NAVOI STATE UNIVERSITY

MKV13410 MICROBIOLOGY AND VIROLOGY — COURSE SYLLABUS

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

COURSE PASSPORT & ACADEMIC METADATA

Course Title: Microbiology and Virology

Course Code: MKV13410

Course Type: Mandatory

Field of Study: 500000 Natural Sciences, Math & Statistics

Field: 510000 Biological & Related Sciences

Program: 60510100 Biology

Academic Year: 2026–2027

Semesters: III & IV

Form of Education: Full-time

Language: Uzbek

Total Workload Allocation: 300 Hours Total (150 Contact Hours: 60 Lectures, 30 Practical, 60 Lab + 150 Independent Study)

Credits: 10 ECTS

Aligned UN SDGs: SDG 3 (Good Health & Well-being), SDG 15 (Life on Land)





1. Course Description & Microbiological Framework

This comprehensive course delivers an in-depth exploration of general microbiology, bacteriology, mycology, virology, environmental microbiology, and biotechnology.

Students analyze bacterial cell morphology, Gram-staining, bacterial genetics, viral replication cycles, bacteriophages, soil and aquatic microbial ecology, industrial fermentations, antibiotics, and biosafety protocols.

2. Course Aims & Practical Competencies

Course Aim: To provide solid theoretical grounding and laboratory skills in culturing, identifying, and controlling microorganisms and viruses for biological, agricultural, medical, and industrial applications.

- Microscopic & Staining Techniques: Master light/fluorescence microscopy, Gram-staining, endospore staining, and capsule staining.
- Pure Culture & Aseptic Techniques: Prepare nutrient media, perform streak-plate/spread-plate isolations, and manage autoclaving/sterilization.
- Bacterial Metabolism & Genetics: Study fermentation pathways, nitrogen fixation, bacterial transformation, conjugation, and transduction.
- Virology & Diagnostic Assays: Analyze viral morphology, plaque assays, ELISA, PCR-based viral diagnostics, and antiviral mechanisms.

3. Prerequisites

Prerequisites: Cytology, Histology & Embryology (SGE11208), Biochemistry and Molecular Biology (BVM13408).

4. Course Structure & Workload Allocation

Semester / Activity	Curriculum & Diagnostic Focus	Workload Allocation
Semester III: General Microbiology & Bacteriology	30 Lectures, 10 Practical, 20 Lab + 60 Independent	120 Hours Total
Semester IV: Virology, Microbial Ecology & Biotechnology	30 Lectures, 20 Practical, 40 Lab + 90 Independent	180 Hours Total
Total Workload (Full Academic Module)	2-Semester Comprehensive 10 ECTS Module	300 Hours Total

5. Detailed Course Curriculum Outline

5.1 Lecture Syllabus Outline

• **L1: Introduction & Historical Milestones in Microbiology:** Scope, historical discoveries (Pasteur, Koch), and role in nature and biotechnology.

• **L2: Prokaryotic Cell Morphology & Fine Structure:** Bacterial shapes, cell wall (Gram-positive vs. Gram-negative), capsule, flagella, and endospores.

• **L3: Microbial Nutrition & Transport Mechanisms:** Nutritional types (phototrophs, chemotrophs, autotrophs, heterotrophs), passive and active transport.

• **L4: Microbial Metabolism & Bioenergetics:** Respiration (aerobic/anaerobic), fermentation pathways (alcoholic, lactic, butyric), and ATP generation.

• **L5: Bacterial Growth Dynamics & Environmental Factors:** Binary fission, growth curve phases, temperature/pH/oxygen requirements, and osmotic pressure.

• **L6: Control of Microorganisms: Sterilization & Disinfection:** Physical methods (heat, radiation, filtration) and chemical agents (antiseptics, disinfectants).

• **L7: Bacterial Genetics & Gene Transfer Mechanisms:** Bacterial chromosome, plasmids, transformation, conjugation, transduction, and transposition.

• **L8: Antimicrobial Agents & Antibiotic Resistance Mechanisms:** Mechanism of action of major antibiotic classes and molecular drivers of multidrug resistance.

• **L9: Fungi and Yeasts in Microbiology:** Morphology, reproduction, classification, and industrial significance of yeasts and molds.

• **L10: Soil & Biogeochemical Microbiology:** Microbial roles in carbon, nitrogen, phosphorus, and sulfur cycles; symbiotic nitrogen fixation.

• **L11: Aquatic & Atmospheric Microbiology:** Microflora of natural waters, wastewater treatment, bioindicators, and aeromicrobiology.

• **L12: Food & Industrial Microbiology:** Microbial food spoilage, preservation techniques, fermented foods, and single-cell protein.

• **L13: Human Microbiome & Pathogenic Microorganisms:** Normal microflora, virulence factors, infection mechanisms, and host defense systems.

• **L14: Fundamentals of General Virology:** Nature of viruses, capsids, envelopes, viral genomes (DNA/RNA, SS/DS), and Baltimore classification.

• **L15: Viral Replication Cycles & Pathogenesis:** Adsorption, penetration, uncoating, biosynthesis, assembly, and release; lytic vs. lysogenic cycles.

