OC 23 Microbiology

Code	OC 23
ECTS credits	5
Attendance time	3 Semester
Language of instruction	Ukrainian
Duration	1
Cycle	Each Winter Semester
Coordinator	Associate professor, PhD Olha Vinnikova
Instructor(s)	Lecturer Iryna Rayevska
Allocation of study programmes	Biology
Recommended prerequisites	knowledge of the disciplines of natural science
Learning objectives	- knowledge of systematics, morphology, cytology of prokaryotes, aspects of genetics of bacteria and archaea, a usage of microorganisms in industrial biotechnologies; - knowledge of interactions between microorganisms in nature; - understanding the role of microorganisms in biogeochemical cycles in the biosphere; - ability to prepare materials and sterilize laboratory glassware, skills in microbiological technique.
Syllabus	**Topic 1. Subject, Tasks, and Perspectives of Microbiology:** • Overview of microbiology: scope, objectives, and contemporary perspectives. • Historical development of microbiology and its significance. • Microbiology in the system of biological disciplines. • Microbial roles in nature and human life. • Sterility and its methods: sterilization and disinfection. **Topic 2. Microorganisms in the System of Living Beings:** • Theories on the origins of primary prenuclear cellular organisms and eukaryotes. • Prokaryotic and eukaryotic organisms: characteristics and structures. • Traditional and modern methods for microbial research.

- Principles of classification: species, strain, and clone concepts in microbiology.
- Phylogenetic systems of prokaryotes, numerical and genosystematics.
- Modern systems and determinants of bacteria, archaea, and actinobacteria.
- Binary nomenclature of species and Bergey's Determinant.

Topic 3. Shapes and Sizes of Bacteria:

- Morphological types of bacteria: cocci, bacilli, spirilla, etc.
- Detailed study of spherical, cylindrical, winding, and unique bacterial shapes.
- The trichome type of organization and multicellular complexes in bacteria.
- Minimum possible size of a prokaryotic cell and features of giant bacteria.

Topic 4. Differences in the Structure of Pro- and Eukaryotic Cells:

- Structural disparities between prokaryotic and eukaryotic cells.
- Detailed study of a prokaryotic cell: organization, chemical composition, biopolymers.
- Compartmentalization within prokaryotic cells.
- Mandatory and non-essential components of a prokaryotic cell.
- "Nuclear" apparatus organization in bacteria: nucleoid, nucleosome.
- DNA replication features in prokaryotes.
- Bacterial plasmids and their significance.
- Factors contributing to multiple drug resistance: RTF factors, colicinogenic factors.
- Ribosomal elements and differences between bacterial and eukaryotic ribosomes.
- Post-transcriptional and post-translational processing: degradosomes, chaperonins, proteasomes.
- Cytoplasmic membrane: structure, function, and significance.
- Intracytoplasmic formations within prokaryotes.
- Structure of non-unitary membranes in prokaryotes.
- Cytoskeleton of a prokaryotic cell and its components: morphoskeleton, diskeleton, endoskeleton.
- Bacterial cell wall: structure, functions, and properties.
- Peptidoglycan as a major component of bacterial cell walls: structure and functions.
- Surface S-layer of bacteria and archaea.
- Gram-positive and gram-negative bacteria: differences in cell structure and Gram staining mechanism.

Topic 5. Structure of Surface and Intracellular Structures of Prokaryotes:

- Capsule and microcapsule of prokaryotes: composition, properties, functions.
- Practical applications of mucous capsule material.

	• Surface structures of a prokaryotic cell: stalks, spines, tubular outgrowths, gas balloons, cellulasomes. • Bacterial flagella: structure, composition, and unique rotation mechanism. • Structure and function of periplasmic flagella in spirochetes. • Bacterial fimbriae: classification, structure, and functions. • Fimbriae features in archaea. • Periplasmic compartment in gram-positive and gram-negative bacteria: structure and participation in transport processes. • Bayer contacts. • Intracellular structures of prokaryotes surrounded by a unitary membrane: vacuoles, magnetosomes, chromatophores, thylakoids. • Optional intracellular structures: rapidosomes. • Intracellular structures in prokaryotic cells surrounded by a single-layer protein membrane: aerosols, chlorosomes, carboxysomes. • Spores and stages of sporulation in bacteria. • Reproduction peculiarities of prokaryotes. **Topic 6. Variability of Microorganisms and Mechanisms of Transformation:** • Variability within microorganisms. • Transformation in Diplococcus pneumoniae and other bacteria. • Influence of living conditions on transformation. • Stages of transformation and agricultural transformation. • Discovery and methods of transduction: penicillin selection method, fingerprint method. • Specific, non-specific, and abortive transduction. • Conjugation in bacteria: plus and minus forms, sex factors. • The evolutionary significance of transformation, conjugation, and transduction in bacteria. **Topic 7. Sources of Nutrition and Energy in Prokaryotes:** • Carbon sources for prokaryotes: autotrophy and heterotrophy. • Basic energy processes in prokaryotes: photosynthesis, chemosynthesis, respiration, fermentation. **Topic 8. Archaea:** • Placement of archaea in the organic world. • Biochemical and physiological differences between archaeal, bacterial, and eukaryotic cells. • Physiological groups of archaea: halobacteria, methanobacteria, thermoacidophiles. • Peculiarities of vital activity and prevalence in nature. • Industrial applications of methanobacteria. **Topic 9. Peculiarities of L-Forms, Mycoplasmas, and Related Structures:** • Structure and organization of L-forms and mycoplasmas. • Stable and labile L-forms of bacteria. • L-transformation and L-reversion: factors and processes.

