

NATIONAL PIROGOV MEMORIAL MEDICAL UNIVERSITY, VINNYTSIA



COURSE SYLLABUS

For the training of master's students

CELL BIOLOGY

Specialty	I8 Pharmacy
Specialisation	I8.01 Pharmacy
Educational Programme	“Pharmacy, Industrial Pharmacy”, (2025, as amended in 2026)
Higher Education Level	Second (Master's)
Academic Year	2026–2027
Status of the Discipline	Elective
Language of Instruction	Ukrainian, English
Total Workload	90 hours (3 ECTS credits)
Year of Study / Semester	Year I / Semester II
Developer(s)	V.V. Rodinkova, Doctor of Biological Sciences, Professor
Instructor(s), Guest Lecturers	V.V. Rodinkova, Doctor of Biological Sciences, Professor
Venue and Contact Details	Department of Pharmacy, 56 Pyrohova Street, Vinnytsia Telephone: 55–39–52; Email: pharmacy@vnmdu.edu.ua

1. DESCRIPTION OF THE ACADEMIC DISCIPLINE

ABSTRACT

The elective course “Cell Biology” is important both for the general development of students and for the formation of the professional competence of the future pharmacist.

Cell biology is a branch of biology that studies the structural and functional organisation of prokaryotic and eukaryotic cells, the molecular mechanisms regulating cellular functions, the interaction of the nuclear and plastid genomes, and the nature and mechanisms of signal transmission that determine cell ontogenesis and the formation of intercellular connections. As one of the fundamental branches of general biology, cell biology is the theoretical basis of medicine and pharmacy and the foundation for training future pharmacists.

The subject of the elective course “Cell Biology” is the study of the most important medical and biological features of the cell, which makes it possible to define the objectives of cell biology as a field of science and an academic discipline and to analyse the influence of physicochemical, molecular genetic, structural and functional, and other cellular factors on human health. Studying the course not only supplements theoretical knowledge but also develops the practical skills needed for the further study of professional training disciplines. The relevance of the course “Cell Biology” lies in the fact that cell biology is the theoretical basis of medicine and pharmacy and the foundation for training future pharmacists.

Prerequisites for the Educational Component. The elective course “Cell Biology” builds on students’ previous study of biology with fundamentals of genetics, botany, zoology, general and inorganic chemistry, information technology in pharmacy, and Latin and Ukrainian, and is integrated with these disciplines.

PURPOSE AND OBJECTIVES

Purpose of the course and its significance for professional practice: to provide pharmacists with a strong foundation in general biology and prepare students for further study in fundamental theoretical and pharmaceutical disciplines; to develop knowledge of the structure and classification of plant, animal, bacterial, and fungal cells and their significance and applications in medicine and pharmacy; and to master methods and procedures for macroscopic and microscopic cell analysis.

Post-requisites for the Educational Component. In accordance with the sectoral higher education standard, the elective course “Cell Biology” provides a biological foundation for professionally oriented and specialist disciplines, including Pharmacognosy, Medicinal Plant Resource Studies, Educational Practice in Pharmacognosy, Medicinal Toxicology, Toxicological and Forensic Chemistry, Pharmaceutical Technology, Medicinal Cosmetic Product Technology, Biological Chemistry, and Pharmaceutical Biotechnology.

Competencies promoted by the course. In accordance with the requirements of the standard, the discipline ensures that students acquire the following competencies:

Integral: the ability to solve typical and complex specialised tasks and practical problems in professional pharmaceutical activity using the provisions, theories and methods of the fundamental, chemical, technological, biomedical and socio-economic sciences; to integrate knowledge and address complex issues, and to formulate judgements on the basis of insufficient or limited information; to communicate one’s conclusions and knowledge clearly and unambiguously, with sound justification, to specialist and non-specialist audiences.

General competencies (GC):

GC 01. Commitment to preserving the environment.

GC 02. Ability for abstract thinking, analysis and synthesis.

GC 03. Knowledge and understanding of the subject area and understanding of professional activity.

GC 04. Ability to adapt and act in a new situation. Ability to show initiative.

GC 05. Ability to communicate in the state language both orally and in writing; ability to communicate in a foreign language (preferably English) at a level that ensures effective professional activity.

GC 06. Skills in the use of information and communication technologies.

GC 07. Ability to choose a communication strategy; ability to work in a team and with experts from other fields of knowledge/types of economic activity.

GC 08. Ability to assess and ensure the quality of work performed.

GC 09. Ability to conduct research at an appropriate level.

Special (professional, subject-specific) competencies (SC):

SC 01. Ability to collect, interpret and apply the data needed for professional activity, research and the implementation of innovation projects in the field of pharmacy.

