Elements of Biotechnology Lab		Semester	I/II
Course Code	**1BEBTL107/207**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	24	Total Marks	100
Credits	1	Exam Hours	3
Examination type (SEE)	**Practical**		

Course outcome

At the end of the course, the student will be able to:

1. CO1: Describe the fundamental concepts of biotechnology, biomolecules, cell structure, and biomimetic principles.
2. CO2: Apply biotechnological techniques such as DNA extraction, gel electrophoresis, microbial culture, and enzyme assays in laboratory settings.
3. CO3: Analyze applications of biotechnology and biomimicry across engineering domains to solve practical problems.
4. CO4: Design and present experimental models or prototypes integrating biological concepts with engineering solutions.
5. CO5: Demonstrate teamwork, communication, and problem-solving skills through interdisciplinary project activities.

Note:

1. The laboratory syllabus consists of PART-A and PART-B. While PART-A has 6 conventional experiments, PART-B has 6 typical open-ended experiments. The maximum marks for the laboratory course are 100.
2. Both PART-A and PART-B are considered for CIE and SEE.
3. Students have answer 1(one) question from PART-A and 1(one) question from PART-B.
   a. The questions set for SEE shall be from among the experiments under PART-A. It is evaluated for 70 marks out of the maximum 100 marks.
   b. The open-ended question set for SEE shall be any other open-ended question and not selected from the experiments under PART-A. It shall be evaluated for 30 marks.
4. For continuous internal evaluation, during the semester, classwork, the typical open-ended questions shall be from PART-B, and any other similar questions to enhance the skill of the students

PART – A
COVENTIONAL EXPERIMENTS

Biochemical Estimations

1. Preparation of standard buffers
2. Estimation of carbohydrates and protein with error analysis

Microbial techniques

3. Sterilization of glassware using dry and wet heat

Microscopy & Staining

4. Onion root tip — stages of mitosis & mitotic index
5. Cell viability studies with Trypan Blue
6. Observation of prokaryotic and eukaryotic cells (Preparation of permanent slides)

PART – B
TYPICAL OPEN-ENDED EXPERIMENTS

Open-ended experiments are a type of laboratory activity where the outcome is not predetermined, and students are given the freedom to explore, design, and conduct the experiment based on the problem statements as per the concepts defined by the course coordinator. It encourages creativity, critical thinking, and inquiry-based learning.

1. Concept 1: Antimicrobial activity: Antimicrobial Sensitivity Testing using Plant Extracts or Antibiotics
2. Concept 2 : Bio fertilizers: : inoculation of *Tichoderma*/*Rhizobium/Azotobacter*/VAM on seeds
3. Concept 3: Fermentation of Local Fruits for Alcohol or Acid Production
4. Concept 4: Estimation of pigments (chlorophyll, anthocyanin, lycopene) from fruits and vegetables
5. Concept 5 : Biomimetic Demonstrations: lotus leaf effect (water droplet rolling), self-cleaning surface models, seashell hardness tests.
6. Concept 6 : Antagonist properties of Soil fungus using dual culture

Suggested Learning Resources: (Text Book/ Reference Book/ Manuals):

Text books:

1. Bhushan, B. Biomimetics: Bioinspired Materials, Structures and Functions, Springer, pp. 1–300, 2017.
2. Singh, B.D. Biotechnology: Expanding Horizons, Kalyani Publishers, pp. 1–796, 2016.
3. Rastogi, S.C. Cell Biology, New Age International, pp. 1–400, 2013.

Reference books / Manuals:

1. Karp, G. Cell and Molecular Biology: Concepts and Experiments, Wiley, pp. 1–848, 2018.
2. Brown, T.A. Gene Cloning and DNA Analysis: An Introduction, Wiley-Blackwell, pp. 1–312, 2016.
3. Pelczar, M.J., Chan, E.C.S., Krieg, N.R. Microbiology: Concepts and Applications, Tata McGraw-Hill, pp. 1–896, 2009.
4. Voet, D., Voet, J.G., Pratt, C.W. Fundamentals of Biochemistry: Life at the Molecular Level, Wiley, pp. 1–1200, 2016.

