotechnology, and medical microbiology, including microbial pathogenesis and infectious diseases.

Course Contents

Unit I	**Introduction to Microbiology**	**(9 Hrs)**
History and scope of microbiology, Ultrastructure and functions of Prokaryotic and Eukaryotic cells, Microscopy techniques and staining methods, Classification of bacteria		
Mapping of Course Outcomes for Unit I	CO1: Explain fundamental concepts in microbiology, including microbial diversity, cell structure, and microscopy techniques.	
Unit II	**Isolation and Culturing of Microorganisms**	**(9 Hrs)**
Nutritional and environmental requirements (macro/micronutrients, growth factors), Classification: Photoautotrophs, Photoheterotrophs, Chemoautotrophs, Chemoheterotrophs, Effect of environmental factors (temperature, oxygen, pH, osmotic pressure, extremophiles), Types, composition, and uses of microbial media (solid, liquid, semi-solid, selective, differential, enrichment), Microbial cultivation: Pure		

culture, co-culture, mixed culture, colony characteristics, Isolation techniques: Streak, spread, and pour plate methods, Anaerobic culture techniques, preservation, and maintenance methods		
Mapping of Course Outcomes for Unit II	CO2: Classify microorganisms based on nutritional requirements and demonstrate isolation, culturing, and preservation techniques.	
Unit III	**Microbial Growth and Enumeration Techniques**	**(9 Hrs)**
Microbial reproduction: Binary fission, asexual reproduction, Growth curve, logarithmic bacterial population growth, generation time calculation, Enumeration techniques: Direct count, standard plate count, microscopic count, turbidimetry, flow cytometry, biomass determination, nucleic acid-based methods, Culture types: Batch, continuous, and synchronous cultures.		
Mapping of Course Outcomes for Unit III	CO3: Analyze bacterial growth characteristics and apply appropriate enumeration methods.	
Unit IV	**Control of Microorganisms**	**(9 Hrs)**
Concept and definitions of sterilization and disinfection, Physical control methods: Heat (dry, moist), pasteurization, radiation, filtration, Chemical control methods: Alcohols, quaternary ammonium compounds, phenolic compounds, disinfectants, antimicrobial agents, antibiotics, Concepts of Minimum Inhibitory Concentration (MIC) and Minimum Bactericidal Concentration (MBC), drug resistance.		
Mapping of Course Outcomes for Unit IV	CO4: Evaluate different microbial control methods and justify their applications in clinical, industrial, and environmental settings.	
Unit V	**Microbial Interactions, Environmental and Medical Microbiology**	**(9 Hrs)**
Microbial interactions: Commensalism, antagonism, symbiosis, Microbiology of air, soil, food, milk, water, and wastewater, Water quality and potability assessment, Epidemiology of infectious diseases, Case-based learning approach to microbial pathogenesis, Bacterial diseases: Typhoid, Cholera, Tuberculosis, Viral diseases: Rabies, HIV, influenza, Fungal diseases: Candidiasis		
Mapping of Course Outcomes for Unit V	CO5: Assess microbial interactions with the environment and analyze their significance in biogeochemical cycles, biotechnology, and medical microbiology, including microbial pathogenesis and infectious diseases.	

Learning Resources

Text Books:

1. Prescott Harley Klein, Microbiology, Fifth Edition, “Microbiology”, 5th Edition, The McGraw Hill Companies,2002
2. Michael Pelczar, “Microbiology”, 5th Edition, Tata McGraw-Hill Education,1993 ISBN-10**:** 0074623206, ISBN-13 **:** 978-0074623206
3. Michael T. Madigan, John M. Martinko, Jack Parker, “Brock biology of microorganisms”, Prentice Hall, 2000.
4. Baker, S., Nicklin, J., & Griffiths, C. (2011). BIOS Instant Notes in Microbiology (4th ed.). Taylor & Francis. ISBN, 1136667792, 9781136667794

Reference Books:

1. J. Salle, “Fundamental Principles of Bacteriology”, 7th edition, Tata McGraw- Hill education.
2. Roger Y. Stainier et al. “General Microbiology”, 5th edition. PHI Publication.
3. Tortora, “Microbiology: An Introduction”, 9th edition, Pearson Education India, 2008.
4. Schlegel H.G. – “General Microbiology”, 8th edition, Cambridge University Press, 1995.
5. Robert Cruikshank, “Medical Microbiology”, Churchill Livingstone, 1975.
6. Thomas Jones Mackie, et al, “Mackie & McCartney medical microbiology: a guide to the laboratory diagnosis and control of infection”, Churchill Livingstone,1989

MOOC / NPTEL Courses:

NPTEL Course

Microbiology
https://archive.nptel.ac.in/courses/102/103/102103015/
General Microbiology
https://onlinecourses.swayam2.ac.in/cec19_bt11/preview

Virtual LAB Link:

- **Microbiology Virtual Lan I https://mvi-au.vlabs.ac.in/**
- **Microbiology Virtual Lab II https://mvii-au.vlabs.ac.in/**

CCE: CONTINUOUS & COMPREHENSIVE EVALUATION

Real World Assignment

(One activity for each unit)

Unit 1: Introduction to Microbiology

Activity 1: Gram Staining & Microscopy

- **Task:** Perform Gram staining on a clinical/environmental/Microbial Products sample and observe under microscope
- **Real-Life Problem Addressed:** Diagnosing bacterial infections/contaminations quickly and accurately
- **Expected Outcome:** Students will identify Gram-positive/negative bacteria and relate to infection types/microbiological quality of product

Activity 2: Cell Structure Comparison

- **Task:** Case-based quiz on differences between prokaryotic and eukaryotic cells
- **Real-Life Problem Addressed:** Accurate diagnosis and treatment selection in clinical microbiology
- **Expected Outcome:** Understanding of cell structures and relevance in medical microbiology

Activity 3: Comparative Report Assignment

- **Task:** Prepare a report comparing prokaryotic and eukaryotic pathogens
- **Real-Life Problem Addressed:** Understanding pathogen complexity for antibiotic development
- **Expected Outcome:** Ability to differentiate between types of microbes and their pathogenicity

Unit 2: Isolation and Culturing of Microorganisms

Activity 1: Media Preparation & Documentation

- **Task:** Prepare selective/differential media and document protocols
- **Real-Life Problem Addressed:** Designing culture media for new microbial isolates from extreme environments
- **Expected Outcome:** Mastery over media formulation and sterile techniques

Activity 2: Pure Culture Techniques

- **Task:** Perform streak/ spread/pour plate techniques
- **Real-Life Problem Addressed:** Isolating specific bacteria from mixed populations
- **Expected Outcome:** Skills in isolating and growing microorganisms in pure cultures

Activity 3: Mini Project

- **Task:** Design culture conditions for microbes from Arctic/soil/ocean
- **Real-Life Problem Addressed:** Culturing novel/environmental microbes for research or industry
- **Expected Outcome:** Creative and applied understanding of nutritional/environmental needs of microbes

Unit 3: Microbial Growth and Enumeration Techniques

Activity 1: Growth Curve Analysis

- **Task:** Analyze microbial growth data and calculate generation time
- **Real-Life Problem Addressed:** Optimizing fermentation (e.g., yogurt, probiotics) for industry
- **Expected Outcome:** Ability to calculate generation time and interpret growth phases

Activity 2: Virtual/Practical Lab – Turbidimetry

- **Task:** Use simulations to measure microbial density
- **Real-Life Problem Addressed:** Non-invasive monitoring of microbial fermentation
- **Expected Outcome:** Understanding of indirect microbial quantification methods

Activity 3: Reflection Discussion

- **Task:** Discuss effect of media/environment on growth
- **Real-Life Problem Addressed:** Improving yield in food and pharma industries
- **Expected Outcome:** Insight into how external conditions affect microbial productivity

Unit 4: Control of Microorganisms

Activity 1: Case Study Analysis

- **Task:** Choose appropriate sterilization for hospital, pharma, food setups
- **Real-Life Problem Addressed:** Preventing spread of drug-resistant microbes/contamination
- **Expected Outcome:** Knowledge of suitable microbial control strategies for different settings

Activity 2: MIC Testing

- **Task:** Perform minimum inhibitory concentration test using agar diffusion
- **Real-Life Problem Addressed:** Combating antibiotic resistance by choosing effective drugs
- **Expected Outcome:** Ability to determine antibiotic sensitivity and resistance

Activity 3: Role-Play Simulation

- **Task:** Act as infection control team solving an outbreak
- **Real-Life Problem Addressed:** Containing hospital-acquired infections
- **Expected Outcome:** Teamwork and decision-making in outbreak management

Unit 5: Microbial Interactions, Environmental and Medical Microbiology

Activity 1: Field-Based Water Testing

- **Task:** Sample and test local water/soil for pathogens
- **Real-Life Problem Addressed:** Post-disaster disease surveillance (e.g., floods)
- **Expected Outcome:** Hands-on skills in detecting and identifying environmental pathogens

Activity 2: Group Presentations/Discussions

- **Task:** Compare microbes in environment Vs. disease
- **Real-Life Problem Addressed:** Understanding dual roles of microbes (beneficial vs. harmful)
- **Expected Outcome:** Broader understanding of microbial ecology and public health

Activity 3: Diagnostic Matrix Assignment

- **Task:** Map diseases to organisms, transmission, control
- **Real-Life Problem Addressed:** Quick identification and control of infectious diseases
- **Expected Outcome:** Ability to link pathogens to symptoms and public health strategy

Savitribai Phule Pune University, Pune Second Year of B.Tech. Biotechnology (2024 Course) Course Code:PCC-202-BIO Course Name: Fluid Flow and Unit Operations		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Theory: 3 Hours/ Week	**03**	**CCE (Theory): 40 Marks ESE (Theory): 60 Marks Total : 100 Marks**

Prerequisite Courses, if any: Basic Knowledge of Physics and Mathematics

Course Objectives:

1. To understand the basics of Unit Operations and analyze the types of forces and flows.
2. To use important concepts involved in fluid dynamics and flow measurements.
3. To present the concept of fluidization and CFD and demonstrate the flow of fluids through solids using a variety of equations.
4. To introduce students to particle technology – basic concepts, laws and unit operations involved in pre-treatment for different bioprocesses.
5. To make students familiar with settling characteristics of suspended particles in various unit operations.

Course Outcomes: On completion of the course, learner will be able to –

CO1: Explain the various types of fluid and interpret their behaviour in various applications.

CO2: Describe the concept of fluid dynamics and demonstrate flow measurements using various measuring devices.

CO3: Analyze the characteristics of flow through solids and demonstrate the concept of Computational Fluid Dynamics (CFD).

CO4: Explain principles of particle technology including their size determination and properties affected during handling.

CO5: Apply the phenomenon of the dynamics of suspended particles by learning the laws and performing the settling of solids.

Course Contents

Unit I	**Introduction to Fluid Flow**	**(9 Hrs)**

System of units and conversions; Basics of Unit Operations & Fluid – Definition and important properties, viscosity, temperature and pressure dependence, Newton's law, Classification of fluids; Fluid statics: hydrostatic forces on surface, Manometer & Inclined Manometer; Types of flow, Laminar and turbulent flow – Concept of Reynold's number; Formation and separation of boundary layer.

Mapping of Course Outcomes for Unit I	CO1: Explain the various types of fluids and interpret their behaviour in various applications.

Unit II	**Fluid Dynamics and Flow Measurements**	**(9 Hrs)**

Mass balances - Continuity equation and its applications to fluid dynamics, Energy balances in fluid dynamics: Euler's equation, Bernoulli's equation and its applications, Flow measurement using venturi meter, orifice meter and pitot tube; Hagen Poiseuelle equation, turbulent flow in pipes, effect of roughness, friction in flowing fluid, valves and its types.

Mapping of Course Outcomes for Unit II	CO2: Describe the concept of fluid dynamics and demonstrate flow measurements using various measuring devices.

Unit III	Flow of Fluid Through Solids	(9 Hrs)
Characteristics of flow through packed beds - Darcy's equation, Equations for laminar flow (Kozeny Carmen) and turbulent flow (Burke Plummer), Ergun equation; Concepts of Fluidization, computational fluid dynamics (CFD), Fluid moving machinery-pumps, Types of pumps: positive displacement pump and centrifugal pumps, Characteristics of Centrifugal Pumps, NPSH; Mixing and Agitation - Necessity of mixing and agitation, Types of Impellers, Mixing equipment; Mixing equipment for pastes and viscous material		
Mapping of Course Outcomes for Unit III	CO3: Analyze the characteristics of flow through solids and demonstrate the concept of Computational Fluid Dynamics (CFD)	
Unit IV	**Particle Technology**	**(9 Hrs)**
Properties of solids - Particle size and shape, Mixtures of particles, Determination of particle size; Screening - Standard screen series, screen analysis, Screen effectiveness and capacity, Industrial screening equipment; Size reduction: Crushing efficiency, energy requirements calculations by using different crushing laws, Size reduction equipment: Primary crushers, secondary crushers, Intermediate and fine grinders, Open circuit and Closed circuit grinding		
Mapping of Course Outcomes for Unit IV	CO4: Explain principles of particle technology including their size determination and properties affected during handling.	
Unit V	**Dynamics of Suspended Particles**	**(9 Hrs)**
Lift and drag forces, drag coefficients; Flow of solids through fluids: Gravity settling of particles, Terminal velocity, Stoke's law, Free and hindered settling, Sink and float method, Differential settling method; Sedimentation: Batch and continuous, equipments for sedimentation, Centrifugal settling: Advantages and equipments – cyclones and hydrocyclones		
Mapping of Course Outcomes for Unit V	CO5: Apply the phenomenon of the dynamics of suspended particles by learning the laws and performing the settling of solids.	

Learning Resources

Text Books:

- R K Bansal, "A Textbook of Fluid Mechanics and Hydraulic Machines", 9th ed., Laxmi Publications, New Delhi,2004
- McCabe, Smith, Harriot, "Unit Operations in Chemical Engineering", 7th ed., Tata McGraw Hill Publications
- Pauline M. Doran, "Bioprocess Engineering Principles" Elsevier Science & Technology Books Publications, ISBN: 0122208552, May 1995.