SC 02. Ability to integrate knowledge and solve complex problems of pharmacy in broad or multidisciplinary contexts.

SC 06. Ability to communicate one's own knowledge, conclusions and arguments in the field of pharmacy clearly and unambiguously to specialists and non-specialists, including those who are studying.

2. LEARNING OUTCOMES

Upon successful completion of the academic discipline, the student will be able to:

Integrative final programme learning outcomes (PLOs) promoted by the academic discipline:

PLO 01. Apply specialised knowledge and skills from general and professional disciplines in professional activity.

PLO 04. Comply with sanitary and hygienic regulations and safety requirements in professional activity.

PLO 05. Plan and carry out professional activity on the basis of the legal and regulatory acts of Ukraine and the recommendations of good pharmaceutical practices.

PLO 06. Communicate professionally in the state language; to use oral communication skills in a foreign language, analyse texts of a professional nature and translate foreign-language information sources.

PLO 07. Demonstrate the ability to search for, analyse and synthesise information independently from various sources, including professional literature, patents and databases; to evaluate it, in particular using statistical analysis; and to apply these results to solve typical and complex specialised tasks of professional activity, including the development and manufacture of medicinal products.

PLO 08. Develop and make effective decisions to solve complex pharmaceutical tasks independently and through joint discussion; formulate individual and team objectives with regard to public and production interests, overall strategy, and existing constraints; and determine the best ways to achieve these objectives.

PLO 15. Formulate, substantiate, and communicate information clearly and specifically to specialists and non-specialists, including higher education students, drawing on personal knowledge, professional experience, and the main trends in global pharmacy and related fields.

3. FORMS OF ORGANISATION OF THE EDUCATIONAL PROCESS AND THEIR SCOPE

Type of Learning Activity	Hours
Lectures:	14
Practical Classes:	16
Independent Study (IS):	60
Total	90

4. THEMATIC PLAN

№	Module and Topic Titles
Module 1 “Molecular and Cellular Level of Life Organisation”	
1	Cell biology as a science. Subject and methods of cytological research. Cell biology and its place in the system of biological sciences. The concept of the cell. History of the study of the cell. Cell theory and its significance. Cytology as a biological science and its main tasks. Methods of studying cells of living organisms.
2	Evolution of the cell. Evolution of the cell: prebiotic conditions, the first primitive cells, the origin of eukaryotic cells. General plan of cell structure in living organisms. Types of cellular organisation. Features of the structure and functioning of plant, fungal and animal cells. Diversity of cells in shape, size, biochemical properties and functions.
3	Cell membranes, their structure and functions, transport and adhesion. Differences in chemical composition between the cell and its environment. Structure and chemical composition of cell membranes. Properties of cell membranes. The plasma membrane, or plasmalemma: its structure, chemical composition and mechanism of growth. Functions of the plasma membrane. Endocytosis (phagocytosis, pinocytosis) and exocytosis. The phenomenon of adhesion and its possible mechanisms. Intercellular junctions and their diversity. Plasmodesmata. Specialised structures of the plasma membrane: microvilli, cilia, flagella, outer segments of receptor cells.
4	Cell envelopes of plants, fungi and prokaryotic cells: structure, chemical composition and functions. The role of cell envelopes, or walls, for prokaryotic cells and plant cells. The plant cell wall, its chemical composition and structure. Pits in the cell wall and their types. Formation of the cell wall. Secondary changes in the structure of the plant cell wall and their significance. Features of the structure and chemical composition of the fungal cell wall. Chemical composition and structure of the bacterial cell envelope.
5	The cell nucleus, its structure and functions. Location of the nucleus in the cell. Anucleate, uninucleate and multinucleate cells. Nucleocytoplasmic ratio. Diagram of the structure of the cell nucleus. The nuclear envelope, its structure and chemical composition. The role of the nuclear envelope in nucleocytoplasmic exchange. Nuclear matrix. Chromatin, its chemical composition and structural organisation. Heterochromatin and euchromatin. Chromatin structure during replication and transcription. Chromosomes. Morphology and ultrastructure of mitotic chromosomes. Nucleoli and their number in the cell. Chemical composition and structure of nucleoli under different functional loads. The role of nuclear structures in cell life.
6	Plastids and mitochondria: cytoplasmic organelles of energy metabolism. Mitochondria and plastids as double-membrane organelles of eukaryotic cells. Mitochondrial content in cells of different organisms. Shape and size of mitochondria and their localisation in cells. Ultrastructure of mitochondria. Functions of mitochondria; the concept of the tricarboxylic acid cycle (Krebs cycle). Plastids and their types. Structure, chemical composition and functions of chloroplasts. Photosynthetic structures of prokaryotic and lower eukaryotic cells. Semi-autonomy of mitochondria and chloroplasts. Biogenesis of energy-producing cell organelles.
7	The endomembrane (vacuolar) system of the cytoplasm. Endoplasmic reticulum, Golgi apparatus. The concept of the endomembrane (vacuolar) system of the cytoplasm and its composition. History of the discovery of the endoplasmic reticulum; its types. Granular (rough) endoplasmic reticulum: location in the cell, structural features, chemical composition, functions, principles of functioning. Characteristics of the agranular (smooth) endoplasmic reticulum. Structural, biochemical and functional organisation of ribosomes. The Golgi complex: history of discovery, content in different cell types, structure, chemical composition, functions.
8	The endomembrane (vacuolar) system of the cytoplasm. Lysosomes, peroxisomes, vacuoles. Lysosomes as membrane-bound intracellular particles. Types of lysosomes (primary lysosomes, secondary lysosomes, autophagosomes, residual bodies) and their characteristics. Microbodies and their role in the cell. Vacuoles of plant cells: their formation, chemical composition, functions.