• **L16: Bacteriophages & Phage Therapy:** Morphology and lifecycle of bacteriophages, plaque assay, and therapeutic applications.

• **L17: Plant Viruses & Phytopathology:** Transmission mechanisms, symptoms, economic impact, and plant virus control strategies.

• **L18: Animal & Human Viral Infections:** Influenza, Hepatitis, HIV, Coronaviruses, Arboviruses, and viral zoonoses.

• **L19: Diagnostic Virology & Immunological Assays:** Serological methods (ELISA, Agglutination), PCR/RT-PCR diagnostics, and cell culture propagation.

• **L20: Antiviral Therapy & Vaccination Strategies:** Mechanism of antiviral drugs, vaccine types (attenuated, inactivated, mRNA, recombinant), and herd immunity.

• **L21: Viroids, Virusoids, and Prions:** Subviral agents, infectious RNAs, proteinaceous infectious particles, and transmissible spongiform encephalopathies.

• **L22: Applied Microbiology & Environmental Biotechnology:** Bioremediation of polluted soils/water, bio-pesticides, bio-fertilizers, and microbial fuel cells.

5.2 Practical & Seminar Discussion Outline

- Microbiological laboratory biosafety rules and biosafety level (BSL-1/BSL-2) standards.
- Microscopic examination of live and stained bacterial preparations.
- Preparation and sterilization of solid, liquid, and synthetic nutrient media.
- Aseptic techniques and isolation of pure bacterial cultures via streak-plate method.
- Morphological characterization of bacterial colonies on selective and differential media.
- Evaluating physical factors (temperature, UV light, osmotic pressure) on bacterial growth.
- Quantitative determination of microbial cell count via serial dilution and spread-plate method.
- Assaying antibiotic susceptibility of bacteria using Kirby-Bauer disk diffusion method.
- Microbiological examination of soil samples and isolation of actinomycetes.
- Microbiological water quality analysis: Determining total coliform count and MPN index.
- Diagnostic identification of plant viral diseases based on symptomology and serology.
- ELISA protocol for detection of viral antigens/antibodies.
- Evaluating efficacy of chemical disinfectants and antiseptics against test strains.
- Biochemical identification of bacteria using IMViC test battery.
- Case study analysis of viral outbreaks, epidemic containment, and immunization programs.

5.3 Laboratory & Field Diagnostics Outline

- Operation and maintenance of optical compound microscopes and immersion optics.
- Preparation of fixed bacterial smears and simple staining with methylene blue/crystal violet.
- Differential Gram-staining protocol and microscopic discrimination of Gram+/Gram- bacteria.
- Endospore staining (Schaeffer-Fulton method) and capsule staining techniques.
- Preparation and autoclaving of Nutrient Agar, Nutrient Broth, and MacConkey Agar.
- Isolation of spore-forming Bacillus species from soil samples.
- Lactic acid fermentation assay using Lactobacillus starter cultures.
- Alcoholic fermentation assay using Saccharomyces cerevisiae yeasts.
- Isolation and cultivation of filamentous fungi (Aspergillus, Penicillium) on Sabouraud agar.
- Demonstration of bacteriophage plaque formation (Plaque Assay) using E. coli host.
- Isolation of nitrogen-fixing Rhizobium bacteria from legume root nodules.
- Microbiological quality control of milk and dairy products (Methylene blue reduction test).
- RNA isolation from plant viral infected tissues for RT-PCR analysis.
- Agarose gel electrophoresis of PCR-amplified viral DNA/cDNA fragments.
- Preservation and subculturing of microbial culture collections (glycerol stocks, lyophilization).

5.4 Independent Study & Analytical Projects

- Contributions of Louis Pasteur, Robert Koch, and Sergei Winogradsky to microbiology.
- Molecular architecture of bacterial peptidoglycan and cell wall synthesis inhibitors.
- Mechanisms of bacterial endospore resistance to heat and radiation.
- Bacterial quorum sensing and biofilm formation in medical/industrial settings.
- Molecular mechanisms of symbiotic and free-living biological nitrogen fixation.

- Emerging and re-emerging viral infections: Zoonotic spillovers and global biosecurity.
- Mechanism of action of mRNA vaccines and viral vector vaccines.
- Prion disease pathogenesis: Conformational changes of PrP proteins.
- Microbial bioremediation of heavy metals and petroleum hydrocarbons.
- Industrial production of antibiotics, amino acids, and recombinant proteins.

6. Recommended Literature & Information Sources

- Madigan M.T. et al. Brock Biology of Microorganisms (15th Ed.). Pearson Education, 2018.
- Willey J.M. et al. Prescott's Microbiology (11th Ed.). McGraw-Hill Education, 2020.
- Tojiboyev A. et al. Microbiology and Virology (Textbook). Tashkent: Fan, 2021.
- Baxramov I.Z. et al. General Microbiology Laboratory Manual. Tashkent: Universitet, 2022.
- NCBI Microbe Database: www.ncbi.nlm.nih.gov/genome
- World Health Organization (WHO) Biosafety Guidelines: www.who.int