Reference Books:

- R K Rajput, "A Textbook of Fluid Mechanics", S. Chand Ltd.,2008
- George Granger Brown, "Unit Operation"; Asia Publishing House' First Edition
- Bird R.B., Stewart W.E., Lightfoot E.N. "Transport phenomena" 2nd ed., Wiley Publications, 2002.

MOOC / NPTEL/YouTube/VLAB Links: -

- https://www.mooc-list.com/tags/fluid-dynamics
- https://archive.nptel.ac.in/courses/103/103/103103147/
- https://archive.nptel.ac.in/courses/103/107/103107127/
- https://www.my-mooc.com/en/video/pro-ii-unit-operations-shortcut-distillation-column-part-1

CCE: CONTINUOUS & COMPREHENSIVE EVALUATION

Real World Assignment

(One activity for each unit)

Unit 1: Introduction to Fluid Flow

Activity 1:

- **Task:** Unit test
- **Expected Outcome:** Students will gain knowledge about properties of fluids, types of flows and unit operations and they will evaluated through unit test.

Activity 2:

- **Task:** Assignments submission
- **Expected Outcome:** Ability to understand the concept of fluids, unit operations and its applications in the field of Biotechnology.

Activity 3:

- **Task:** To present Virtual Lab (VLAB) of Fluid properties.
- **Expected Outcome:** Ability to understand the concept of fluids, proprieties of fluids virtually and learn its applications in the field of Biotechnology.

Unit 2: Fluid Dynamics and Flow Measurements

Activity 1:

- **Task:** Unit Test
- **Expected Outcome:** Students will gain knowledge about different laws involved in fluid dynamics and they will be evaluated through unit test.

Activity 2:

- **Task:** Assignment submission.
- **Expected Outcome:** Understanding the concept of fluid dynamics and its applications in the field of Biotechnology.

Unit 3: Flow of Fluid Through Solids

Activity 1:

- **Task:** Case study & report writing on CFD and types of pumps & mixing equipments.
- **Expected Outcome:** Case studies will be valuable tool for teaching and learning, engaging students in active learning and critical thinking.

Activity 2:

- **Task:** Assignment submission.
- **Expected Outcome:** Understanding the CFD, types of pumps & mixing units and its applications.

Activity 3:

- **Demonstration of various mixing equipment configurations virtually:**
- To show various mixers virtually.

Unit 4: Particle Technology

Activity 1:

- **Task:** Quiz and open book test on particle technology & particle size reduction equipment.

Expected Outcome: To apply concepts and engage students in critical thinking, rather than simply recalling facts.

Unit 5: Dynamics of Suspended Particles

Activity 1: Quiz / Flash Cards

- **Task:** Examining the selection of a settling method for the collection of suspended particles.
- **Outcome:** The activity will enhance critical thinking ability of students.

Savitribai Phule Pune University
Second Year of Engineering (2024 Course)
Course Code: PCC-203-BIO Course Name: Cell Biology and Tissue Culture

Teaching Scheme:	Credit	Examination Scheme:
Theory: 3 Hours/Week	03	CCE (Theory): 40 Marks ESE (Theory): 60 Marks Total:100 Marks

Prerequisite Courses, if any: Basic knowledge of Biology and Chemistry

Course Objectives:

- To study cell structure and functions of organelle functions
- To understand transportations through cell membrane
- To focus on different receptors and model of signalling
- To explore the different functionalities of cell types in multicellular organisms.
- To highlight the applications of cell biology in biotechnology and its relevance in medical and industrial fields.

Course Outcomes: On completion of the course, learner will be able to –

CO1: Understand the structure and function of eukaryotic cells, including organelles and their roles.

CO2: Understand the principles of biomembranes transport cytoskeleton structure and function, cell movement, ion transport, membrane proteins, endocytosis / exocytosis, cell-cell interactions, and extracellular vesicles in cellular processes.

CO3: Assess the principles of signalling molecules, receptor types, intracellular signal transduction, cellular communication, cell cycle regulation, cell division, and apoptosis in cellular processes and development.

CO4: Analyze and apply the functions of animal tissues, stem cell types and their roles in development and regeneration, and the biology of cancer, including its progression and characteristics.

CO5: Apply knowledge of cell biology in understanding disease mechanisms and developing therapeutic strategies.

Course Contents

Unit I	Cell Structure and Function of Organelles	(9 Hrs)
Overview of prokaryotic and eukaryotic cell structure, plant and animal cells, Sub-cellular Compartmentalization, Organelles and their functions: Cytoplasm, Nucleus, Mitochondria, Ribosome, Endoplasmic reticulum, Golgi bodies, Lysosomes, Peroxisomes, Chloroplasts, Vacuoles, Extracellular Matrix, Locomotor Organelles		
Mapping of Course Outcomes for Unit I	CO1: Understand the structure and function of eukaryotic cells, including organelles and their roles.	
Unit II	**Cell Cycle**	**(9 Hrs)**
Cell Cycle, Types of cell division: Mitosis and Meiosis, Checkpoints and control system, Regulation of the cell cycle, Karyokinesis, Cytokinesis, Programmed cell death and its role in development and diseases, Cancer Biology.		

Mapping of Course Outcomes for Unit II	CO2: Understand the principles of biomembranes, cytoskeleton structure and function, cell movement, ion transport, membrane proteins, endocytosis / exocytosis, cell-cell interactions, and extracellular vesicles in cellular processes.	
Unit III	**Membrane Transport and Signalling**	**(9 Hrs)**
Fluid Mosaic Model, Cytoskeleton, Cell movement and motility mechanisms, Membrane proteins: Carrier proteins and active membrane transport, ATP dependent Proton pumps, Cotransport: Symport, Antiport, Transport in Prokaryotic cell, Mechanisms of Endocytosis / Exocytosis / Pinocytosis, Cell–cell interactions and cell junctions. Cell signalling molecules and receptors: types and functions, cAMP, cGMP, Calcium ion flux, G-protein		
Mapping of Course Outcomes for Unit III	CO3: Assess the principles of signalling molecules, receptor types, intracellular signal transduction, cellular communication, cell cycle regulation, cell division, and apoptosis in cellular processes and development.	
Unit IV	**Tissues**	**(9 Hrs)**
Types of animal tissues and their functions: Epithelial tissue, Connective tissue, Muscle tissue, Nervous tissue, Blood and hematopoietic tissues, Stem cells: Hematopoietic stem cells, Embryonic stem cells, Role of stem cells in regeneration and development genes		
Mapping of Course Outcomes for Unit IV	CO4: Analyze and apply the functions of animal tissues, stem cell types and their roles in development and regeneration, and the biology of cancer, including its progression and characteristics.	
Unit V	**Plant and Animal tissue Culture**	**(9 Hrs)**
Plant tissue culture: Internal organization of plant, Plant growth hormones, Totipotency, Types of culture: Callus culture, Pollen culture, Anther culture, Protoplast fusion, Application: Production of secondary metabolites, Transgenic plants. Animal tissue culture: Tissue culture media, Types of culture: Primary, explant, organ and continuous culture, Adherent cell lines and suspension cell cultures, Routine characterization of cells, Passaging, Preservation of animal cells		
Mapping of Course Outcomes for Unit IV	CO5: Apply knowledge of cell biology in understanding disease mechanisms and developing therapeutic strategies.	

Learning Resources

Text Books:

- Karp, “Cell and Molecular Biology” John Wiley and Sons Pvt. Ltd.
- Sudha Gangal, ‘Animal tissue culture’, Orient Longman, 2006
- The Cell: A molecular approach by Geoffrey M. Cooper. ASM Press,Pages:673

Reference Books:

- Cooper G.M. & Hausman, “The Cell”, fifth edition, ASM Press.
- Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. “MolecularBiologyoftheCell”,4thedition,GarlandPublishing,NewYork,London,(2002)
- Harvey Lodishetal “ Molecular Cell Biology”, 4th edition, NewYork
- M.K. Razdan , “Introduction to Plant Tissue culture”.
- Freshney Ian ,”Animal tissue culture”

Tortora and Grabowasky “Human anatomy and physiology”, Wiley publication

MOOC / NPTEL Courses:

- Cell Biology, IIT Guwahati, Prof. Sanjukta Patra [https://nptel.ac.in/courses/102103012]
- Cell Biology: Cellular Organization, division and processes, IISc Bangalore, Prof. Shikha Laloraya [https://nptel.ac.in/courses/102108086]
- Introduction to Cell Biology, IISER Pune, Prof. Nagaraj Balasubramanian, Prof. Girish Ratnaparakhi [https://nptel.ac.in/courses/102106096]
- Introduction to Molecular Cell Biology, IIT Madras, Prof. Devaranjan karunagaran [https://nptel.ac.in/courses/102106025]
- Tissue Engineering, IIT Madras, Dr. S. Swaminathan [https://nptel.ac.in/courses/102106036]
- Tissue Engineering, IIT Madras, Prof. Vignesh Muthuvijayan [https://nptel.ac.in/courses/102106081]

Virtual LAB Link:

- Biotechnology and Biomedical engineering – Cell Biology virtual Lab I [https://cbi-au.vlabs.ac.in/]
- Biotechnology and Biomedical engineering – Cell Biology virtual Lab II [https://cbii-au.vlabs.ac.in/]

CCE: CONTINUOUS & COMPREHENSIVE EVALUATION

Real World Assignment

(One activity for each unit)

Unit 1: Cell Structure and Function of Organelles

Activity 1: Overview of prokaryotic and eukaryotic cells

- **Task:** Poster making
- **Expected Outcome:** Students will understand and remember the cell compartmentalization and various cell organelles

Activity 2: Chloroplasts: Role in energy conversion

- **Task:** Case Study
- **Expected Outcome:** Students will relate the experimental application of chloroplasts in real world (Plant Health and Ecosystem Balance)

Unit 2: Cell Cycle

Activity 1: Regulation of cell cycle

- **Task:** Flow Chart / Animation / Power point presentation / Video
- **Expected Outcome:** Students would practice communicating scientific ideas using visual aids for different audiences

Activity 2: Cell division and development in model organism

- **Task:** Assignment based on study of literature
  Expected Outcome: Students will demonstrate the ability to interpret and summarize primary research involving model organisms.

Unit 3: Intracellular Signaling and the Cell Cycle

Activity 1: Signalling molecules and receptors

- **Task:** Quiz / Crossword puzzle/ Flash cards
- **Expected Outcome:** Recognize how components of signaling pathways interact

Activity 2: ATP Dependent Proton pumps

- **Task:** Flow Chart / Animation / Power point presentation / Video
- **Expected Outcome:** Students would practice communicating scientific ideas using visual aids for different audiences

Unit 4: Tissues

Activity 1: Tissues of animals and their functions

- **Task**: Identify real-world medical conditions associated with disfunctioning of epithelial tissue, connective tissue, muscle tissue, nervous tissue, blood and hematopoietic tissue
- **Expected Outcome**: Analyze how dysfunction at the tissue level can lead to systemic problems.

Activity 2: Stem Cell and Haematopoiesis

- **Task**: Assignment
- **Expected Outcome**: Students would be able to **differentiate between types of stem cells** and articulate their biological roles.

Unit 5: Plant and Animal tissue Culture

Activity 1: Plant Tissue Culture

- **Task:** Design and experiment to regenerate plant from a single cell
- **Outcome:** The activity will enhance critical thinking ability of students

Activity 2: Animal Tissue Culture

- **Task:** Case study
- **Outcome:** Understand the application of animal tissue culture in real world

Savitribai Phule Pune University, Pune Second Year of B.Tech. Biotechnology (2024 Course) Course Code: PCC-204-BIO Course Name: Microbiology Lab		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Practical: 4 Hours/Week	**02**	**TW: 25 Marks** **PR : 50 Marks** **Total : 75 Marks**

Course Objectives:

1. To train the students to aseptic handling techniques and elimination of microorganisms from different environments.
2. To train the students different methods of isolation and culturing of microorganisms from different sources.
3. To make the students aware of the ubiquitous nature, diversity and growth of different microorganisms.
4. To make students aware for the significance of microorganisms in Biotechnology.

Course Outcomes:

On completion of the course, learner will be able to–

CO1: Understand the significance of clean and aseptic techniques.

CO2: Identify, handle, cultivate and eliminate microorganisms from different environments

CO3: Understand growth requirements of different microorganisms

CO4: Understand different microbiology related processes in the fields of agriculture, medicine and food.

Suggested List of Laboratory Assignments: (Any 8)

Group A: Study of Laboratory Equipment

1. Identify and explain the working principles of basic laboratory instruments.
2. Demonstrate aseptic handling techniques such as Laminar Flow System operation and autoclaving.

Group B: **Culture Media Preparation and Aseptic Techniques**

3. Prepare cotton plugs, wrap plates and pipettes, and perform autoclaving for sterilization.
4. Prepare and sterilize nutrient media (broth, plate, and slant) for bacterial and fungal cultures.
5. Apply culture transfer and preservation techniques such as subculturing and glycerol stock preparation.

Group C: Bacterial Morphology and Staining

6. Perform smear preparation and simple staining techniques.
7. Differentiate bacterial species using Gram's staining method.

Group D: Isolation of Microorganisms

8. Apply serial dilution techniques for microbial isolation.
9. Execute spread plate, pour plate, and streak plate methods for microbial growth.
10. Analyze colony characteristics such as size, shape, colour, margin, consistency, opacity, and Gram reaction.

Group E: Microbial Growth Characteristics

11. Determine the generation time of *E. coli* under controlled conditions.
12. Evaluate the effect of temperature/pH/atmospheric oxygen on *E. coli* growth.