Web links and Video Lectures (e-Resources):

NPTEL Courses

1. NPTEL – Introduction to Biotechnology, https://nptel.ac.in/courses/102/105/102105086/
2. NPTEL – Cell Biology, https://nptel.ac.in/courses/102/103/102103012/
3. NPTEL – Molecular Biology, https://nptel.ac.in/courses/102/106/102106025/
4. NPTEL – Principles of Downstream Techniques in Bioprocess, https://nptel.ac.in/courses/103/103/103103112/
5. NPTEL – Biomimicry: Innovation Inspired by Nature, https://nptel.ac.in/courses/112/106/112106324/

Virtual Labs (Amrita / IIT)

1. Biotechnology & Biomedical Engineering Virtual Labs – Amrita Vishwa Vidyapeetham, https://vlab.amrita.edu/?sub=3
2. Microbiology Virtual Lab – IIT Bombay, https://vlab.co.in/mainsite/Virtual-Labs.php?id=36
3. Biochemistry Virtual Lab – IIT Bombay, https://vlab.co.in/mainsite/Virtual-Labs.php?id=39

Teaching-Learning Process (Innovative Delivery Methods):

1. The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of course outcomes.
2. Use flipped classroom for active discussions and problem-solving during sessions.
3. Apply virtual labs for pre-lab familiarization and concept reinforcement effectively.
4. Introduce problem-based learning projects linking biotechnology and biomimetic applications.

5. Conduct case study discussions on real-world biotechnology and biomimicry innovations.
6. Utilize gamified quizzes through Kahoot or Quizizz for formative assessments.
7. Demonstrate experimental setups before student hands-on laboratory practical sessions start.
8. Encourage interdisciplinary mini-projects integrating biology concepts with engineering solutions.
9. Invite industry experts for webinars on recent biotechnological and biomimetic trends.
10. Implement peer teaching activities to enhance student understanding and presentation skills.
11. Use mind-mapping tools to visually connect complex interdisciplinary course concepts.

Assessment Structure:

The assessment for each course is equally divided between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each component carrying **50% weightage** (i.e., 50 marks each).
The CIE Theory component will be 25 marks and CIE Practical component will be 25 marks.

The CIE marks awarded shall be based on the continuous evaluation of the laboratory report using a defined set of rubrics. Each experiment report can be evaluated for 30 marks. The laboratory test (duration 03 hours) at the end of the last week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 20 marks. For both CIE and SEE, the student is required to conduct one experiment each from both Part A and Part B.

Rubrics for CIE – Continuous Assessment: 30 Marks

Performance Indicators	Excellent	Good	Satisfactory	Needs Improvement	Poor
Technical Skills & Procedure (PO1 & PO5) (10)	Performs all experimental steps (e.g., microscopy staining, enzyme assay) with precision, no errors in methodology. (9–10)	Minor procedural errors but overall method correct; understands principles. (7–8)	Requires occasional guidance, some procedural mistakes. (5–6)	Frequent mistakes, unable to maintain experimental standards. (3–4)	Unable to perform basic techniques independently. (0–2)
Safety Compliance (PO6) (5)	Strict adherence to PPE and biosafety rules; workspace well-maintained. (5)	Follows safety rules with occasional lapses. (4)	Sometimes neglects safety precautions. (3)	Unsafe chemical/microbial handling practices. (2)	No PPE; high-risk unsafe behavior. (0–1)
Team Interaction (PO8) (5)	Leads effectively, collaborates, resolves issues constructively. (5)	Cooperative, completes assigned role well. (4)	Minimal participation in teamwork. (3)	Reluctant or slow in group tasks. (2)	Disruptive or uncooperative in team activities. (1)
Lab Report Quality (PO9) (10)	Exceptionally detailed, well-organized; data accurate; insightful analysis. (9–10)	Complete, well-structured; minor inaccuracies. (7–8)	Minor errors in data/analysis; slightly unclear organization. (5–6)	Incomplete or inaccurate data; poorly organized. (3–4)	No submission or unacceptable quality. (0–2)

Rubrics for SEE / CIE Test:
(CIE test -To be conducted for 100 marks and the marks obtained shall be reduced to 20)
(SEE-To be conducted for 100 marks)