9	The cytoplasm: its structure, functions and properties. The cytoplasm: chemical composition, structure, properties, functions. Structure of the hyaloplasm and the cytoskeleton. Cytoplasmic movements.
10	The cytoskeleton, its structure and functions. Structure and chemical nature of myofibrils and the mechanism of their contraction. Actin filaments and the cell cortex. Microfilaments: structure, chemical composition, localisation in the cell, functional significance. Intermediate filaments: chemical nature, features, functional significance. Microtubules: their structure, chemical nature, properties, functional significance.
11	The cell motility apparatus. Structure and functions of centrioles. Basal bodies, cilia and flagella and their role in the motor functions of the cell. The bacterial motility apparatus.
12	Mitosis in animal and plant cells. Alternative pathways of cell division. The significance of cell division. Features of cell division in prokaryotes. Modes of division of eukaryotic cells. Phases of the mitotic cycle (prophase, metaphase, anaphase, telophase) and their characteristics. Mitosis in the plant cell. Disturbances of mitosis and their consequences. Features of the life cycle of different cell types. Alternative pathways of cell division. Direct cell division.
13	Meiosis and its biological characteristics. Types of meiosis. Meiosis and its biological significance. Types of meiosis (gametic and sporic) and their characteristics. Characteristics of the first and second meiotic divisions.
14	The cell and developmental processes. Cell differentiation. Cell lifespan and pathology. The cell and developmental processes. Cell differentiation. Stem cells. Dependence of cell lifespan on the lifespan of organisms. Rate of cell replacement in different tissues and organs. Cell death during ontogenesis. The Hayflick limit. Two levels of cell pathology (cell destruction, changes in regulatory processes). Features of the reaction of nuclear and cytoplasmic cell components to the action of external factors. Dependence of the mitotic activity of cells on their damage. Forms of disruption of regulatory processes in the cell. Theories of cell ageing. Cell therapy as a promising method of rejuvenating the organism. Tumour growth of cells. Theories of oncogenesis. Characteristic features of the organisation of tumour cells. The possibility of cell repair.

5. FORMS AND METHODS OF ASSESSMENT OF LEARNING OUTCOMES

Ongoing Assessment during Practical Classes	Methods: oral or written assessment and testing, computer-based assessment and testing, solving of situational tasks.
Final Assessment of the Academic Discipline – Pass/Fail Assessment	Conducted during the final practical class and determined by ongoing academic performance in accordance with the Regulations on the Organisation of the Educational Process at VNMU: https://www.vnmua.edu.ua/downloads/other/polog_organiz_ocv_proc(2026).pdf
Assessment Tools for Learning Achievement	Theoretical questions, tests, situational tasks, practical assignments, demonstration of practical skills.

6. ASSESSMENT CRITERIA

Assessment of students' knowledge is carried out in accordance with the current Regulations on the Organisation of the Educational Process at National Pirogov Memorial Medical University, Vinnytsia.

([https://www.vnmua.edu.ua/downloads/other/polog_organiz_ocv_proc\(2026\).pdf](https://www.vnmua.edu.ua/downloads/other/polog_organiz_ocv_proc(2026).pdf))

Type of Assessment	Assessment Criteria / Scale
Ongoing Assessment	According to the traditional grading scale: 5 – “Excellent”, 4 – “Good”, 3 – “Satisfactory”, 2 – “Unsatisfactory”
Interim Assessments	According to the traditional grading scale
Assessment of Practical Skills	According to the traditional grading scale
Pass/Fail Assessment	According to the 200-point scale (the arithmetic mean of the grades obtained during the semester is converted into points). Passed: 122–200 points. Failed: fewer than 122 points.