- Pathogenic L-form bacteria and complications in microbiological diagnosis.
- Mycoplasmas: prokaryotes without a cell wall, structure, and unique characteristics.
- Differences between mycoplasmas and other prokaryotes.
- Reproduction, movement, and ecology of mycoplasmas.

Topic 10. Rickettsia, Chlamydia, and Actinobacteria:

- Rickettsia: obligate intracellular parasites of animals and humans.
- Pleomorphism in Rickettsia, cell structure, and metabolism.
- Transmissible diseases concept and the role of invertebrates in disease spread.
- Chlamydia: obligate intracellular energy parasites, structure, and metabolism.
- Development stages of Chlamydia: vegetative and elementary bodies.
- Diseases caused by Chlamydia and associated infections.
- Difficulty in microbiological diagnosis of Chlamydia.
- Actinobacteria: place in the organic world, general characteristics, cell structure, metabolism, and reproduction.
- Distribution of actinobacteria in nature.
- Human pathogenic forms of actinobacteria: tuberculosis, leprosy, actinomycosis.
- Immune response of the macroorganism to damage by pathogenic actinobacteria.
- Actinobacteria as producers of antibiotics, vitamins, and other biologically active substances.
- Development of bacterial populations and hyphal microorganisms.

Topic 11. Photosynthesizing and Chemosynthesizing Prokaryotes:

- Photosynthesis in bacteria and quasi-photosynthesis concept.
- Photosynthetic pigments in prokaryotes: chlorophylls, bacteriochlorophylls, carotenoids, bacteriorhodopsin, phycobiliproteins.
- Groups of phototrophic prokaryotes: green, purple bacteria, cyanobacteria, prochlorophytes, erythrobacteria, heliobacteria, halobacteria.
- Ecology of phototrophs and hydrogen bacteria: biology and application prospects.
- Groups of chemotrophic prokaryotes: nitrifying bacteria, sulfur and iron bacteria, thione bacteria, sulfate reducers, carboxybacteria, methylotrophic bacteria.
- Role of photo- and chemotrophs in nature.

Topic 12. Heterotrophy:

- Aerobic processes carried out by heterotrophs.
- Acetic bacteria and their industrial use, methods of vinegar production.
- Microorganisms involved in cellulose breakdown.
- Ammonification processes and the microorganisms responsible.

	Topic 13. Fermentation: • Historical overview: Works of L. Pasteur on lactic acid and alcoholic fermentation. • Discovery of two-phase fermentation by V.M. Shaposhnikov. • Types of fermentation: lactic acid, alcoholic, butyric, propionic, acetone-butyl, and other types. • Homo- and heterofermentative lactic acid fermentation and industrial applications. • Alcoholic fermentation: production of beer, wine, and alcohol. **Topic 14. Nitrogen Fixation in Nature:** • Mechanism of nitrogen fixation by microorganisms. • Nitrogen-fixing bacteria: symbiotic and free-living types. • Penetration mechanism of bacteria into plant tissue and infectious thread. • Free-living nitrogen fixers: azotobacter, clostridia, bacilli, cyanobacteria, and associative nitrogen fixers. • Role of diazotrophs in nature and their applications, including bacterial fertilizers. **Topic 15. Peculiarities of the Ecology of Microorganisms:** • Participation of microorganisms in substance and element cycles. • Cycles of biogenic elements: carbon, sulfur, and nitrogen. • Features of microbial ecology: commensalism, syntrophism, antagonism, parasitism, and predation among microorganisms
Literature	• Hudz S.P. Mikrobiolohiya / S.P. Hudz, S.O. Hnatush, I.S. Bilinska. Lviv: Vydavnychyy tsentr LNU im. I. Franka, 2009. • Kaprelyants L.V. Tekhnichna mikrobiolohiya / L.V. Kaprelyants, L.M. Pylypenko, A.V. Yehorova ta in. Kherson: OLDI-PLYUS, 2017. • Lyuta V.A. Mikrobiolohiya z tekhnikoyu mikrobiolohichnykh doslidzhen, virusolohiya ta immunolohiya. Pidruchnyk. / V.A. Lyuta, O.V. Kononov. K.: VSV "Medycyna", 2017. • Mikrobiolohiya: pidruch. dlya studentiv VNZ / za zah. red. N. I. Filimonovoyi. Kharkiv: Zoloti storinky, 2019. • Osnovy mikrobiolohiyi: navchalno-metodychnyy posibnyk / L.V. Dovzhenko, V.A. Zinchenko. K.: VSV «Medycyna», 2017. • Pyroh T.P. Zahalna mikrobiolohiya: Pidruchnyk / T.P. Pyroh. K: NUHT, 2010. • Praktychna mikrobiolohiya: navchalnyy posibnyk / S.I. Klymnyuk, I.O. Sytnyk, V.P. Shyrobokov; za zah. red.: V.P. Shyrobokova, S.I. Klymnyuka. Vinnytsya: Nova knyha, 2018. • Chorna T. M. Mikrobiolohiya: navch. posib. / T. M. Chorna. – Irpin, 2020. • Shyrobokov V. P. Medychna mikrobiolohiya, virusolohiya ta immunolohiya: pidruchnyk / V. P. Shyrobokov. Vinnytsya: Nova knyha, 2011.

Teaching and learning methods	Lecture (2 WH), Laboratory (3 WH)
Workload	Classroom hours: 80 h Individual study time: 70 h Total: 150 h
Assessment	The assessment consists of written examination and preliminary graded study achievements
Grading procedure	The module grade is the sum of preliminary study achievements and the examination grade
Basis for	Biology, Metabolism and Systematics of Microorganisms Biology of Mineral Nutrition of Plants Intracellular Signaling Systems and Mechanisms of Adaptation of Plants a Microorganisms Ecophysiology of Plants and Microorganisms Isolation and Identification of Microorganisms