Group F: Microbiological Testing

13. Antimicrobial Testing-Agar Diffusion Assay/MIC
14. Standard Plate Count/TVC

References:

1. Harley, J.P. and Prescott, L.M. (2002) Laboratory Exercises in Microbiology. 5th Edition, The McGraw-Hill Companies ISBN: 9780072333459, 0072333456
2. Laboratory Manual and Workbook in Microbiology Applications to Patient Care 7th Edition Josephine A. Morello Paul A. Granato Helen Eckel Mizer ISBN: 0-07-246354-6

VLAB: Microbiology Virtual Lab I - Virtual Labs

https://mvi-au.vlabs.ac.in/

Microbiology Virtual Lab I

https://vlab.amrita.edu/?sub=3&brch=73

https://vlab.amrita.edu/index.php?sub=3&brch=73

Savitribai Phule Pune University, Pune
Second Year of B.Tech. Biotechnology (2024 Course)
Course Code: PCC-205-BIO Course Name: Fluid Flow and Unit Operations Lab

Teaching Scheme:	Credit	Examination Scheme:
Practical: 2 Hours/Week	01	TW: 25 Marks OR: 25 Marks Total : 50 Marks

Course Objectives:

1. To learn the fluid properties and fundamentals of fluid flow.
2. To introduce the flow measuring devices.
3. To impart knowledge in measuring pressure, discharge and velocity of fluid flow.
4. To provide practical knowledge in verification of principles of fluid flow.

Course Outcomes:

On completion of the course, learner will be able to–

CO1. Understand basic physics of fluid.
CO2. Calculate and design engineering applications involving fluid.
CO3. Analyse flow in terms of mass, momentum and energy balance.
CO4. Predict the coefficient of discharge for flow through different unit operations.

Suggested List of Laboratory Assignments: (Any 8)

1. Verification of Stoke's law
2. Verification of Darcy's law
3. Flow through packed bed
4. Flow through Venturimeter, Orificemeter, Pitot tube
5. Friction during flow through pipe
6. Determination of pressure difference using a manometer.
7. To determine energy consumption and crushing law constants for jaw crusher.
8. To determine filter medium resistance and specific cake resistance by using Rotary Drum
9. To determine filter medium resistance and specific cake resistance by using Plate & frame filter Press
10. To determine area of batch thickener by conducting batch sedimentation test.
11. To determine collection efficiency of Cyclone separator for various particle sizes and pressure drops.
12. To determine Critical speed of Ball mill & Average particle size of the product obtained in ball mill.

VLAB Links: -

- https://fm-dff-iitb.vlabs.ac.in/
- https://ceiitb.vlabs.ac.in/List%20of%20experiments.html?domain=Chemical%20Engineering
- https://fm-vfc-iitb.vlabs.ac.in/List%20of%20experiments.html

Savitribai Phule Pune University, Pune Second Year of B.Tech. Biotechnology (2024 Course) Course Code: MDM-221-BIO Course Name: Applied Biotechnology		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Theory: 2 Hours/ Week	**02**	**CCE (Theory): 40 Marks** **ESE (Theory): 60 Marks** **Total: 100 Marks**

Prerequisite Courses, if any: Basic Knowledge of Physics and Mathematics, Problem Solving ability, Information manipulation and Processing skills.

Course Objectives:

1. To provide a comprehensive understanding of applied biotechnology and its applications in various fields such as agriculture, medicine, and environmental science.
2. To equip students with knowledge of biotechnological techniques and tools used to solve real-world problems.
3. To analyse the role of biotechnology in improving productivity and sustainability in various industries.
4. To analyse the role of biotechnology in environmental management and sustainability.
5. To explore the intersection of biotechnology and artificial intelligence, focusing on innovative case studies.

Course Outcomes: On completion of the course, learner will be able to –

CO 1: Describe and explain the key concepts and applications of applied biotechnology.
CO 2: Analyse various biotechnological techniques and their real-world applications in agriculture.
CO 3: Evaluate the impact of biotechnology in health care and pharma sector.
CO 4: Evaluate the impact of biotechnology in environmental management.
CO 5: Discuss the role of AI in enhancing biotechnological processes and applications.

Course Contents

Unit I	**Introduction to Applied Biotechnology**	**(6 Hrs)**
Definition and Scope of Applied Biotechnology, Historical Development and Milestones, Overview of Biotechnological Processes, Biotechnological Innovations in Various Industries		
Mapping of Course Outcomes for Unit I	CO1: Describe and explain the key concepts and applications of applied biotechnology.	
Unit II	**Biotechnology in Agriculture**	**(6 Hrs)**
Genetic Engineering for Crop Improvement, Biotechnology in Plant Breeding and Disease Resistance, Role of Biopesticides and Biofertilizers, Case Studies of Successful Biotech Crops		
Mapping of Course Outcomes for Unit II	CO2: Analyse various biotechnological techniques and their real-world applications in agriculture.	
Unit III	**Biotechnology in Medicine**	**(6 Hrs)**
Biopharmaceuticals: Production and Applications, Gene Therapy and Genetic Disorders, Biotechnology in Vaccine Development, Ethical Considerations in Medical Biotechnology		

Mapping of Course Outcomes for Unit III	CO3: Evaluate the impact of biotechnology in health care and pharma sector.	
Unit IV	**Environmental Biotechnology**	**(6 Hrs)**
Bioremediation: Techniques and Applications, Waste Management and Biofuels, Role of Biotechnology in Sustainable Development, Case Studies of Environmental Biotechnology Solutions		
Mapping of Course Outcomes for Unit IV	CO4: Evaluate the impact of biotechnology in environmental management.	
Unit V	**AI in Biotechnology**	**(6 Hrs)**
Introduction to Artificial Intelligence in Biotech, Machine Learning Applications in Genomic Data Analysis, AI in Drug Discovery and Development, Case Studies: Successful Integration of AI in Biotechnological Processes.		
Mapping of Course Outcomes for Unit V	CO5: Discuss the role of AI in enhancing biotechnological processes and applications.	

Learning Resources

Text Books:

1. "Principles of Biotechnology" by David P. Clark and Nanette J. Pazdernik
2. "Fundamentals of Biotechnology" by S. B. Jaiswal
3. "Biotechnology for Beginners" by Reinhard Renneberg
4. "Biotechnology: Academic Cell Update Edition" by David T. H. W. Chien
5. "Artificial Intelligence in Healthcare and Biotechnology" by Parag D. Bansal

Reference Books:

1. "Biotechnology: Academic Cell Update Edition" by David T. H. W. Chien
2. "Environmental Biotechnology: Principles and Applications" by Bruce E. Rittman & Perry H. P. Stokstad
3. "Plant Biotechnology: Principles and Applications" by C. E. T. A. H. Van Dijk
4. "Medical Biotechnology: Understanding Healthcare" by R. Timothy LeRoy & A. K. Gupta
5. "AI Applications in Healthcare and Bioengineering" by A. Mukherjee & P. Arora

NPTEL Courses:

1. **Course: Applied Biotechnology**
   (https://nptel.ac.in/courses/102/101/102101004/)
2. **Course: Bioprocess Engineering**
   (https://nptel.ac.in/courses/102/103/102103028/)

MOOCs Courses:

1. **Course: Biotechnology and Its Applications**
   (https://www.coursera.org/learn/biologybiotechnologyapplications)
2. **Course: Principles of Biochemistry**
   (https://www.edx.org/course/principlesofbiochemistry)

Savitribai Phule Pune University, Pune
Second Year of B.Tech. Biotechnology (2024 Course)
Course Code: VEC-231-BIO Course Name: Universal Human Values and Professional Ethics (UHVPE)

Teaching Scheme:	Credit	Examination Scheme:
Theory: 2 Hour/Week	02	CCE (Theory): 20 Marks ESE (Theory): 30 Marks Total: 50 Marks

Prerequisite Courses, if any: UHV-1 of Student Induction Program (SIP)

Course Objectives:

- To help the students develop a holistic, humane world-vision, and appreciate the essential complementarity between values and skills to ensure mutual happiness and prosperity
- To elaborate on 'Self-exploration' as the process for Value Education
- To facilitate the understanding of harmony at various levels starting from self and going towards family and society.
- To elaborate on the salient aspects of harmony in nature and the entire existence and explain how the Right understanding forms the basis of Universal human values and definitiveness of Ethical human conduct.

Course Outcomes: On completion of the course, learner will be able to –

CO1: Recognize the concept of self-exploration as the process of value education and see they have the potential to explore on their own right.

CO2: Explore the human being as the coexistence of self and body to see their real needs / basic aspirations clearly.

CO3: Explain relationship between one self and the other self as the essential part of relationship and harmony in the family.

CO4: Interpret the interconnectedness, harmony and mutual fulfilment inherent in the nature and the entire existence and draw ethical conclusions based on right understanding facilitating the holistic development.

Course Contents

Unit I	Introduction to Value Education	(7 Hrs)

Understanding Value Education , Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity - the Basic Human Aspirations and their Fulfilment, Right Understanding, Relationship and Physical Facility, Happiness and Prosperity - Current Scenario, Method to Fulfil the Basic Human Aspirations

Mapping of Course Outcomes for Unit I	CO1: Recognize the concept of self-exploration as the process of value education and see they have the potential to explore on their own right.

Unit II	Harmony in the Human Being	(7 Hrs)

Understanding Human being as the co-existence of the Self and the Body, Distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Programme to Ensure self-regulation and Health

Mapping of Course Outcomes for Unit II	CO2: Explore the human being as the coexistence of self and body to see their real needs / basic aspirations clearly.	
Unit III	**Harmony in the Family and Society**	**(8 Hrs)**
Harmony in the Family - the Basic Unit of Human Interaction "Trust' - the Foundational Value in Relationship, 'Respect'- as the Right Evaluation, Values in Human-to-Human Relationship, Understanding Harmony in the Society, Vision for the Universal Human Order		
Mapping of Course Outcomes for Unit III	CO3: Explain relationship between one self and the other self as the essential part of relationship and harmony in the family.	
Unit IV	**Harmony in the Nature (Existence)**	**(8 Hrs)**
Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature, Realizing Existence as Co-existence at All Levels, The Holistic Perception of Harmony in Existence, Professional Ethics in the light of Right Understanding, Strategies for Transition towards Value-based Life and Profession		
Mapping of Course Outcomes for Unit IV	CO4: Interpret the interconnectedness, harmony and mutual fulfilment inherent in the nature and the entire existence and draw ethical conclusions based on right understanding facilitating the holistic development.	

Learning Resources

Text Books:

- A Foundation Course in Human Values and Professional Ethics, RR Gaur, R Asthana, GP Bagaria, 3rd revised edition, UHV Publications, 2023, ISBN: 978-81-957703-7-3 (Printed Copy), 978-81-957703-6-6 (e-book)
- Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, RR Gaur, R Asthana, GP Bagaria, 3rd revised edition, UHV Publications, 2023, ISBN: 978-81-957703-5-9 (Printed Copy), 978-81-957703-0-4 (e-Book)

Reference Books:

- P. L. Dhar, R. R. Gaur, 1990, Science and Humanism, Commonwealth Publishers.
- A. Nagaraj, 1999, Jeevan Vidya: Ek Parichaya, Jeevan Vidya Prakashan, Amarkantak
- B. P. Banerjee, 2005, Foundations of Ethics and Management, Excel Books.
- A. N. Tripathy, 2003, Human Values, New Age International Publishers.
- E. G. Seebauer & Robert L. Berry, 2000, Fundamentals of Ethics for Scientists & Engineers , Oxford University Press
- B. L. Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.
- M. Govindrajran, S Natrajan & V.S. Senthil Kumar, Engineering Ethics and Human Values, Eastern Economy Edition, Prentice Hall of India Ltd.
- M. K. Gandhi, "The Story of my Experiments with Truth", Discovery Publisher

MOOC / NPTEL Courses:

E-Resources:

- https://fdp-si.aicte-india.org/download.php#1/
- https://madhyasth-darshan.info/postulations/knowledge/knowledge-of-humane-conduct/
- https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw

MOOC Courses:

- Swayam Course on "Understanding Human Being Nature and Existence Comprehensively" by Dr. Kumar Sambhav, Director, UP Institute of Design (UPID), Noida. https://onlinecourses.swayam2.ac.in/aic22_ge23/preview
- NPTEL Course on "Exploring Human Values: Visions of Happiness and Perfect Society" by Prof. A. K. Sharma, Department of Humanities and Social Sciences, IIT Kanpur. https://nptel.ac.in/courses/109104068

Savitribai Phule Pune University, Pune
Second Year of B.Tech. Biotechnology (2024 Course)
Course Code: EEM-232-BIO Course Name: Leadership and Personality Development

Teaching Scheme:	Credit	Examination Scheme:
Tutorial: 1 Hour/Week Practical: 2 Hours/Week	01+01=02	TW: 25 Marks Total: 25 Marks

Prerequisite Courses, if any: Nil

Course Objectives:

1. To develop leadership, communication, and ethical decision-making skills through Assignment exercises, self-assessment, and collaborative activities in diverse team and technology-driven environments.

Course Outcomes: After successful completion of the course, learner will be able to:

CO1: Demonstrate enhanced leadership, communication, and ethical decision-making abilities, effectively applying these skills in team-based and technology-driven contexts.

CCE: CONTINUOUS & COMPREHENSIVE EVALUATION

Suggested List of Real-World Assignments

(Any 8 considering minimum 2 from each set)

Set 1	Leadership and Self-awareness

Assignment 1: Leadership Styles in Action

- **Objective:** Explore different leadership styles through role-play.
- **Discussion Points:**
  Each student selects or is assigned a leadership style (Transformational, Transactional, Servant).
  Role-play scenarios to demonstrate chosen styles in resolving conflicts or team dynamics.
- **Expected Outcome**: Group reflections on effectiveness and adaptability of styles in real situations.

Assignment 2: Self-Assessment Workshop

- **Objective:** Use self-assessment tools to identify personal leadership traits.
- **Discussion Points:**
  Completion of assessments (e.g., Myers Briggs, Big Five).
  Group discussions on individual results and how these traits impact leadership effectiveness.
- **Expected Outcome**: Development of personal growth plans based on assessment feedback.

Assignment 3: Reflective Journaling

- **Objective:** Foster self-awareness through structured reflective practices.
- **Discussion Points:**
  Weekly journaling prompts related to leadership experiences.

Sharing insights with peers in small groups to promote open dialogue on personal growth.
Discussion of challenges and successes encountered in applying learned theories.

- **Expected Outcome:** Students develop a deeper understanding of their personal leadership style**,** values, and behaviors.