GRADING SCALE: NATIONAL AND ECTS

Total Score for All Learning Activities	ECTS Grade	National Grade: Examination, Course Project (Paper), Practical Training	National Grade: Pass
180–200	A	Excellent	Passed
170–179.99	B	Good	Passed
160–169.99	C	Good	Passed
141–159.99	D	Satisfactory	Passed
122–140.99	E	Satisfactory	Passed
0–121.99	FX	Unsatisfactory, with the possibility of retaking	Failed, with the possibility of retaking
0–121.99	F	Unsatisfactory, with mandatory repetition of the discipline	Failed, with mandatory repetition of the discipline

Criteria for Assessing Students’ Knowledge

Assessment of Oral/Written Responses during Ongoing Assessment

The grade “Excellent” is awarded when a student demonstrates comprehensive knowledge of the topic, illustrating responses with a variety of relevant examples; provides complete, accurate, and clear answers without prompting or leading questions; presents the material without errors or inaccuracies; confidently solves problems and completes practical tasks of varying levels of complexity; and independently generates innovative ideas.

The grade “Good” is awarded when a student demonstrates good knowledge and understanding of the topic and provides correct, coherent, and well-structured answers, although they may not be fully comprehensive. The student answers additional questions correctly and without significant errors; successfully solves problems and completes practical tasks, experiencing difficulties only with the most complex assignments.

The grade “Satisfactory” is awarded when a student demonstrates knowledge of the overall content of the topic and a satisfactory level of understanding. With the help of guiding questions, the student is able to solve modified (simplified) problems; solves problems and completes practical tasks, although experiencing difficulties even with relatively simple assignments; is unable to formulate a coherent and systematic response independently but provides correct answers to direct questions.

The grade “Unsatisfactory” is awarded when a student’s knowledge and skills do not meet the requirements for the grade “Satisfactory”.

The assessment criteria for all other types of students’ academic work are based on the requirements of the Regulations on the Organisation of the Educational Process at National Pirogov Memorial Medical University, Vinnitsia,

([https://www.vnmu.edu.ua/downloads/other/polog_organiz_ocv_proc\(2026\).pdf](https://www.vnmu.edu.ua/downloads/other/polog_organiz_ocv_proc(2026).pdf)) and are specified in the programme of the academic discipline.

Assessment of Students’ Independent Study

Students' independent study undertaken as part of a topic alongside contact hours is assessed as part of the ongoing assessment of that topic during the relevant practical class.

The maximum number of points a student may receive upon completion of the discipline is 200 points. The minimum passing score is 122 points.

7. METHODOLOGICAL SUPPORT

Teaching and learning materials (lecture notes or extended lecture outlines), thematic plans for lectures, practical classes and independent study, assignments for ongoing assessment, methodological guidelines, and teaching manuals.

8. ACADEMIC DISCIPLINE POLICIES

The completion of learning activities and all academic work within the discipline must comply with the requirements of the Regulations on the Organisation of the Educational Process at National Pirogov Memorial Medical University, Vinnytsia; ([https://www.vnmu.edu.ua/downloads/other/polog_organiz_ocv_proc\(2026\).pdf](https://www.vnmu.edu.ua/downloads/other/polog_organiz_ocv_proc(2026).pdf)), the Regulations on the Organisation of the Educational Process for Higher Education Students Pursuing the Degree of Doctor of Philosophy at National Pirogov Memorial Medical University, Vinnytsia (https://www.vnmu.edu.ua/downloads/other/pologPhD_org.pdf); the Law of Ukraine "On Education" (Article 42); the Law of Ukraine "On Academic Integrity"; and the Code of Academic Integrity of National Pirogov Memorial Medical University, Vinnytsia (https://www.vnmu.edu.ua/downloads/other/kodex_akad_dobr_edit%202026.pdf)

Students are entitled to high-quality educational services and a safe learning environment under martial law, emergency situations and states of emergency; access to up-to-date scientific and educational information; and qualified academic guidance and support in studying the discipline and acquiring practical skills.

The Department's policy on the provision of educational services is student-centred and is based on the regulatory documents of the Ministry of Education and Science of Ukraine and the Ministry of Health of Ukraine, the University Statute, the procedures governing the provision of educational services, including in emergency situations, as stipulated by the principal regulations and administrative directives governing the organisation of the educational process at National Pirogov Memorial Medical University, Vinnytsia, as well as on the principles of academic integrity.

Academic Integrity. When studying the discipline and completing all types of learning assignments and/or research activities, students must comply with the Law of Ukraine "On Education" (Article 42), the Law of Ukraine "On Academic Integrity", and the Code of Academic Integrity of National Pirogov Memorial Medical University, