Elements of Biotechnology and Biomimetics		Semester	I/II
Course Code	**1BEBT105/205**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	**Theory**		

Course outcome (Course Skill Set)

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

CO1: Explain the fundamental concepts of biotechnology.
CO2: Demonstrate a foundational understanding of biotechnological techniques.
CO3: Apply introductory practical approaches in biotechnology.
CO4: Integrate interdisciplinary thinking to address challenges in engineering sectors.

Module-1

Basics of Biology:

Structure and functions of prokaryotic and eukaryotic cells. Central dogma of Biology (DNA to RNA to Protein), Biomolecules of life - Carbohydrates (examples of Mono, Di, Polysaccharides), Proteins (examples of enzymes, structural proteins, transport proteins, regulatory proteins, and hormones).

Number of Hours: 8

Module-2

Overview of Biotechnology:

History, scope, and branches/types of biotechnology such as medical biotechnology (red) - focusing on healthcare; agricultural biotechnology (green) : improving crops and livestock; industrial biotechnology (white): using biological systems for industrial processes; environmental biotechnology (grey/brown): focused on environmental protection and remediation; marine biotechnology (blue): (oil slick), yellow biotechnology (food production),:probiotics and bioinformatics/computational biology; drug discovery

Number of Hours: 8

Module-3

Biotechnology Processes-& Sustainability

Bioprocess stages: Case study of Bio Ethanol production from agri-waste-qualitative (steps in upstream, and downstream processing, Biosafety levels, containment, cGMP/GLP and IPR issues). Circular bioeconomy and biotechnology's role in UN SDGs, Ethical, legal, and social issues in biotechnology, GI tags, specific case studies related to Basmati or Turmeric.

Number of Hours: 8

Module-4

AI application in Biological Research

Role of AI in genomics (flow chart). Role of AI in drug development (flow chart), AI-assisted target (receptor) design and ligand (inhibitor) design (flow chart), AI in medical imaging and disease diagnosis (flow chart), AI-driven personalized medicine and predictive healthcare (flow chart), Role of AI in agriculture and crop improvement (flow chart), Role of AI in fermentation industry and bioprocess optimization (flow chart), Role of AI in Protein and enzyme engineering (flow chart), Role of AI in biosensors and diagnostics (flow chart).

Number of Hours: 8

Module-5

Bioinspired Engineering:

History and scope of biomimetics/biomimicry, Examples involving a) Bioinspired materials: nacre, bone, spider silk, cuticle-based composites, b) Self-cleaning surfaces and biocement c) artificial blood. termite mound passive cooling, d) Bioinspired mechanisms: hygromorphic actuators, fish/bird locomotion, Seashell-based, spider web-inspired, and insect eye-inspired innovations, mosquito proboscis inspired needles, e) Medical devices and drug delivery inspired by biology (Exosomes, Liposomes, VLPs), f) Bioinspired energy (artificial photosynthesis).

Number of Hours: 8

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

Text books:

1. P. K. Gupta, Elements of Biotechnology, Rastogi Publications, 468, 2010.
2. Vogel, Steven. Cats' Paws and Catapults: Mechanical Worlds of Nature and People. W. W. Norton & Company, 2000.

Reference books / Manuals:

1. Singh B.D., Biotechnology: Expanding Horizons, Kalyani Publishers, 768 pages, 2019.
2. Barnum, Susan R., Biotechnology: An Introduction, Cengage Learning, 432 pages, 2021.
3. Bar-Cohen, Yoseph, Biomimetics: Nature-Based Innovation, CRC Press, 788 pages, 2012.
4. Mukherjee, A.K., and Ghosh, S.K., Biomimicry: Nature Inspired Solutions, Narosa Publishing House, 260 pages, 2018.
5. Vincent, Julian F.V., Structural Biomaterials, Princeton University Press, 252 pages, 2012.
6. Herren, Ray V., Introduction to Biotechnology, Cengage Learning, 672 pages, 2018.
7. Nath, Bhaskar, Advances in Biotechnology, Atlantic Publishers, 300 pages, 2020.

Web links and Video Lectures (e-Resources):

1. Bioengineering: An Interface with Biology and Medicine, https://onlinecourses.nptel.ac.in/noc21_bt05/preview?utm_source=chatgpt.com.
2. Introduction to Biomimicry (Multi-Disciplinary), https://onlinecourses.nptel.ac.in/noc22_ge24/preview?utm_source=chatgpt.com.
3. Industrial Biotechnology, https://onlinecourses.nptel.ac.in/noc20_bt21/preview?utm_source=chatgpt.com
4. Fundamentals of Bioprocess Engineering, https://onlinecourses.nptel.ac.in/noc25_bt84/preview?utm_source=chatgpt.com.
5. Medical Biomaterials, https://onlinecourses.nptel.ac.in/noc20_bt12/preview?utm_source=chatgpt.com.

Teaching-Learning Process (Innovative Delivery Methods):

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.

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1. Flipped class
2. Chalk and talk
3. NPTEL and other videos for theory topics
4. Partial Delivery of course by Industry expert/ industrial visits
5. ICT-Enabled Teaching.
6. Activity based learning.
7. Keep fundamentals as the core teaching content.
8. Present recent trends as short "industry snapshot" segments at the end of each module (e.g., 15–20 minutes), not as examinable depth topics.
9. Use case studies, videos, or demonstrations for the advanced concepts so students see applications without getting bogged down in mechanisms.
10. Make the trends part of assessments via assignments, mini-seminars, or group presentations, so the main lecture hours focus on the basics.