Assignment 4: Leadership Characteristics Assessment

- **Objective:** Identify and discuss key characteristics of effective leaders.
- **Discussion Points:**
  Students create a list of characteristics and identify leaders they admire.
  Analyzing case studies of recognized leaders against the identified characteristics.
  Group presentations on findings and leadership effectiveness.
- **Expected Outcome:** Students define and articulate core leadership qualities based on theory, observation, and personal values.

Set 2	Communication and Team Dynamics

Assignment 1: Communication Styles Simulation

- **Objective:** Practice verbal and nonverbal communication techniques.
- **Discussion Points:**
  Structured simulations where students must convey messages using different communication styles.
  Feedback sessions to discuss clarity, persuasion, and empathy in communication.
  Exploration of barriers to effective communication.
- **Expected Outcome:** Students learn to express themselves clearly, confidently, and respectfully in different contexts.

Assignment 2: Team Building Exercise

- **Objective:** Enhance team dynamics through collaborative activities.
- **Discussion Points:**
  Engage in activities that require collaboration to achieve a common objective.
  Reflect on roles within the team and how different styles affect team performance.
  Discussion on the importance of diversity in team roles and perspectives.
- **Expected Outcome:** Identify and reflect on personal contributions and tendencies in group settings

Assignment 3: Conflict Resolution Scenarios

- **Objective:** Develop negotiation and conflict resolution skills.
- **Discussion Points:**
  Roleplaying conflict scenarios and practicing negotiated outcomes.
  Assessment of personal conflict resolution styles and their effectiveness.
  Group discussion on strategies for constructive conflict resolution.
- **Expected Outcome:** Students would improve ability to stay calm, clear, and respectful during high-stakes or emotionally charged discussions.

Assignment 4: Presentation Skills Workshop

- **Objective:** Strengthen public speaking and presentation skills.

- **Discussion Points:**
  Preparation and delivery of presentations on leadership topics.
  Peer feedback to improve delivery techniques, such as body language and audience engagement.
  Reflection on personal comfort levels and areas for improvement.
- **Expected Outcome:** The activity would prepare students for future academic, professional, or leadership roles where effective presentation is essential.

Set 3	Technology, Ethics, and Leadership

Assignment 1: AI in Leadership Case Study Analysis

- **Objective:** Analyse how AI tools are transforming leadership practices.
- **Discussion Points:**
  Select and discuss various case studies on AI applications in leadership.
  Group analysis of positive and negative impacts of AI in decision-making processes.
  Discussion on ethical implications of AI integration in leadership.
- **Expected Outcome:** Demonstrate how AI tools (e.g., predictive analytics, machine learning, NLP) are reshaping leadership tasks such as: Strategic decision-making, Employee management, Data-driven forecasting

Assignment 2: Ethical Dilemmas in Biotech Leadership

- **Objective:** Explore ethical challenges faced in the biotech industry.
- **Discussion Points:**
  Scenario based analysis of ethical dilemmas in biotechnology projects.
  Group brainstorming on potential solutions and ethical considerations.
  Discussions on real world implications for public health and sustainability.
- **Expected Outcome:** Identify and explain common ethical dilemmas in areas such as: Genetic modification (e.g., CRISPR), Personalized medicine, Biopiracy and intellectual property, Use of animals in biotech research

Assignment 3: Risk Assessment Workshop

- **Objective:** Learn and apply risk assessment techniques in leadership situations.
- **Discussion Points:**
  Hands-on activities assessing risks in hypothetical biotechnology projects.
  Evaluation of decision-making processes used during risk analysis.
  Reflection on balancing innovation with risk in leadership choices.
- **Expected Outcome:** Understand key components of risk assessment: Hazard identification, Risk analysis (likelihood vs. impact), Risk evaluation and prioritization, Mitigation strategies

Assignment 4: Innovation and Leadership Thinking

- **Objective:** Foster creative problem solving in leadership roles.
- **Discussion Points:**
  Group brainstorming sessions to generate innovative solutions for leadership challenges.

Techniques for fostering a culture of innovation in teams.
Sharing of individual innovative ideas and collaborative refinement.

- **Expected Outcome:** Students would be able to develop the ability to think divergently, exploring multiple possible solutions to leadership-related problems.

Guidelines

A. Assignment Conduction:

a. **Preparation:** Instructors should prepare a detailed outline of objectives, materials, and outcomes for each Assignment session.
b. **Safety & Ethics:** Emphasize safety protocols and ethical considerations, especially for discussions on real world applications and implications.
c. **Inclusivity:** Foster an inclusive environment where all participants can contribute and learn without bias.

B. Feedback Mechanism: Establish a robust feedback mechanism for students to evaluate the delivery and content of the Assignment sessions, supporting continuous course improvement.

C. For Continuous Course Evaluation (CCE)

a. Regularity and sincerity of students during lab Assignment sessions
b. Journal presentation
c. Understanding of the experiment
d. Attendance during Tutorial lectures

Learning Resources

Recommended Textbooks:

1. "Leadership: Theory and Practice" by Peter G. Northouse
2. "Emotional Intelligence 2.0" by Travis Bradberry and Jean Greaves
3. "The 7 Habits of Highly Effective People" by Stephen R. Covey
4. "The Leader's Guide to Negotiation" by Graham Turnbull
5. "Leadership in Organizations" by Gary Yukl

Reference Books:

1. "Developing the Leader Within You 2.0" by John C. Maxwell
2. "Drive: The Surprising Truth About What Motivates Us" by Daniel H. Pink
3. "Mindset: The New Psychology of Success" by Carol S. Dweck
4. "Influence: The Psychology of Persuasion" by Robert B. Cialdini
5. "The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses" by Eric Ries

MOOC / NPTEL / COURSERA Courses:

1. Course: Developing Soft Skills and Personality (https://nptel.ac.in/courses/109/106/109106143/)
2. Course: Communication Skills (https://nptel.ac.in/courses/109/106/109106128/)
3. Course: The Science of Well-being (https://www.coursera.org/learn/thescienceofwellbeing)
4. Course: Developing Your Emotional Intelligence (https://www.linkedin.com/learning/developingyouremotionalintelligence)

Savitribai Phule Pune University, Pune Second Year of B.Tech. Biotechnology (2024 Course) Course Code: CEP-241-BIO Course Name: Community Engagement Project		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Practical: 4 Hours/Week	**02**	**TW: 25 Marks** **OR/Presentation: 25 Marks** **Total: 50 Marks**

Prerequisite Courses, if any: Students should have prior knowledge of

1. Basic understanding of social and ethical responsibilities
2. Teamwork and communication skills acquired in prior coursework or group activities
3. Familiarity with problem-solving methodologies and project planning
4. Conversation in local language

Companion Course:

- CEP is an experiential learning approach that combines education, learning, community development, and meaningful community service.
- Project involves students in community development and service activities and applies the experience to personal and academic development.
- The targeted contribution of college students to the village/local development will benefit the community.
- The college has an opportunity to help students become more socially conscious and responsible while simultaneously becoming a socially conscious organization.

Course Objectives:

1. Establish a mutually beneficial relationship between the college and the community.
2. Opportunities to engage with their local community, fostering empathy, teamwork, and problem- solving skills while contributing positively to their surroundings.
3. To develop an understanding of the challenges faced by the local community and the role of engineering in addressing those challenges by applying technical knowledge and skills to design solutions or interventions that create a positive sustainable impact on the community.

Course Outcomes: On completion of the course, learner will be able to –

CO1: Identify and analyze local community needs and challenges by engaging with stakeholders and evaluating real-world problems.

CO2: Design and implement practical, creative, and context-specific solutions using engineering principles to address community issues.

CO3: Reflect and evaluate the effectiveness of their interventions and articulate lessons learned through reports and presentations.

Course Contents

Implementation

1. A group of 3 to 4 students could be assigned for a particular habitation or village or municipal ward, as far as possible, in the near vicinity of their place of stay/college premise.
2. Each group/practical batch is allotted to a faculty member of the department as a mentor.

3. A division of 60 students can have 3 batches of minimum upto 20 students. Practical load of 4 hours to be allocated to each batch.
4. The group of students will be associated with a government official / village authorities /NGOs etc. concerned, allotted by the district administration, during the duration of the project.
5. The Community Engagement Project should be different from the regular programmes of NSS/NCC/Gr Club/Hobby Clubs, Special Interests Groups etc.
6. An activity book has to be maintained by each of the students to record the activities undertaken /involved and will be countersigned by the concerned mentor/HoD.
7. Project report shall be submitted by each student/group of students.
8. An internal evaluation shall also be conducted by a committee constituted by the HoD. Evaluation to be done based on the active participation of the student and marks could be awarded by the mentor/HoD.
9. Students groups can conduct an awareness programme on Health and Hygiene or in Organic Farming or in Fisheries or in advocating prohibition of liquor or about renewable energy, e-waste management or any other activity in an area of their studies and as per his/her aptitude.
10. Oral Examination shall consist of presentation and demonstration of the project work carried out by the project groups.

The below lists are not exhaustive and open for HoD's or mentors to add, delete or modify. It is expected that the focus should be on specific local issues in their nearby areas. The students are expected to carry out these projects with involvement, commitment, responsibility and accountability.

Project List

1. Use/misuse of cell phones
2. Career orientation of youths
3. Water facilities and drinking water availability
4. Health and hygiene of the school going students, home makers and old personals
5. Health intervention and awareness programmes
6. Horticulture
7. Herbal and Nutrition
8. Traditional and Modern health care methods
9. Food habits
10. Air/Sound/Water pollution
11. Plantation and Soil protection
12. Renewable energy and Solar Systems
13. Yoga awareness and practice
14. Health care awareness programmes and their impact
15. Organic farming
16. Food adulteration
17. Incidence of Diabetes and other chronic diseases
18. Blood groups and blood levels
19. Chemicals in daily life
20. Music and dance

21. Women education and empowerment
22. Antimicrobial Testing
23. Rapid Test for Food Quality and Adulteration Testing
24. Prevalence and Risk Analysis of Disease/Diabetes in a Community
25. Statistical Comparison of Male vs. Female Heights in a Population
26. Hydrogel and its Applications

Project Scope

- Conduct workshops or awareness drives on topics like digital literacy, environmental sustainability, mental health, or career planning for local stakeholders.
- Develop a simple prototype or solution that addresses a real-world problem (e.g., a water-saving device, simple mobile apps, or tools for community use).
- Organize clean-up drives, tree plantations, recycling campaigns, or energy conservation initiatives.
- Promote health through awareness programs on hygiene, nutrition, and exercise.
- Teach basic computer or technical skills to students, staff, or the community

Proposal Submission

CEP Group should Submit a two-page project proposal, preferably prior to the term commencement outlining the following:-

- Title of the project
- Aim, Objective and expected outcome
- Plan of execution (timeline and activities).
- Place of the CEP and involvement of any local authority, NGP
- Required resources (if any).
- Get approval from the designated faculty mentor.

Learning Resources

Reference Books:

1. Waterman, A. Service-Learning: A Guide to Planning, Implementing, and Assessing Student Projects. Routledge, 1997.
2. Beckman, M., and Long, J. F. Community-Based Research: Teaching for Community Impact. Stylus Publishing, 2016.
3. Design Thinking for Social Innovation. IDEO Press, 2015.
4. Dostilio, L. D., et al. The Community Engagement Professional's Guidebook: A Companion to The Community Engagement Professional in Higher Education. Stylus Publishing, 2017

MOOC / NPTEL Courses:

- NPTEL course: Ecology and Society, https://onlinecourses.nptel.ac.in/noc20_hs77/preview
- UNESCO: Education for Sustainable Development https://www.unesco.org
- EPICS (Engineering Projects in Community Service) https://engineering.purdue.edu/EPICS
- Ashoka: Innovators for the Public https://www.ashoka.org
- Design for Change https://www.dfcworld.com

Virtual LAB Link:

https://www.vlab.co.in/ba-nptel-labs-biotechnology-and-biomedical-engineering

Microbiology Virtual Lab I https://mvi-au.vlabs.ac.in/

Antibiotic Susceptibility Testing https://mvi-au.vlabs.ac.in/Antibiotic_Susceptibility_Testing

Cell biology Virtual Lab I https://cbi-au.vlabs.ac.in/

Basics of Plant Tissue Culture https://cbi-au.vlabs.ac.in/Basics_of_Plant_Tissue_Culture

Cell biology Virtual Lab II https://cbii-au.vlabs.ac.in/

Haemocytometer (Counting of Cells) https://cbii-au.vlabs.ac.in/Hemocytometer

SECOND YEAR BIOTECHNOLOGY

NEP 2024 SYLLABUS

SEMESTER IV

Savitribai Phule Pune University
Second Year of Engineering (2024 Course)
Course Code: PCC-251-BIO Course Name: Biochemistry

Teaching Scheme:	Credit	Examination Scheme:
Theory: 3 Hours/Week	03	CCE(Theory): 40 Marks ESE (Theory): 60 Marks Total: 100 Marks

Prerequisite Courses, if any: Knowledge of subjects like Basic Chemistry, Microbiology and Cell Biology.

Course Objectives:

1. To make students acquainted with the functioning of the buffering system
2. To understand common structural features of biomolecules
3. To understand the basic functioning of enzymes
4. To recall various categories of carbohydrates; and understand chemical properties of nucleic acids
5. To understand the chemistry, nomenclature, and functions of lipids, including fatty acids

Course Outcomes: After successful completion of the course, learner will be able to:

CO1: Understand various interactions and biological buffering systems.
CO2: Understand the common structural features of amino acids and proteins.
CO3: Analyze and apply principle of enzyme kinetics while evaluating the effects of pH and temperature on enzyme activity.
CO4: Define and classify various categories of carbohydrates, evaluate the structure, function and chemical properties of nucleic acids
CO5: Define and categorize lipid types, analyze their chemical properties, evaluate their biological functions, and apply concepts to the roles of lipids in membrane structure, signalling, and cellular processes.

