NAVOI STATE UNIVERSITY

IXT1104 INTRODUCTION TO BIOTECHNOLOGY — COURSE SYLLABUS

Faculty of Natural Sciences & Medicine | Program: 60710200 Biotechnology

COURSE PASSPORT & ACADEMIC METADATA

Course Title: Introduction to Specialty (Biotechnology)

Course Code: IXT1104

Course Type: Mandatory

Field of Study: 100000 Education

Program: 60710200 Biotechnology

Academic Year: 2026–2027

Semester: 1

Form of Education: Full-time

Language of Instruction: Uzbek

Total Workload: 120 Hours (30 hrs Lecture, 30 hrs Practical, 60 hrs Independent Study)

Credits: 4 ECTS

Aligned UN SDGs: SDG 3 (Good Health), SDG 9 (Industry & Innovation), SDG 12 (Responsible Consumption)



1. Course Description & Benchmarking Framework

This course introduces core theoretical principles and industrial applications of modern biotechnology, including bio-agent screening, fermentation systems, cell & gene engineering (CRISPR-Cas9), protein engineering, recombinant pharmaceuticals, bioprocess management, and quality assurance (GMP/ISO).

Benchmarked against world-class programs at The University of Melbourne (Master of Engineering - Biochemical), Universiti Putra Malaysia (BSc Biotechnology), and University College Dublin (Microbiology BSc), incorporating advanced modules in protein isolation, recombinant insulins/vaccines, and biocatalysis.

2. Course Aims & Learning Outcomes

Course Aim: To provide foundational knowledge and laboratory skills in bioprocess design, recombinant DNA technologies, cell culture engineering, monoclonal antibody production, and environmental bioremediation.

- Theoretical Mastery: Understand industrial producer strain selection, fermentation kinetics, bioreactor design, gene cloning vectors, CRISPR genome editing, and recombinant biopharmaceuticals.
- Laboratory Competencies: Execute plasmid DNA extraction, PCR amplification, gel electrophoresis, enzyme immobilization, ELISA assays, and antimicrobial MIC testing.
- Professional & Quality Standards: Apply Aseptic protocols, Good Manufacturing Practice (GMP), ISO standards, and microbiological quality control.
- SDG & Innovation Competencies: Design bio-based solutions for health, sustainable agriculture, and ecological bioremediation (SDG 3, SDG 9, SDG 12).

3. Prerequisites

Prerequisites: Cytology, Histology & Embryology (1108), Microbiology & Virology (1310), Fundamentals of Genetics & Genomics (1210).

4. Course Structure & Workload Allocation

Activity Type	Contact / Activity Breakdown	Total Hours Allocation
Lectures	Core Theoretical Bioprocesses	30 Hours
Practical Classes	Laboratory Protocols & Assays	30 Hours
Independent Study	Group & Individual Case Studies	60 Hours
Total Workload	Full Module (4 ECTS)	120 Hours

5. Detailed Course Curriculum Outline

5.1 Lecture Syllabus Outline

• **L1: Introduction & Trends in Modern Biotechnology:** Scope, branches (medical, industrial, agricultural, environmental), historical developments.

• **L2: Bio-agent Classification & Producer Strain Selection:** Industrial microbiology, mutant/recombinant strain screening and preservation.

• **L3: Fermentation Technology & Bioreactor Systems:** Batch, continuous, fed-batch, submerged fermentation, and fermenter engineering design.

• **L4: Cell Engineering & Tissue Culture Systems:** Plant/animal cell cultures, in vitro micropropagation, callogenesis, and organogenesis.

• **L5: Recombinant DNA Technology & Gene Cloning:** Gene isolation, restriction enzymes, vectors (plasmids, phages), and host cell transformation.

• **L6: CRISPR-Cas9 & Genome Editing Technologies:** Molecular mechanism of CRISPR-Cas9, transgenic organisms (GMOs), and biosafety.

• **L7: Protein & Enzyme Engineering:** Enzyme extraction, purification, stabilization, and industrial enzyme immobilization.

• **L8: Monoclonal Antibodies & Hybridoma Technology:** Hybridoma production, monoclonal antibodies in diagnostic ELISA and immunotherapy.

• **L9: Recombinant Hormones & Biopharmaceuticals:** Biosynthesis of recombinant human insulin, human growth hormone, and interferons.

• **L10: Modern Vaccine Biotechnology:** Recombinant DNA vaccines, mRNA vaccine technology, and viral vector platforms.

• **L11: Industrial Biosynthesis of Amino Acids & Vitamins:** High-tonnage fermentation for L-lysine, monosodium glutamate, and vitamin B12.

• **L12: Antibiotic Biotechnology & Strain Selection:** Next-generation antibiotic discovery, strain mutagenesis, and potency bioassays.

• **L13: Environmental Biotechnology & Bioremediation:** Biodegradation of xenobiotics, heavy metals, oil spills via microbes and plants.

• **L14: Quality Control, GMP & ISO Standards:** Good Manufacturing Practice (GMP), ISO certifications, and aseptic sanitary regimes.

• **L15: Bioethics, Biosafety & Global Horizons:** Ethical considerations, dual-use risks, and ecological biosafety in 21st-century biotechnology.

5.2 Practical & Laboratory Outline

- Biotechnology laboratory safety rules, aseptic techniques, and glass/media sterilization.
- Preparation, stoichiometry calculation, and autoclaving of microbial growth media and buffers.
- Aseptic streak plating, pure culture isolation, and oil-immersion microscopy.
- Bioprocess kinetics: Evaluating cell growth via spectrophotometry and plotting growth curves.
- Plant tissue culture: In vitro explant isolation and meristem micropropagation setup.
- Bacterial plasmid DNA isolation via alkaline lysis and centrifugation.
- Polymerase Chain Reaction (PCR): Primer design, reaction mix setup, and thermal cycler programming.
- Agarose gel electrophoresis for DNA fragments and SDS-PAGE for proteins.
- Enzyme immobilization in calcium alginate beads and activity comparisons.
- Enzyme-Linked Immunosorbent Assay (ELISA) setup and optical density analysis.

- Potentiometric pH measurement and buffer capacity determination in biopharmaceuticals.
- Chromatographic quality control: Thin-layer chromatography (TLC) of amino acids and antibiotics.
- Antimicrobial susceptibility testing: Kirby-Bauer disk diffusion and Minimum Inhibitory Concentration (MIC).
- Gravimetric analysis: Loss on drying measurement for lyophilized probiotic formulations.
- Airborne microbial contamination monitoring via sedimentation plating and protocols.

5.3 Independent Study & Case Study Tasks

- Group Case 1: Industrial Bioreactor Design & Sterilization SOP for recombinant insulin production (10 hrs).
- Group Case 2: In Vitro Micropropagation & CRISPR Editing for Drought/Salinity-Tolerant Crops (10 hrs).
- Group Case 3: Microbial Consortia Bioremediation System Design for Industrial Wastewater (10 hrs).
- Individual Case 4: Gravimetric Quality Assessment & Loss-on-Drying Calculations for Probiotic Powders (10 hrs).
- Individual Case 5: Troubleshooting Failed PCR Reactions & Primer Optimization Strategies (10 hrs).
- Individual Case 6: Laboratory Protocol & MIC Analysis for Novel Antibiotic Efficacy against S. aureus (10 hrs).

6. Recommended Literature & Information Sources

- Davronov Q.D., Alikulov B.S. Biotechnology (Textbook). Tashkent, 2022.
- Bo'riyev S.B. et al. Microorganism Biotechnology. Bukhara, 2024.
- Shodmonov F.Q. et al. Laboratory Manual for Microbiology. Bukhara, 2024.
- Zagoskina N.V., Nazarenko L.V. Fundamentals of Biotechnology (4th Ed.). Moscow: Yurayt, 2023.
- Renneberg R. etal. Biotechnology for Beginners (3rd Ed.). Academic Press, 2023.