Performance Indicators	Excellent	Good	Satisfactory	Needs Improvement	Poor
Execution of Experiment (PO3 & PO5) (40) / (8)	Perfect execution of both Part A & B experiments; correct equipment handling. (33–40) / (7–8)	Minor errors in parameter settings; method mostly correct. (25–32) / (5–6)	Acceptable work with several handling mistakes. (17–24) / (3–4)	Multiple execution errors, frequent intervention needed. (9–16) / (2)	Unable to perform experiment without assistance. (0–8) / (0–1)
Results & Discussion (PO4) (40) / (7)	Accurate data, insightful analysis linked to theory. (33–40) / (7–8)	Data correct but limited analysis depth. (25–32) / (5–6)	Mostly correct results, basic discussion. (17–24) / (3–4)	Incomplete/wrong results, weak interpretation. (9–16) / (2)	No valid results or analysis. (0–8) / (0–1)
Viva Voce (PO9) (20) / (5)	Confident, correct answers demonstrating deep understanding. (17–20) / (5)	Mostly correct answers; minor gaps. (13–16) / (4)	Limited but relevant answers. (9–12) / (3)	Vague, incomplete answers. (5–8) / (2)	No relevant answers. (0–4) / (1)
Performance Indicators	Excellent	Good	Satisfactory	Needs Improvement	Poor

- To qualify and become eligible to appear for SEE, in the **CIE component**, a student must secure **a minimum of 40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE component**, a student must secure **a minimum of 35% of 50 marks**, i.e., **18 marks**.
- A student is deemed to have **successfully completed the course** if the **combined total of CIE and SEE is at least 40 out of 100 marks**.

Rubrics suggested for Practical continuous assessment				
Performance Indicators	Excellent	Very Good	Good	Satisfactory
Fundamental Knowledge (4) (PO1)	The student demonstrates in-depth knowledge of core biotechnology principles and lab techniques, confidently explaining the theory behind experiments like buffer preparation, biochemical	The student has a solid understanding of key concepts related to the experiments, such as the principles of cell viability studies	The student can narrate the basic steps and purpose of the experiments but struggles to explain the	The student has a limited understanding of the concepts and procedures involved in

	estimations, sterilization, and staining. (4 marks)	or the function of different microbial techniques. (3 marks)	underlying scientific principles. (2 marks)	the lab work. (1 mark)
Design of Experiment (5) (PO2 & PO3)	For open-ended experiments (Part B), the student is capable of proposing and justifying a novel experimental design, selecting the best approach with proper reasoning (e.g., justifying the choice of plant extract for antimicrobial activity or the type of fermentation setup). (5 marks)	The student can discuss a few potential experimental designs for an open-ended problem but may not fully justify the selection of the most suitable one. (4 marks)	The student can describe a single, standard experimental design but shows limited understanding of its variations or alternatives. (3 marks)	The student struggles to formulate a coherent design for the open-ended experiments. (1-2 marks)
Implementation (8) (PO3 & PO8)	The student flawlessly executes the experimental procedure, including accurate media preparation, dilutions, and staining techniques, and uses optimal methods for data collection. (7-8 marks)	The student correctly implements the experiment following the standard protocol with minor deviations that do not impact the overall outcome. (5-6 marks)	The student attempts to implement the experiment but makes several procedural errors that affect the quality or reliability of the results. (3-4 marks)	The student is unable to correctly follow the experimental procedure, leading to an incomplete or failed experiment. (1-2 marks)
Result & Analysis (5) (PO4)	The student accurately records and presents all results, including error analysis for estimations, and provides a thorough analysis of the findings, comparing results from different trials or conditions (e.g., comparing the effectiveness of different plant extracts in the antimicrobial test). (5 marks)	The student records the results for all cases and can provide a basic analysis of the outcomes. (4 marks)	The student collects data for a few cases and offers a limited analysis of the results. (3 marks)	The student records data but is unable to perform a meaningful analysis or interpret the results. (1-2 marks)
Demonstration (8) (PO9)	The lab record is exceptionally well-organized and detailed, with clear sections on methods, results, and conclusions. The write-up reflects a deep understanding of the experiment and its relevance. (7-8 marks)	The lab record is organized and follows the required structure, but some sections could be more detailed or clearly defined. (5-6 marks)	The lab record lacks a clear structure or logical flow, with incomplete or unclear sections. (3-4 marks)	The lab record is poorly organized and contains significant missing or unclear information, making it difficult to follow the experiment. (1-2 marks)