Course Contents

Unit I	Water and Buffer	(9 Hrs)

Weak interactions in aqueous systems, Ionization of water, weak acids and weak bases, Acids, Bases, and pH (Henderson – Hasselbach equation), Buffers, Titration Curve, Buffering against pH changes in biological systems, Water as a reactant, The fitness of the aqueous environment for living organisms, Numericals based on all the above topics

Unit II	Amino Acids and Proteins	(9 Hrs)

Common structural features of amino acids, Classification of amino acids (Based on R groups) Structure of peptides, Primary structure of protein, Secondary structure of protein (alpha helix, beta sheets, turns and loops), Tertiary structure of protein (Collagen, Myoglobin), Quaternary structure of protein (Haemoglobin), Protein stability and Protein folding

Unit III	Enzymes	(9 Hrs)

Introduction to enzymes – Naming and classification of enzymes, How enzymes work, Enzyme kinetics – Michaelis-Menten equation, Enzyme Inhibition, Effect of pH and temperature on the enzyme activity, Regulation of enzyme activity		
Unit IV	**Carbohydrates, Nucleotides and Nucleic acids**	**(9 Hrs)**
Monosaccharides and Disaccharides, Oligosaccharides and Polysaccharides, Glycoconjugates – Proteoglycans, Glycoproteins, and Glycosphingolipids, Basics of Nucleotides and nucleic acids – Characteristic bases and Pentoses, Phosphodiester bond, Properties of nucleotides, Structure of Nucleic acid, Nucleic acid chemistry, Other functions of nucleotides		
Unit V	**Fatty acids and Lipids**	**(9 Hrs)**
Basic chemistry of lipids, Nomenclature of lipids, Classification of lipids – Storage lipids & Structural lipids, Fatty acids as hydrocarbon derivatives, Triacylglycerol, Structural lipids in membranes, Lipids as signals, cofactors, and pigments		
Learning Resources		
Text Books: D. L. Nelson, M. M. Cox, "Lehninger Principles of Biochemistry", 6th Edition, W. H. Freeman and Company, New York B. D. Hames, N.M. Hooper, "Instant Notes Biochemistry", 2nd Edition, BIOS Scientific Publishers Limited, 2000		
Reference Books: J. H. Weil, "General Biochemistry", New Ages International (P) Ltd.1997. J. M. Berg, J. L. Tymoczko, L. Stryer,"Biochemistry",6th Edition, W. H. Freeman and Company, New York		
MOOC / NPTEL Courses: Biochemistry IIT Madras – Prof. Subramanian K. [https://nptel.ac.in/courses/102106087]		

CCE: CONTINUOUS & COMPREHENSIVE EVALUATION

Real World Assignment

(One activity for each unit)

Unit 1: Water and Buffer

Activity 1: Acids, Bases

- **Task:** Unit Test/ Quiz
- **Expected Outcome:** Students will get ability to distinguish substances on the basis of pH

Activity 2: Buffers

- **Task:** Assignments submission/ Quiz
- **Expected Outcome:** Ability to understand the buffer system and resistance to change in pH

Unit 2: Amino Acids and Proteins

Activity 1: Protein Structure

- **Task:** Case Study
- **Expected Outcome:** Students will understand the importance of structural features of proteins through a case study.

Activity 2: Protein Separation

- **Task:** Assignment submission
- **Expected Outcome:** Understand separation of proteins using their physical/chemical properties

Unit 3: Enzymes

Activity 1: Enzyme naming and classification

- **Task:** Quiz/Crossword puzzle/Flash cards
- **Expected Outcome:** Flash cards/ Crossword would develop critical thinking of students about naming and classification of enzymes

Activity 2: Role of enzymes in Human metabolism

- Task: Chart Preparation
- Expected Outcome: Students will remember various enzymes crucial for life

Unit 4: Carbohydrates, Nucleotides, and Nucleic acids

Activity 1: Carbohydrates

- **Task:** Quiz / Unit Test
- **Expected Outcome:** Deepen the understanding of carbohydrates and their role various biochemical processes

Activity 2: Nucleotides and Nucleic acids

- **Task:** Assignment – Nucleic acid/Nucleotide based drugs.
- **Expected Outcome:** Understanding the application of nucleic acid and nucleotides in real world.

Unit 5: Fatty Acids and Lipids

Activity 1: Nomenclature and Classification of Lipids

- **Task: Flashcards / Crossword Puzzle/ Quiz**
- **Outcome:** To remember names, classification and function of lipids

Activity 2: Lipids as signals, cofactors, and pigments

- **Task: Case Study where lipids are shown as signalling molecules**
- **Outcome:** To study and explore lipids as signalling molecules / cofactors in biochemical pathways

Savitribai Phule Pune University, Pune Second Year of B.Tech. Biotechnology (2024 Course) Course Code: PCC-252-BIO Course Name: Genetics and Molecular Biology		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Theory: 3 Hours/ Week	**03**	**CCE (Theory): 40 Marks ESE (Theory): 60 Marks Total: 100 Marks**

Prerequisite Courses, if any: Basic knowledge of Biology

Course Objectives:

- To understand the classical Mendelian genetics.
- To understand the structure and topological features of DNA and RNA.
- To understand the process of DNA replication.
- To understand the process of transcription.
- To understand the process of translation.

Course Outcomes: On completion of the course, learner will be able to –

CO1: Understand the concept of Mendelian genetics and inheritance patterns.
CO2: Emphasize on the role of different types of DNA and RNA nucleic acid structure.
CO3: Comprehend the replication mechanism in eukaryotes and prokaryotes.
CO4: Analyze the transcription process in prokaryotes and eukaryotes.
CO5: Deduce the process of translation in prokaryotes and eukaryotes.

Course Contents

Unit I	Mendelian Genetics	(9 Hrs)
Introduction, Mendelian inheritance pattern study and laws of heredity, Co-dominance, linkage, linkage maps, Hardy-Weinberg Equation, Model systems like *Drosophila, C. Elegans, Zebra fish, Arabidopsis.*		
Mapping of Course Outcomes for Unit I	CO1: Understand the concept of Mendelian genetics and inheritance patterns.	
Unit II	**DNA and RNA Topology**	**(9 Hrs)**
Watson-Crick's discovery of the structure of DNA, Chargaff's rule, Physicochemical properties of DNA, DNA supercoiling, DNA packaging: Chromosome, Chromatin, Chromatid, Euchromatin, and Heterochromatin. Types of RNA, Coding and non-coding RNAs, RNA splicing, splicing pathways, ribozyme.		
Mapping of Course Outcomes for Unit II	CO2: Emphasize on the role of different types of DNA and RNA nucleic acid structure.	
Unit III	**DNA Replication in Eukaryotes and Prokaryotes**	**(9 Hrs)**
Central dogma of molecular biology, Introduction to replication of DNA, Chemistry of DNA synthesis, Mechanism of DNA polymerase, Replication Fork, DNA synthesis at the replication fork, Initiation, Elongation, Finishing replication, Telomere replication. Mutation and Repair.		
Mapping of Course Outcomes for Unit III	CO3: Assemble fermenter auxiliaries and able to set the required process parameters.	

Unit IV	Transcription in Eukaryotes and Prokaryotes	(9 Hrs)
Transcription, RNA polymerase, Transcription cycle in bacteria, concept of Operon, Transcription cycle in eukaryotes, Reverse Transcriptase, Regulation		
Mapping of Course Outcomes for Unit IV	CO4: Analyze the transcription process in prokaryotes and eukaryotes.	
Unit V	**Translation in Eukaryotes and Prokaryotes**	**(9 Hrs)**
Genetic code, Protein synthesis in prokaryotes and eukaryotes, Translation Process: Initiation, Elongation, Termination of Translation, Regulation, Posttranslational modifications, chaperones, Heat shock proteins.		
Mapping of Course Outcomes for Unit V	CO5: Deduce the process of translation in prokaryotes and eukaryotes.	

Learning Resources

Reference Books:

- Benjamin Lewin, "Gene IX", Oxford University Press, Oxford, New York, (2000)
- Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. "Molecular Biology of the Cell", 4th edition, Garland Publishing, New York, London, (2002)
- T.A. Brown, "Genomes" John Wiley and Sons Pvt. Ltd.
- Ansumbel F.M, Brent R, Kingston R.E, Moore D.D., 'Curernt Protocols in Molecular Biology' Green Publishing Associates, (1988)
- Old R W and Primrose SB, "Principles of Gene manipulations: An introduction to Genetic Engineering" Blackwell Science Publications, (1993)

MOOC / NPTEL Courses:

- Course: Molecular Biology, IIT Guwahati (https://nptel.ac.in/courses/102103341)

Virtual LAB Link:

- Molecular Biology Virtual Lab I (https://vlab.amrita.edu/?sub=3&brch=77)
- Molecular Biology Virtual Lab II (https://vlab.amrita.edu/?sub=3&brch=186)

CCE: CONTINUOUS & COMPREHENSIVE EVALUATION

Real World Assignment

(One activity for each unit)

Unit 1: Mendelian Genetics

Activity 1:

Data Analysis of Inherited Traits in a Sample Population

- **Task:** Survey at least 20 individuals for 3 Mendelian traits. Tabulate genotypic and phenotypic frequencies. Use Hardy-Weinberg Equation to calculate allele frequencies and analyze population equilibrium.
- **Real-Life Problem Addressed:** Applying population genetics to understand how genetic traits persist or change across generations.
- **Expected Outcome:** Students will develop skills in statistical genetics and interpretation of inheritance data.

Activity 2:

MCQ-Based Quiz on Genetic Crosses and Gene Mapping

- **Task:** Solve a 20-question quiz covering monohybrid/dihybrid crosses, recombination frequency, and linkage analysis.
- **Real-Life Problem Addressed:** Strengthening foundational understanding necessary for genomic diagnostics.
- **Expected Outcome:** Reinforcement of key concepts in classical and molecular genetics.

Unit 2: DNA and RNA Topology

Activity 1:

Nucleic Acid Terminology Puzzle

- **Task:** Solve a crossword puzzle using key terms related to DNA and RNA. Use clues based on textbook definitions and class discussions.
- **Real-Life Problem Addressed:** Difficulty in remembering and applying essential molecular biology terms.
- **Expected Outcome:** Improved vocabulary retention and understanding of core concepts in nucleic acid biology.

Activity 2:

Molecular Basis and Therapeutic Design of Synthetic mRNA in Vaccine Development

- **Task:** Write a brief report (150–200 words) explaining how synthetic mRNA (like that used in COVID-19 vaccines) is designed and functions inside the body.
- **Real-Life Problem Addressed:** Understanding the molecular design of RNA therapeutics used in public health.
- **Expected Outcome:** Students relate RNA structure and processing to real-world biomedical applications.

Unit 3: DNA Replication in Eukaryotes and Prokaryotes

Activity 1:

Thought Experiment – DNA Replication Without Topoisomerase

- **Task:** Imagine DNA replication without topoisomerase activity. Predict what will happen to the replication fork. Write a short paragraph with reasoning.
- **Real-Life Problem Addressed:** Encourages critical thinking about enzyme necessity in molecular biology.
- **Expected Outcome:** Understanding the mechanical stress and torsion control during replication.

Activity 2: DNA Replication Flowchart

- **Task:** Cut out 6–8 steps of DNA replication written on paper slips. Mix them up and arrange in correct order with arrows.
- **Real-Life Problem Addressed:** Students often memorize steps without proper order or causality.
- **Expected Outcome:** Students internalize the logical flow of the replication process.

Unit 4: Transcription in Eukaryotes and Prokaryotes

Activity 1:

Viral Hijacking of Transcription

- **Task:** Analyze a case study on how viruses like HIV manipulate host transcription using host RNA polymerase and transcription factors. Write down your understanding about this process with diagrams.
- **Real-Life Problem Addressed:** Understanding viral control over host gene expression is key to developing antiviral strategies.
- **Expected Outcome:** Students will relate transcriptional regulation to real-world disease mechanisms and therapeutic challenges.

Activity 2:

Open Book Assessment – Compare Polymerases

- **Task:** Using textbook content, compare DNA polymerase I, II, and III in prokaryotes. Write their primary function, proofreading ability, and unique roles, etc.
- **Real-Life Problem Addressed:** Confusion among DNA polymerase types and their features.
- **Expected Outcome:** Clear distinctions between enzymes critical for replication and repair.

Unit 5: Translation in Eukaryotes and Prokaryotes

Activity 1:

Case Study – Antibiotics That Inhibit Protein Synthesis

- **Task:** Research and present how specific antibiotics (e.g., tetracycline, chloramphenicol, erythromycin) inhibit bacterial translation without affecting eukaryotic cells.
- **Real-Life Problem Addressed:** Importance of understanding molecular targets in drug design.
- **Expected Outcome:** Students appreciate the role of ribosomal structure in selective drug action.

Activity 2:

RNA World – Fact or Fiction Quiz

- **Task:** Students will attempt a 20-statement quiz based on concepts of RNA structure, function, and the RNA world hypothesis. For each statement, they must mark it as Fact or Fiction and correct the statement if it is false.
- **Real-Life Problem Addressed:** Students often memorize RNA facts but struggle to distinguish between accurate and outdated or oversimplified information.
- **Expected Outcome:** Students will develop critical thinking by identifying and correcting false scientific statements.

Savitribai Phule Pune University
Second Year of B.Tech. Biotechnology (2024 Course)
Course Code: PCC-253-BIO Course Name: Material Balances and Stoichiometry

Teaching Scheme:	Credit	Examination Scheme:
Theory: 2 Hours/Week	02	CCE (Theory): 40 Marks ESE (Theory):60 Marks Total: 100 Marks

Prerequisite Courses, if any: Basic concepts of fundamental and derived properties and their units.

Course Objectives:

1. To introduce the concept of unit operations and unit processes and develop an ability to perform basic chemical calculations involved in the bioprocesses.
2. To make students conversant with different unit operations used in the process industry and formulate material balances for each step.
3. To make students conversant with different unit processes and chemical reactions encountered in the process industry and formulate material balances for each step.
4. To make students familiar with energy balance calculations involved in different unit operations and unit processes.

Course Outcomes: On completion of the course, learner will be able to –

CO1: Analyse importance of process calculation and unit conversions while calculating compositions of mixtures and solutions.
CO2: Apply concepts of material balance to effectively design processes at various physical steps.
CO3: Understand and apply material balance for designing of reactors with biochemical reactions.
CO4: Quantify heat and energy changes accompanying unit operations and unit processes and apply it to various processes with chemical changes

Course Contents

Unit I	Basic Chemical Calculations	(7 Hrs)

Introduction to process calculation, Dimensions and systems of units, Fundamental quantities of units, Derived quantities, Definition and units of force, volume, pressure, work, energy, power, heat, Definition and calculations of mole, atomic weight, molecular weight, equivalent weight, specific gravity and API gravity, Composition of solid, liquid by weight % and mole % , Morality, normality, morality, gm/lit and related simple numericals

Mapping of Course Outcomes for Unit I	CO1: Analyse importance of process calculation and unit conversions while calculating compositions of mixtures and solutions.

Unit II	Material Balances without Biological/ Chemical Reactions	(7 Hrs)

Law of conversation of mass, Brief description and simple material balance calculation of drying, distillation, absorption, mixing, crystallization, evaporation, Single stage material balance calculation of leaching and extraction, Brief idea regarding recycle, by pass, Purge operation.

Mapping of Course Outcomes for Unit II	CO2: Apply concepts of material balance to effectively design processes at various physical steps	
Unit III	**Material Balances involving Biological/ Chemical Reactions**	**(8 Hrs)**
Definition: Limiting reactant, Excess reactant, conversion, yield and selectivity, Simple numerical for finding yield, conversion and composition, Simple calculation of material Balance based on reaction.		
Mapping of Course Outcomes for Unit III	CO3: Understand and apply material balance for designing of reactors with biochemical reactions.	
Unit IV	**Energy Balances for a process involving chemical reaction**	**(8 Hrs)**
Concept of conservation of energy, Heat capacity and specific heat, Calculations of heat capacity by integral equation up to three terms, Brief explanation of sensible Heat and latent heat of fusion, sublimation, vaporization, Calculations of standard heat of formation and heat of reaction from heat of combustion data		
Mapping of Course Outcomes for Unit IV	CO4: Quantify heat and energy changes accompanying unit operations and unit processes and apply it to various processes with chemical changes	

Learning Resources

Text Books:

1. B. I. Bhatt, S.B. Thakore, "Stoichiometry" 5th Edition, Tata McGraw Hill Publications, New Delhi (2011)
2. K.A. Gavhane, "Introduction to process calculations stoichiometry", 22nd Edition, Nirali Prakashan (2009)
3. Himmelablau David M.,"Basic principles and calculations in Chemical Engineering", New Delhi, Year 2003.

Reference Books:

1. David M. Himmelblau " Basic Principles and Calculations in Chemical Engineering" 6th Edition, Eastern Economy Edition, Prentice Hall of India

MOOC/ NPTEL Courses:

- NPTEL Course "Material and Energy Balances" https://nptel.ac.in/courses/102/106/102106069/
  NPTEL Course "Basic Principles and Calculations in Chemical Engineering".
  https://nptel.ac.in/courses/103/103/103103165/

CCE: CONTINUOUS & COMPREHENSIVE EVALUATION

Real World Assignment

(One activity for each unit)

Unit 1: Basic Chemical Calculations

Activity 1:

- **Task:** Unit test
- **Expected Outcome:** Analyse importance of process calculation and unit conversions while calculating compositions of mixtures and solutions.

Activity 2:

- **Task:** Assignments submission

  Expected Outcome: Assignments should be given to students on similar type of numericals in the field of Biotechnology for more practice.

Unit 2: Material Balances without Biological/ Chemical Reactions

Activity 1:

- **Task:** Unit Test
- **Expected Outcome:** Ability to understand and apply material balances to different physical steps in a process and thus efficiently design processes.

Activity 2:

- **Task:** Assignment submission.
- **Expected Outcome:** Understanding the concept of material balance by solving more numerical based on mass balance for important unit operations

Unit 3: Material Balances involving Biological/ Chemical Reactions

Activity 1:

- **Task:** Numericals based on mass balance involving chemical/biological reactions along with real examples.
- **Expected Outcome:** Understand and apply material balances to different chemical/biological steps in a process and thus efficiently design processes.

Activity 2:

- **Task:** Unit Test
- **Expected Outcome:** Apply material balances to different chemical/biological steps in a process and thus efficiently design processes.

Unit 4: Energy Balances for a process involving chemical reaction

Activity 1:

- **Task:** Assignment submission
- **Expected Outcome:** Understand how to quantify heat and energy changes accompanying unit operations and unit processes by solving more examples.

Activity 2:

- **Task:** Quiz and open book test on writing energy balances to various processes involving chemical/biological changes and for designing a process.
- **Expected Outcome:** Quantify heat and energy changes accompanying unit operations and unit processes and apply it to various processes with chemical changes

Savitribai Phule Pune University Second Year of Engineering (2024 Course) Course Code: PCC-254-BIO Course Name: Biochemistry Lab		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Practical: 02 Hours/week	**01**	**TW: 25 Marks** **PR: 25 Marks** **Total: 50 Marks**

Course Objectives:

1. To train the students in preparing and standardizing chemical solutions
2. To provide hands-on experience in the extraction and isolation of biomolecules
3. To assist students in understanding the principles and procedures behind qualitative and quantitative biochemical assays.
4. To guide students to interpret experimental data and assess biomolecular functions and properties.

Course Outcomes: After successful completion of the course, learner will be able to:

CO1: Explain the procedures and importance of preparing and standardizing molar and normal buffer solutions.

CO2: Describe the methods used for the extraction and isolation of proteins, enzymes, polysaccharides, and lipids from biological samples.

CO3: Summarize the principles behind biochemical assays and distinguish between qualitative and quantitative testing methods.

CO4: Interpret experimental data and explain the functional roles and properties of various biomolecules based on assay results.

Suggested list of laboratory Practicals (Any 8)

1. Preparation of molar and normal solutions
2. Preparation of buffer solution and testing its buffering capacity
3. Extraction of protein from sprouted seeds
4. Quantitative estimation of protein by biuret assay
5. Isolation of enzyme
6. Extraction of polysaccharide
7. Qualitative analysis of polysaccharide by iodine Test
8. Quantitative estimation of carbohydrates using DNS assay
9. Extraction of lipid Qualitative analysis of lipid

Virtual LAB Link:

Biotechnology and Biomedical Engineering – Biochemistry Virtual Lab I [https://www.vlab.co.in/broad-area-biotechnology-and-biomedical-engineering]

Savitribai Phule Pune University, Pune Second Year of B.Tech. Biotechnology (2024 Course) Course Code:PCC-255-BIO Course Name: Genetics and Molecular Biology Lab		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Practical: 2 Hours/Week	**02**	**OR: 25 Marks** **Total: 25 Marks**

Course Objectives:

1. To understand the significance of different stocks and reagents used in molecular biology
2. To isolate and purify the DNA from prokaryotic and eukaryotic cells.
3. To estimate the quantitative purity of isolated DNA.
4. To understand the process of gel electrophoresis for qualitative analysis of nucleic acid.

Course Outcomes: After successful completion of the course, learner will be able to:

CO1: Explain the role and preparation of essential molecular biology reagents and buffers used in experimental protocols.

CO2: Perform DNA isolation procedures from both prokaryotic and eukaryotic sources using standard laboratory protocols.

CO3: Demonstrate the ability to quantify DNA and assess its purity using spectrophotometric techniques.

CO4: Interpret the results of agarose gel electrophoresis for qualitative analysis of nucleic acids.

Suggested List of Laboratory Assignments (Any 8)

1. Introduction to Molecular Biology Laboratory and various equipments.
2. Preparation of Stock and Working solutions
3. Isolation of plant genomic DNA
4. Isolation of *E. coli* genomic DNA
5. Quantification and purity check of extracted DNA from Plant and *E. coli* by at 260/280, 260/230 nm Spectrophotometer
6. Agarose Gel Electrophoresis
7. Study of effect of agarose concentration on electrophoretic mobility of DNA
8. Visualization of plant genomic DNA by agarose gel electrophoresis
9. Visualization of *E. coli* genomic DNA by agarose gel electrophoresis
10. Polyacrylamide Gel Electrophoresis

Virtual LAB Link:

- Biotechnology and Biomedical Engineering – Molecular Biology Virtual Lab I [https://mbvi-au.vlabs.ac.in/]
- Biotechnology and Biomedical Engineering – Molecular Biology Virtual Lab II [https://mbvii-au.vlabs.ac.in/Introduction.html]

Savitribai Phule Pune University, Pune
Second Year of B.Tech. Biotechnology (2024 Course)
Course Code: MDM-271-BIO Course Name: Biodiversity

Teaching Scheme:	Credit	Examination Scheme:
Theory: 2 Hours/Week	02	CCE (Theory): 40 Marks ESE (Theory) :60 Marks Total: 100 Marks

Prerequisite Courses, if any: Basic knowledge of Biology.

Course Objectives:

- Understand the concept of biodiversity and recognize the significance of biodiversity for ecosystems and human life.
- Evaluate different conservation strategies and their effectiveness while identifying the role of biotechnology in enhancing conservation efforts.
- Analyse the relationship between biodiversity and ecosystem health.
- Understand the ethical implications of biotechnology in biodiversity research and explore how biotechnological tools can be applied for biodiversity conservation.
- Understand the role of AI technologies in biodiversity management and evaluate case studies where AI has effectively contributed to conservation efforts.

Course Outcomes: Upon completion of this course, students will be able to:

CO1: Demonstrate a comprehensive understanding of biodiversity, its significance, and current issues.
CO2: Critically evaluate various biodiversity conservation strategies.
CO3: Analyse the interplay between biodiversity and ecosystem functions.
CO4: Apply biotechnological principles to real-world biodiversity challenges.
CO5: Assess the integration of AI technologies in biodiversity monitoring and management.

Course Contents

Unit I	Introduction to Biodiversity	(6 Hrs)
Definition and Importance of Biodiversity, Levels of Biodiversity: Genetic, Species, Ecosystem, Biodiversity Hotspots, Current Global Biodiversity Status and Trends		
Mapping of Course Outcomes for Unit I	**CO1:** Demonstrate a comprehensive understanding of biodiversity, its significance, and current issues.	
Unit II	**Biodiversity Conservation Strategies**	**(6 Hrs)**
Types of Conservation: In-situ vs. Ex-situ, Protected Areas and Conservation Policies, Role of Biodiversity in Ecosystem Services, Case Studies of Successful Conservation Programs: Tiger Project		
Mapping of Course Outcomes for Unit II	**CO2:** Critically evaluate various biodiversity conservation strategies.	
Unit III	**Biodiversity and Ecosystem Functions**	**(6 Hrs)**
Ecosystem Dynamics and Interactions, the Role of Biodiversity in Ecosystem Resilience, Biodiversity Loss and Its Impacts on Ecosystems, Case Studies of Ecosystem Restoration		

Mapping of Course Outcomes for Unit III	**CO3:** Analyse the interplay between biodiversity and ecosystem functions.	
Unit IV	**Biotechnological Applications in Biodiversity**	**(6 Hrs)**
Biotechnology for Conservation: Genetic Engineering, Cloning, and Database Systems, Use of Biotechnology in Sustainable Practices, Bioprospecting: Exploring Genetic Resources, Ethical Considerations in Biotechnology		
Mapping of Course Outcomes for Unit IV	**CO4:** Apply biotechnological principles to real-world biodiversity challenges.	
Unit V	**Artificial Intelligence in Biodiversity Management**	**(6 Hrs)**
Introduction to AI and Machine Learning, applications of AI in Biodiversity Monitoring and Data Analysis**,** AI for Predicting Ecosystem Changes and Assessing Biodiversity, Case Studies: AI Tools in Conservation Practices		
Mapping of Course Outcomes for Unit V	**CO5:** Assess the integration of AI technologies in biodiversity monitoring and management.	

Learning Resources

Recommended Textbooks:

- 1. “Conservation Biology: Foundations, Concepts, Applications” by Fred van Dyke
- 2. “Biodiversity Conservation and Habitat Management” by Michael J. O'Connor
- 3. “Genetics and Conservation of Endangered Species” by William V. Holt
- 4. “Environmental Biotechnology: Principles and Applications” by Bruce E. Rittman & Perry H. P. Stokstad
- 5. “AI for Earth: The Role of Artificial Intelligence in Environmental Science” by the Microsoft AI for Earth Team

Reference Books:

- 1. “Biodiversity: An Introduction” by Peter J. Brown
- 2. “The Diversity of Life” by Edward O. Wilson
- 3. “Biodiversity and Conservation Biology” by David L. Hawksworth
- 4. “Biotechnology and Biodiversity” by Iris G. Ebert
- 5. “Artificial Intelligence for Earth System Science” by Tamara M. Wenzel
- 6. “Ecology:” Begon & Hareper
- 7. “The biology of biodiversity:” M.Kato
- 8. “Biodiversity:” E.O. Willson
- 9. “Evolution:” Stearns & Hoekstra
- 10. “Animal behaviour:” Alcock
- 11. “Ecological analysis:” Freeman & Herron
- 12. Elements of taxonomy:” E. Mayor
- 13. “Plant Taxonomy & Biodiversity:” Stace
- 14. “Fundamentals of Plant Systematics:” Radford
- 15. “Taxonomy of Angiosperms:” Naik, V.N.

MOOC / NPTEL Courses:

1. **Course: Biodiversity: Theory and Applications**
   (https://nptel.ac.in/courses/102/102/102103048/)

2. **Course: Environmental Studies**
   (https://nptel.ac.in/courses/112/103/112103060/)
3. **Course: Biodiversity and Green Economy**
   (https://www.coursera.org/learn/biodiversitygreeneconomy)
4. **Course: Biodiversity and Conservation**
   (https://www.edx.org/course/biodiversityandconservation)

Savitribai Phule Pune University Second Year of Engineering (2024 Course) Course Code: MDM-272-BIO Course Name: Lifestyle and Nutrition		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Theory: 2 Hours/Week	**02**	**CCE (Theory):40 Marks ESE (Theory): 60 Marks Total: 100 Marks**

Prerequisite Courses, if any: Knowledge of subjects like Basic Biology, Basic Chemistry

Course Objectives:

1. To understand the fundamental concepts of lifestyle, nutrition, and health.
2. To comprehend the principles of healthy eating, including balanced diets, eating habits, meal planning, and mindful eating.
3. To explain the essential nutrients required for a healthy lifestyle.
4. To elaborate on the nutritional requirements across different life stages.
5. To discuss the impact of lifestyle habits on health and well-being.