Assessment Structure:
The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

- To qualify and become eligible to appear for SEE, in the **CIE**, a student must score at least **40% of 50 marks**, i.e., **20 marks**.
- To pass the **SEE**, a student must score at least **35% of 50 marks**, i.e., **18 marks**.
- Notwithstanding the above, a student is considered to have **passed the course,** provided the combined total of **CIE and SEE is at least 40 out of 100 marks**.

Continuous Comprehensive Assessments (CCA):

CCA will be conducted for a total of 25 marks. It is recommended to include a maximum of two learning activities aimed at enhancing the holistic development of students. These activities should align with course objectives and promote higher-order thinking and application-based learning.

Learning Activity - 1: Case Study / Practical Assignment (Marks – 25)

INSTRUCTIONS:

1. Course instructor will refer to relevant textbooks, NPTEL resources, or recent research articles to derive the questions for problem-solving and application.
2. Course instructor must identify problems or activities from these areas:
    - Biotechnology Fundamentals (DNA/RNA structure, biomolecules, cell ultrastructure)
    - Biotechnological Techniques (PCR, gel electrophoresis, blotting, gene transfer methods)
    - Applications (insulin production, stress-resistant plants, bioremediation, gene therapy)
    - Biomimetics Basics (natural materials, bioinspired designs)
    - Applications of Biomimetics (civil engineering, medical devices, robotics, energy systems)
3. Course instructor will assign THREE tasks from the above areas to the students for:
    - Background study of the concept
    - Experimental design or application design
    - Data collection/analysis or feasibility study
4. Students must demonstrate the solutions, experimental results, or design prototypes to the course instructor and submit the record containing:
    - Introduction & objectives
    - Methodology / approach used
    - Observations & results
    - Analysis & discussion
    - Conclusion & future scope
5. Course instructor must evaluate the student performance as per the rubrics provided for Learning Activity-1.

Rubrics for Learning Activity-1 (Case Study / Practical Assignment on Biotechnology & Biomimetics

Component & CO–PO Mapping	Outstanding (5)	Exceeds Expectations (4)	Meets Expectations (3)	Needs Improvement (2)	Unsatisfactory (1)
Clarity & Accuracy of Concept Explanation [CO1] [PO9]	Concepts are explained with complete accuracy, well-structured, and free of ambiguity; strong linkage to syllabus topics.	Concepts are clear and mostly accurate; minor ambiguity present.	Concepts are somewhat clear but lack precision; moderate ambiguity.	Concepts are vague and missing important details; high ambiguity.	Concepts are unclear, incomplete, or irrelevant to the activity.
Appropriate Use of Scientific Terminology and Experimental/Design Approach[CO2, CO4] [PO1, PO3]	Demonstrates precise and context-appropriate use of biotechnology/biomimetics terminology; experimental/design approach is innovative and well-structured.	Correctly uses terminology with minor gaps; approach is clear but not highly innovative.	Uses terminology with partial understanding or inconsistent accuracy; approach is basic.	Limited understanding of terminology; approach is unclear or weak.	No evidence of correct terminology usage or relevant approach.
Data Collection, Analysis & Interpretation	Provides accurate results/data with detailed analysis for multiple cases; comparisons highlight strengths and weaknesses clearly.	Provides correct results/data with analysis for multiple cases, though slightly less detailed.	Provides correct results/data with limited analysis; comparisons are shallow.	Provides partially correct data; minimal analysis, weak or incomplete comparisons.	Results/ data are incorrect or missing; no meaningful analysis.
Creativity & Problem-Solving in Application [CO3, CO4] [PO3, PO11]	Demonstrates outstanding creativity and innovation in applying biotech/biomimetics concepts to solve real-world problems.	Shows creativity and some innovation; solutions are practical and relevant.	Shows moderate creativity; solutions are functional but not innovative.	Minimal creativity; solutions are repetitive or unimaginative.	No creativity or problem-solving evident in the work.
Documentation & Reflection [CO1, CO4] [PO8, PO9, PO11]	Documentation is complete, well-organized, and includes deep reflection on improvements, challenges, and learning outcomes.	Documentation is complete with some reflection on refinement and learning.	Documentation is present but lacks detail or depth in reflection.	Incomplete documentation; minimal reflection.	No documentation or reflection provided as per schedule.

Suggested Learning Activities may include (but are not limited to):

- Course Project
- Case Study Presentation
- Programming Assignment
- Tool/Software Exploration
- Literature Review
- Open Book Test (preferably at RBL4 and RBL5 levels)
- GATE-based Aptitude Test
- Assignment (at RBL3, RBL4, or RBL5 levels)
- Any other relevant and innovative academic activity
- Use of MOOCs and Online Platforms

Suggested Innovative Delivery Methods may include (but are not limited to):

- Flipped Classroom
- Problem-Based Learning (PBL)
- Case-Based Teaching
- Simulation and Virtual Labs
- Partial Delivery of course by Industry expert/ industrial visits
- ICT-Enabled Teaching
- Role Play