NAVOI STATE UNIVERSITY

BX1506 BIOTECHNOLOGY — COURSE SYLLABUS

Faculty of Natural Sciences & Medicine | Department of Biology | Program: 60510100 Biology

COURSE PASSPORT & ACADEMIC METADATA

Course Code: BX1506

Course Title: Biotechnology

Course Type: Mandatory (60510100-1506)

Field of Knowledge: 500000 Science, Mathematics & Statistics

Field of Education: 510000 Biological Sciences

Academic Year: 2026–2027

Semester: V

Form of Education: Full-time

Language of Instruction: English

Benchmarked against TOP-300 Global Universities: University of Milan / Università degli Studi di Milano, Italy (QS #276)

Total Workload Allocation: 180 Hours Total (90 Classroom Contact Hours: 44 Lectures, 46 Laboratory + 90 Independent Study)

Credits: 6 ECTS

Aligned UN SDGs: SDG 2 (Zero Hunger), SDG 3 (Good Health & Well-Being), SDG 7 (Affordable & Clean Energy), SDG 9 (Industry, Innovation & Infrastructure), SDG 12 (esponsible Consumption & Production), SDG 15 (Life on Land)



1. Course Purpose & University of Milan Benchmarking Framework

This course is benchmarked against the curriculum standards of the University of Milan (Università degli Studi di Milano, QS World Ranking #276, Microbial Biotechnology Program).

It aims to equip students with comprehensive theoretical knowledge and practical expertise in microbial biotechnology, genetic and cell engineering, recombinant DNA technology, bioreactor design, immobilized biocatalysts, and agricultural/medical applications.

2. Intended Learning Outcomes (LO)

Upon completion of the course, students will acquire the following competencies:

- LO1–LO4 (Knowledge): Understanding prokaryotic and eukaryotic expression systems, central dogma regulation, bioreactor design parameters (pH, DO, agitation), enzyme immobilization, and vector systems (plasmids, phages).
- LO5–LO8 (Skills): Proficiency in recombinant DNA cloning, PCR amplification, restriction digestion, gel electrophoresis, microclonal propagation in vitro, microalgae biomass cultivation, and downstream purification (HPLC, extraction).

3. Prerequisites

Prerequisites: Cytology, Histology & Embryology (SGE11208), Microbiology and Virology (MKV13410), Fundamentals of Genetics and Genomics (GGA13410).

4. Course Structure & Workload Allocation

Semester / Academic Activity	Curriculum Focus & Unimi Benchmark Module	Workload Allocation
Semester V: Interactive Lectures (L)	44 Hours of Interactive Theoretical Instruction	44 Contact Hours
Semester V: Laboratory Work (Lab)	46 Hours of Hands-on Experimental Training	46 Contact Hours
Semester V: Independent Study	90 Hours of Analytical Projects & Literature Review	90 Hours
Total Workload (BX1506 Module)	Full Academic Module (Unimi Benchmark)	180 Hours Total (6 ECTS)

5. Detailed Course Curriculum Outline

5.1 Lecture Syllabus Outline

• L1: Fundamental Concepts & History of Biotechnology: Definitions, historical phases (Traditional, New, Modern), color classification (Green, Red, White, Blue).

• **L2: Objects of Biotechnology: Prokaryotes & Eukaryotes:** Prokaryotic vs. eukaryotic expression hosts, industrial advantages of bacteria, yeasts, and mammalian cell lines.

• **L3: Genetic Processes in the Cell:** Central Dogma of Molecular Biology: Replication, transcription, translation, and gene expression control.

• **L4: Strain Selection & Mutagenesis in Vivo:** Screening high-yield industrial strains, physical and chemical mutagenesis, super-mutant selection.

• **L5: Bioreactor Design & Fermentation Technology:** Bioreactor types, vessel design, automated control of temperature, pH, dissolved oxygen, and agitation.

• **L6: Cultivation Methods for Plant and Animal Cells:** Adherent and suspension culture methods, nutrient media formulations, cell culture scale-up.

• **L7: Downstream Processing & Product Purification:** Cell harvesting (centrifugation, filtration), cell disruption, extraction, precipitation, HPLC chromatography.

• **L8: Fundamentals of Enzyme Engineering:** Industrial biocatalysts, enzyme kinetics, thermal stability enhancement, site-directed mutagenesis.

• **L9: Industrial Applications of Immobilized Enzymes & Cells:** Immobilization matrixes (gels, carrier beads), carrier binding, continuous bioprocess economy.

• **L10: Essence of Genetic Engineering & Vector Systems:** Recombinant DNA principles, cDNA synthesis, expression vectors (plasmids, bacteriophages, YACs).

• **L11: Enzymes of Recombinant DNA Technology:** Restriction endonucleases, DNA ligases, reverse transcriptases, exonucleases, and polymerases.

• **L12: Higher Plant Cell & Tissue Culture in Vitro:** Totipotency, callus induction, somatic embryogenesis, microclonal propagation in vitro.

• **L13: Mammalian Cell Culture Applications:** Monoclonal antibody production, viral vaccine manufacturing, tissue engineering, drug toxicity assays.

• **L14: Agrobiotechnology & Transgenic Crop Development:** Bt-crops, herbicide resistance, drought/salinity tolerance, biofertilizers, biosafety regulations.

• **L15: Medical Biotechnology & Recombinant Therapeutics:** Recombinant therapeutics (human insulin, growth hormone), monoclonal antibodies, mRNA vaccines, gene therapy.

5.2 Laboratory & Practical Sessions Outline

- Safety regulations and instrumentation in a modern biotechnology laboratory.
- Sterilization techniques: Autoclaving, dry heat, membrane filtration.
- Preparation and nutrient balance of culture media for bacterial growth.
- Isolation and pure culture streak-plating of industrial bacteria.
- Isolation and cultivation of filamentous fungi and yeasts.
- Morphological and microscopic characterization of biotechnological strains.
- Assaying antibacterial and antifungal antagonistic activity of biocontrol agents.
- Evaluation of antibiotic resistance profiles in microbial strains.
- Cryopreservation, glycerol stocks, and long-term storage of culture collections.

- In vitro plant tissue culture and aseptic explant initiation.
- Cultivation dynamics of microalgae (Chlorella vulgaris, Scenedesmus).
- Bioprocess technology for biofuel production (bioethanol, biogas).

5.3 Independent Study Assignments

- Industrial enzyme production for food and detergent industries.
- Technological workflows for transgenic animal production.
- Biotechnology of organic acid fermentation (citric, acetic, gluconic acids).
- Biofuel generation dynamics and renewable energy bioprocesses.
- Industrial production of antibiotics, amino acids, and recombinant proteins.
- Monoclonal antibody synthesis, purification, and therapeutic delivery.

6. Recommended Literature & Information Sources

- Davronov Q.D., Alikulov B.S. Biotechnology (Textbook). Tashkent, 2022.
- Renneberg R. et al. Biotechnology for Beginners (3rd Ed.). Academic Press, 2023. (* Unimi Benchmark)
- Zagoskina N.V., Nazarenko L.V. Fundamentals of Biotechnology (4th Ed.). Moscow: Yurayt, 2023.
- Bo‘riyev S.B. et al. Microbial Biotechnology. Bukhara, 2024.
- Shodmonov F.Q. et al. Laboratory Manual in Microbiology and Biotechnology. Bukhara: Durdona, 2024.
- University of Milan Curriculum Portal: www.unimi.it/en/education/degree-programme-courses/2026/microbial-biotechnology