Course Outcomes: After successful completion of the course, learner will be able to:

CO1: Understand key nutrition terms, Relationship between food, nutrients, and health.

CO2: Understand the impact of eating habits, the components of a balanced diet, Identify strategies for meal planning, and compare various diet trends and supplements.

CO3: Identify essential nutrients, their functions, sources, deficiencies, and understand related health problems.

CO4: Understand the nutritional requirements across different life stages.

CO5: Identify and describe the impact of lifestyle factors and personal habits on health and well-being.

Course Contents

Unit I	**Introduction to Lifestyle and Nutrition**	**(6 Hrs)**
Introduction to Nutrition, Inter-relationship between food, nutrients & health, Role of lifestyle habits on health, Basics of Nutrition – Macronutrients, Micronutrients, Water, Nutrition and Hydration requirements in children and adults		
Mapping of Course Outcomes for Unit I	CO1: Understand key nutrition terms, Relationship between food, nutrients, and health.	
Unit II	**Healthy eating habits**	**(6 Hrs)**
Eating Habits – eating disorders, skipping breakfast, junk food consumption, Balanced diet- Definition, Components, and importance for health, Meal Planning, Mindful eating, Diet trends, Supplements		
Mapping of Course Outcomes for Unit II	CO2: Understand the impact of eating habits, the components of a balanced diet, identify strategies for meal planning, and compare various diet trends and supplements.	

Unit III	Essential Nutrients	(6 Hrs)
Various essential nutrients including carbohydrate, protein, fats, fibers, vitamins, minerals; their sources, functions, and their deficiencies, Health problems related to Malnutrition, Micronutrient deficiency, and overnutrition (Overweight, Obesity, Diabetes, Heart disease, High blood pressure)		
Mapping of Course Outcomes for Unit III	CO3: Identify essential nutrients, their functions, sources, deficiencies, and understand related health problems.	
Unit IV	**Nutritional requirement across life stages**	**(6 Hrs)**
Nutritional requirement for infants, Nutritional requirement for children, Nutritional requirement for adults, Nutritional requirement for Elderly		
Mapping of Course Outcomes for Unit IV	CO4: Understand the nutritional requirements across different life stages.	
Unit V	**Impact of Lifestyle Factors, and Personal Habits on Health and Well-being**	**(6 Hrs)**
Lifestyle related problems, Role of physical activity, Resting pattern – Circadian rhythm, Personal habits – alcoholism, and other tobacco products, electronic addiction etc., Stress management – Mental Health, Social and Cultural influence		
Mapping of Course Outcomes for Unit V	CO5: Identify and describe the impact of lifestyle factors and personal habits on health and well-being.	

Learning Resources

Suggested reading:

- Mann, J. and Truswell, S. eds., 2017. Essentials of human nutrition. Oxford University Press. [https://global.oup.com/academic/product/essentials-of-human-nutrition-6e-9780198866671?lang=3n&cc=se]
- Eastwood, M.A., 2013. Principles of human nutrition. Springer.
- Bender, D., 2014. An introduction to nutrition and metabolism. CRC Press
- B. Srilakshmi, "Dietetics", New age international (P) ltd, publishers, 2010.
- "Nutrient requirement and Recommended Dietary Allowances for Indians", published by Indian Council of Medical Research, ICMR, 2010.

MOOC / NPTEL Courses:

- Wageningen: Nutrition and Health: Micronutrients and malnutrition [https://www.edx.org/learn/nutrition/wageningen-university-research-nutrition-and-health-micronutrients-and-malnutrition#syllabus]
- UCR: Nutrition and Healthy Living [https://www.edx.org/learn/nutrition/university-of-california-riverside-nutrition-and-healthy-living]
- NOC: Maternal, Infant, Young Child Nutrition, IIT Bombay [https://nptel.ac.in/courses/102101091]

Savitribai Phule Pune University, Pune
Second Year of B.Tech. Biotechnology (2024 Course)
Course Code: VSEC-281-BIO Course Name: Lab Practices and Data Analysis

Teaching Scheme:	Credit	Examination Scheme:
Practical: 4 Hours/Week	02	TW: 25 Marks PR: 25 Marks Total: 50 Marks

Prerequisite Courses, if any: Basic knowledge in Biology, Chemistry, and Mathematics

Course Objectives:

1. To familiarize students with Good Laboratory Practices (GLP), laboratory safety protocols, proper documentation methods, and accurate handling of laboratory equipment.
2. To develop proficiency in calibrating laboratory instruments and in conducting measurements of key physical and chemical properties of biological and chemical samples.
3. To build skills in cell biology techniques including microscopic observation and quantitative analysis using tools like the hemocytometer.
4. To enable students to design, execute, and analyse biochemical experiments such as fermentation and protein separation using aqueous two-phase extraction methods.
5. To train students in designing and conducting public health and biotechnology awareness surveys, and to apply data collection, statistical analysis, and reporting techniques to real-world biological and community health problems.

Course Outcomes: On completion of the course, learner will be able to –

CO1. Apply the principles of Good Laboratory Practices (GLP), including safety procedures, documentation protocols, and proper equipment handling, and calibration in a biotechnology lab.

CO2. Determine and analyse the physical and chemical properties of various biological liquids using standard laboratory methods.

CO3. Perform microscopic cell observation and quantitative analysis of cells using hemocytometer techniques.

CO4. Conduct fermentation processes and biochemical separations, such as aqueous two-phase extraction, and analyse the outcomes using appropriate calculations.

CO5. Design, administer, and analyse public health and biotechnology-related surveys, and interpret data to prepare informed scientific reports.

Course Contents

Suggested List of Experiments (Any 8)

Practical 1: Introduction to Laboratory practices:

Explain the principles of Good Laboratory Practices (GLP), including proper documentation using lab logbooks and electronic records, adherence to laboratory safety rules, and correct handling of laboratory equipment.

Practical 2: Calibration of Laboratory Instruments:

Demonstrate and guide students in the calibration of essential laboratory instruments and equipment, including weighing balances, refrigerators, pH meters, and micropipettes.

Practical 3: Determination And Analysis of Physical Quantities of Liquid:

Determine, compare, and analyse physical properties—temperature, density, viscosity, surface tension, and specific gravity—of various liquids such as water, sugar solution, oil, milk, honey, and mercury using appropriate instruments and standard laboratory methods.

Practical 4: Determination And Analysis of Chemical Properties:

Determine, compare, and analyse chemical properties such as pH, acidity, alkalinity, and solubility using standard laboratory techniques and reagents.

Practical 5: Microscopic Observation of Cells

Observe plant cells (e.g., onion, Elodea) and animal cells under a microscope to study their structure and identify key organelles such as the cell wall, nucleus, and cytoplasm.

Practical 6: Cell counting using a Hemocytometer:

Determine the concentration of cells in a given suspension using a hemocytometer.

Practical 7: Media and Inoculum Preparation for Fermentation:

Prepare a liquid media, sterilize it using appropriate methods, prepare the inoculum, and perform fermentation of sugar to produce alcohol.

Practical 8: Aqueous Two Phase Separation:

Demonstrate and guide students to perform aqueous two-phase extraction of proteins and calculate the partition coefficient of the protein.

Practical 9: Knowledge and Awareness Survey on Biotechnology:

Assess public knowledge and awareness regarding biotechnology applications such as GMOs, gene editing (CRISPR), vaccines, and biofuels. Conduct the survey using an online form or interviews, and analyse and report the collected data.

Practical 10: Design and perform a Public Health Survey:

Design a questionnaire for a general public health survey covering age, lifestyle diseases, genetic diseases, antibiotic usage, frequency of doctor visits, awareness of communicable diseases, and hygiene practices; then collect and analyse the data to prepare a comprehensive report.

Guidelines for Practical and Term Work Assessment

Term work marks distribution should be carried considering the following points.

1. **Regularity and sincerity** of the student during practical sessions.
2. **Clear understanding** of safety procedures, given instructions, and the objective of each experiment.
3. **Accuracy and precision** in conducting experiments, including the correct use of instruments, tools, and materials.
4. **Well-maintained journals** that are detailed, accurate, original, and submitted on time.
5. **Logical interpretation and effective presentation** of results based on the data obtained.

The assessment of practical examinations may vary depending on the specific question paper; however, general evaluation should include key criteria such as the student's understanding of the task, presentation quality of the written work, confidence during the performance of the practical, and responsiveness during the viva voce.

Savitribai Phule Pune University
Second Year of Engineering (2024 Course)
Course Code: AEC-282-A-BIO Course Name: Modern Indian Language (Marathi)

Teaching Scheme:	Credit	Examination Scheme:
Tutorial: 1 Hour/Week **Practical:2 Hours/Week**	**02**	**TW: 50 Marks** **Total: 50 Marks**

Prerequisite Courses, if any: Knowledge of basic Marathi and Hindi language

Course Objectives:

अभ्यासक्रमाची उद्दिष्टे :

१. प्रगत भाषिक कौशल्यांची क्षमता विकसित करणे.
२. प्रसारमाध्यमांतील संज्ञापनातील स्वरूप आणि स्थान स्पष्ट करणे.
३. व्यक्तिमत्त्व विकास आणि भाषा यांच्यातील सहसंबंध स्पष्ट करणे.
४. लोकशाहीतील जीवनव्यवहार आणि प्रसारमाध्यमे यांचे परस्पर संबंध स्पष्ट करणे.
५. प्रसारमाध्यमांसाठी लेखनक्षमता विकसित करणे.

Course Outcomes: After successful completion of the course, learner will be able to understand and speak marathi

Course Contents

Unit I & II **(12 Hours)**

घटक	तपशील
१	१. भाषा आणि व्यक्तिमत्त्व विकास : सहसंबंध २. लोकशाहीतील जीवनव्यवहार आणि प्रसारमाध्यमे
२	प्रसारमाध्यमांसाठी लेखन १ वृत्तपत्रासाठी बातमीलेखन आणि मुद्रितशोधन २ नभोवाणीसाठी भाषणाची संहितालेखन ३ दूरचित्रवाणीसाठी माहितीपटासाठी संहितालेखन

Unit III & IV **(12 Hours)**

१	१. भाषा, जीवन व्यवहार आणि नवमाध्यमे, समाजमाध्यमे २. नवमाध्यमे आणि समाजमाध्यमांचे प्रकार : ब्लॉग, फेसबुक, ट्विटर. ३. नवमाध्यमे आणि समाजमाध्यमांविषयक साक्षरता, दक्षता, वापर आणि परिणाम
२	१. वेबसाईट आणि ब्लॉग, ट्विटरसाठी लेखन २. व्यावसायिक पत्रव्यवहार

Learning Resources

Suggested Reading:

संदर्भ ग्रंथ :

१ सायबर संस्कृती, डॉ. रमेश वरखेडे
२ उपयोजित मराठी, संपादक डॉ. केतकी मोडक, संतोष शेणई, सुजाता शेणई
३ ओळख माहिती तंत्रज्ञानाची, टिमोथी जे. ओ लिअरी
४ संगणक, अच्युत गोडबोले, मौज प्रकाशन, मुंबई.
५ इंटरनेट, डॉ. प्रबोध चोबे, मनोरमा प्रकाशन, मुंबई.
६ व्यावहारिक मराठी, डॉ. ल. रा. नसिराबादकर, फडके प्रकाशन, कोल्हापूर.
७ आधुनिक माहिती तंत्रज्ञानाच्या विश्वात, शिक्रापूरकर दीपक, मराठे उज्ज्वल, उत्कर्ष प्रकाशन, पुणे.

Savitribai Phule Pune University
Second Year of Engineering (2024 Course)
Course Code: AEC-282-B-BIO Course Name: Modern Indian Language (Hindi)

Teaching Scheme:	Credit	Examination Scheme:
Tutorial: 1 Hour/Week	01	TW: 25 Marks Total: 25 Marks

Prerequisite Courses, if any: Knowledge of basic Marathi and Hindi language

Course Objectives:

उद्देश्य :

१. छात्रों में हिंदी भाषा श्रवण कौशल विकसित करना।
२. छात्रों में हिंदी भाषा संवाद कौशल विकसित करना।
३. छात्रों में हिंदी भाषा वाचन कौशल विकसित करना।
४. छात्रों में हिंदी भाषा लेखन कौशल विकसित करना।
५. हिंदी भाषा—विधि तथा भाषा—व्यवहार से अवगत करना।

Course Outcomes: After successful completion of the course, learner will be able to understand and speak Hindi

Course Contents

Unit I & II **(12 Hours)**

इकाई	पाठ्यविषय
इकाई— I	**वर्ण विचार :** १) हिंदी वर्णमाला — परिचय २) लिपि — परिचय ३) वर्णों का उच्चारण और वर्गीकरण ४) स्वराघात ५) संधि : स्वर संधि, व्यंजन संधि, विसर्ग संधि।

Unit III & IV **(12 Hours)**

इकाई— II	**भाषा कौशल शिक्षण : लघुकथाओं द्वारा भाषा कौशल शिक्षण (श्रवण, संवाद, वाचन, लेखन)** १) शिक्षा — ज्योति जैन २) पानी के पेड़ — ज्योति जैन ३) पशुभाषा — ज्योति जैन ४) अपशगुन — ज्योति जैन

Learning Resources

Suggested Reading:

संदर्भ ग्रंथ :

१. हिंदी भाषा शिक्षण — संपा. हिंदी अध्ययन मंडल, सावित्रीबाई फुले पुणे विश्वविद्यालय, पुणे, राजकमल प्रकाशन, नई दिल्ली।

२. हिंदी व्याकरण — पं. कामताप्रसाद गुरु, प्रकाशन संस्थान, नई दिल्ली।

३. प्रयोजनमूलक हिंदी — डॉ. माधव सोनटक्के, लोकभारती प्रकाशन, नई दिल्ली।

Savitribai Phule Pune University
Second Year of B.Tech. Biotechnology (2024 Course)
Course Code: EEM-283-BIO Course Name: Entrepreneurship

Teaching Scheme:	Credit	Examination Scheme:
Tutorial: 1 Hour/Week **Practical: 2 Hours/Week**	**01+ 01=02**	**TW: 25 Marks** **Total: 25 Marks**

Prerequisite Courses, if any: Basic concepts of fundamental and derived properties and their units.

Course Objectives:

1. To understand the concept of entrepreneurship, its process, and key characteristics.
2. To guide individuals through the initial stages of starting a business venture, from generating a business idea to conducting feasibility studies.
3. To describe the Entrepreneurship functional plan with the source of finance and legal issues,
4. To apply financial concepts relevant to supporting entrepreneurs, including various funding options, intellectual property protection, and financial planning for a business.
5. To understand various parameters of project ideas for collaborative partnership and strategic technology.

Course Outcomes: On completion of the course, the learner will be able to –

CO1: Distinguish between an Entrepreneur and Entrepreneurship, process and feasibility study
CO2: Describe the Entrepreneurship with idea generation, planning and its feasibility study
CO3: Demonstrate an Entrepreneurship functional plan with the source of finance and legal issues
CO4: Describe business technology and decision support systems.
CO5: Describe business, collaborative partnership, and strategic technology

Course Contents

Unit I	Introduction to Entrepreneurship	(6 Hrs)

Concept, Knowledge, and skills requirement; Characteristics of successful entrepreneurs, role of entrepreneurship in economic development; Entrepreneurship process, factors impacting the emergence of entrepreneurship, managerial vs. entrepreneurial approach, and emergence of entrepreneurship, Challenges to women and achievements of women Entrepreneurs.

Mapping of Course Outcomes for Unit I	CO1: Distinguish between an Entrepreneur and Entrepreneurship, process and their study

Unit II	Idea Generation and Opportunity Recognition	(6 Hrs)

Starting the Venture: Generating business idea–sources of new ideas, methods of generating ideas, creative problem solving, opportunity recognition, environmental scanning, competitor and industry analysis.

Feasibility study: Market feasibility, Technical/operational feasibility, Financial feasibility; drawing a business plan; preparing a project report; presenting a business plan to investors.

Mapping of Course Outcomes for Unit II	CO2: Describe the Entrepreneurship with idea generation, planning and its feasibility study	
Unit III	**Strategic Start up Planning**	**(6 Hrs)**
Functional Plans: Marketing plan – marketing research for the new venture, steps in preparing the marketing plan, and contingency planning. **Organizational plan** - Form of ownership, designing organization structure, job design, manpower planning. **Financial plan** - cash budget, working capital, Performance income statement, Performance cash flow, perform balance sheet, break-even analysis.		
Mapping of Course Outcomes for Unit III	CO3:Demonstrate an Entrepreneurship functional plan with the source of finance and legal issues	
Unit IV	**Start-up Finance & Intellectual Property**	**(6 Hrs)**
Debtor equity financing, commercial banks, venture capital, and financial institutions support entrepreneurs. Intellectual property rights: patents, trademarks, copyrights, trade secrets, licensing, Franchising.		
Mapping of Course Outcomes for Unit IV	CO4: Describe business technology and decision support systems.	
Unit V	**Project Development and Evaluation**	**(6 Hrs)**
Meaning of Project, Project Identification, Project Selection, Project Report, Need and Significance of Report, Contents, formulation, Guidelines by Planning Commission for Project report, Network Analysis, Errors of Project Report, and Project Appraisal.		
Mapping of Course Outcomes for Unit V	CO5: Describe business, collaborative partnership, and strategic technology	

Learning Resources

Text Books:

1. Entrepreneurship (Fifth Edition 2002); Robert Hisrich, Michael Peters; Tata McGraw-Hill
2. Entrepreneurship: New Venture Creation by David Holt, Prentice Hall of India Pvt. Ltd.
3. Business Driven Technology – Haag/Baltzan/Philips – Tata McGraw Hill Publication
4. Management of Information Technology – Carroll W. Frenzel and John C. Frenzel, Thomson Press
5. Entrepreneurship Development – Small Business Enterprises – Poornima M Charantimath – Pearson Education –2006, 2nd Edition.

Reference Books:

1. Innovation and Entrepreneurship- Peter F. Drucker, Harpercollins Publications

MOOC/NPTEL Courses:

1. List of Open-Source Software/learning websites: www.nptel.ac.in

CCE: CONTINUOUS & COMPREHENSIVE EVALUATION

Real World Assignment

(One activity for each unit)

Unit 1: Entrepreneurship

Activity 1: Case Study – Journey of a Successful Entrepreneur

- **Task:** Study the story of a well-known entrepreneur (e.g., Dr. Kiran Mazumdar-Shaw or Ritesh Agarwal). Identify their key traits, challenges, and turning points.
- **Real-Life Relevance:** Understand how entrepreneurs emerge and succeed in different industries.
- **Expected Outcome:** Students will identify qualities and decisions that define real entrepreneurs.

Activity 2: Assignment – Entrepreneur vs. Manager

- **Task:** Write a short comparison between an entrepreneur and a manager with real-world examples.
- **Expected Outcome:** Students will understand different roles in an organization.

Unit 2: Starting the Venture

Activity 1: Case Study – How a Biotech Startup Was Born

- **Task:** elect a biotech startup and describe how the idea came up, how feasibility was studied, and how the plan was developed.
- **Real-Life Relevance:** Demonstrates the early stages of venture creation.
- **Expected Outcome:** Students will learn the steps from idea generation to business planning.
-

Activity 2: Assignment – Your Own Business Idea

- **Task:** Think of a simple product or service and write how you would check if it's feasible (market, technical, financial).
- **Expected Outcome:** Practical understanding of feasibility study basics.
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Unit 3: Functional Plans

Activity 1: Case Study – Marketing & Financial Planning of a Startup

- **Task:** Read about how a startup built its marketing strategy and managed its budget. Describe how they structured their team and resources.
- **Real-Life Relevance:** Connects classroom concepts with actual business planning.
- **Expected Outcome:** Students understand how startups plan for marketing, finance, and team structure.

Unit 4: Sources of Finance and Legal Issues:

Activity 1: Case Study – How Startups Raise Money

- **Task:** Explore how a startup raised money through investors, banks, or government schemes. Write how it used the funds.
- **Real-Life Relevance:** Shows how funding decisions affect growth.
- **Expected Outcome:** Students learn about funding options and financial support for businesses.

Activity 2: Assignment – Types of Intellectual Property

- **Task:** Find and write examples of patents, trademarks, and copyrights used by real companies.
- **Expected Outcome:** Students will understand the role of IP in protecting business ideas.

Unit 5: Preparation of Project

Activity 1: Case Study – Breakdown of a Real Project Report

- **Task:** Go through a simple project report or proposal. Identify sections like goals, costing, planning, and timeline.
- **Real-Life Relevance:** Helps in understanding how to prepare and structure a project idea.
- **Expected Outcome**: Students learn how to frame and present project ideas professionally.

Activity 2: Group Activity – Create a Project Idea

- **Task:** In groups, create your own small business idea and make a basic project report including purpose, plan, and cost estimation.
- **Expected Outcome:** Team-based learning of how projects are developed and presented.

Savitribai Phule Pune University
Second Year of Engineering (2024 Course)
Course Code: VEC-284-BIO Course Name: Environmental Studies

Teaching Scheme:	Credit	Examination Scheme:
Practical:2 Hours/Week	02	CCE (Theory): 20 Marks ESE (Theory): 30 Marks Total : 50 Marks

Prerequisite Courses, if any: Knowledge of Biology, Biochemistry, Microbiology.

Course Objectives:

- To introduce the multidisciplinary nature and scope of environmental studies.
- To explore the causes, effects, and control technologies of air and water pollution.
- To understand biochemical and microbial processes in pollutant degradation.
- To analyse the classification, treatment, and sustainable management of E-waste.

Course Outcomes: After successful completion of the course, learner will be able to:

CO1: Illustrate the interdependence of ecosystems through activity-based exploration

CO2: Understand types and sources of pollution, effects, control devices, and global impacts like smog, acid rain, and climate change.

CO3: Analyse microbial and enzymatic roles in pollutant degradation, bioremediation techniques, and application of bioreactors and algae in environmental clean-up.

CO4: Explore the sources, classification, and management of E-waste, including E-waste minimization policies, treatment, recycle and technologies for recovery

Course Contents

Unit I	Environment and Its Issues	(7Hrs)
Environment Meaning of Environment, Types of Environments, Components of Environment, Man-Environment relationship, importance of environment, Need for Public Awareness, Ecosystem-Meaning, Major Components of Ecosystem, Case studies of Forest Ecosystem, Grassland Ecosystem, Desert Ecosystem, Aquatic Ecosystem, Stability of Ecosystem in Sustainable Environment, Global issues: smog, acid rain, climate change		
Mapping of Course Outcomes for Unit I	CO1: Illustrate the interdependence of ecosystems through activity-based exploration	
Unit II	**Environnent Pollution**	**(7 Hrs)**
Definition of Pollution, Types of Pollution, Air Pollution-Meaning, Sources, effects of air pollution, Air Pollution Act, Water Pollution Meaning, Sources, Effects of Water pollution, Water Pollution Act, Water quality parameters: DO, BOD, COD, TOC, and TSS. Bacteriological indicators and standards (ICMR, WHO), Noise Pollution Meaning, Sources, Effect of Noise Pollution, Solid Waste Pollution Meaning, sources, Effect of Waste Pollution		
Mapping of Course Outcomes for Unit II	CO2: Understand types and sources of pollution, effects, control devices, and global impacts like smog, acid rain, and climate change	
Unit III	**Biochemical Principles in Environmental Systems**	**(8 Hrs)**
Microbial metabolism and environmental applications, Enzymes and biodegradation of pollutants,		

Bioreactors: aerobic and anaerobic, Role of algae in carbon capture, Bioremediation - Definition and scope, Role of bacteria, fungi, algae in degradation, In-Situ (Bioventing, biosparging, phytoremediation) and Ex-Situ Bioremediation techniques (Biopiles, land farming, bioreactors), Case studies of oil spill cleanup, pesticide-contaminated soils		
Mapping of Course Outcomes for Unit III	CO3: Analyse microbial and enzymatic roles in pollutant degradation, bioremediation techniques, and the application of bioreactors and algae in environmental clean-up.	
Unit IV	**E-Waste Managements and Acts**	**(8 Hrs)**
E-waste; composition and generation, Global context in e-waste; E-waste pollutants, E waste hazardous properties, Effects of pollutant (E-waste) on human health and surrounding environment, domestic e-waste disposal, Basic principles of E-waste management, Technologies for recovery of resources from electronic waste, resource recovery potential of e-waste, steps in recycling and recovery of materials-mechanical processing, technologies for recovery of materials, occupational and environmental health perspectives of recycling e-waste in India.		
Mapping of Course Outcomes for Unit IV	CO4: Explore sources, classification, and management of E-waste, including E-waste minimization policies, treatment, recycle and technologies for recovery	

Practical Assignments

Topics to be covered (Any 8)

1. Introduction: Group discussion and poster making on "Why Environmental Studies Matter for technologists"
2. Eco Mapping: Identify and document elements of an ecosystem within the college campus
3. Model the Food Web: Create food chains and food webs using flowcharts (digital tools like Canva / Lucid chart)
4. Case Study Review: Present real-world examples of forest, grassland, and aquatic ecosystems
5. Soil and Water Testing Activity: Test soil pH, water quality, BOD, COD,DO, TDS (use school-level kits), and interpret results
6. Case study on Activated sludge process of waste water from industries
7. Review on case study of biological waste water treatment programs includes RBC, Aerated lagoons, Land farming, Trickling filters.
8. Case study on use of higher organisms and microorganisms from for waste water treatment.
9. Case study on biodegradation of polycyclic aromatic hydrocarbons (PAH).
10. Case study on biodegradation of oil, heavy metals form industrial soil and waste water.
11. Case study on Bioleaching
12. Field Visit / Virtual Tour: Document deforestation or mining impact in a chosen region; students prepare a comparative report
13. Water Audit Exercise: Estimate water usage at home/hostel and identify areas of overuse; propose conservation measures
14. Renewable Energy Models: Create a simple model or PPT on any renewable energy source (e.g., solar cooker, wind energy demo)
15. Biodiversity Documentation: Survey nearby areas for plant/animal species; identify any endemic/endangered species
16. Conservation Proposal Pitch: In groups, students prepare a mini proposal for biodiversity

conservation at local level

17. Group Project Work: Work on mini project report/documentation on any ecosystem/natural resource/e-waste management topics
18. Presentation & Viva: Final presentation and oral examination based on project work and learning portfolio

Learning Resources

Text Books:

1. Odum, Eugene P. "Fundamentals of Ecology"
2. R. Rajagopalan, "Environmental Studies – From Crisis to Cure", Oxford
3. Johri R., E-waste: implications, regulations, and management in India and current global best practices, TERI Press, New Delhi

Reference Books:

1. Erach Bharucha, "Textbook of Environmental Studies", UGC
2. Anubha Kaushik and C.P. Kaushik, "Environmental Studies", New Age International Ltd, New Delhi, India, 1998
3. Waste water treatment for pollution control , Soli J. Arciwala, Tata McGraw-Hill Publications, New Delhi
4. Manual Sewerage and Sewage Treatment – Public Health Department, Govt. of India.
5. Sewage disposal and treatment – Dr. Modi, Standard Publications, New Delhi.
6. Wastewater Treatment – M. N. Rao and A. K. Dutta, Oxford and IBH Publlishing Co Pvt Ltd, New Delhi, 1987
7. Environmental Pollution Control Engineering, First edition, C.S. Rao, New Age International (P) Ltd., 1991
8. Wastewater Engineering, second edition, B.C.Punmia, Ashok Kr Jain– Laxmi Publications (P) Ltd, New Delhi, India, 1998

MOOC / NPTEL Courses:

1. Environmental Engineering, IIT Roorkee, Dr. V. C. Srivastava [https://nptel.ac.in/courses/103107084]
2. Basic Environmental Engineering and Pollution Abatement, IIT Roorkee, Prof. P. Mondal [https://nptel.ac.in/courses/103107215]

ssE-Books Links:

1. https://www.environment.gov.in
2. https://www.unep.org
3. https://news.mit.edu/2013/ewaste-mit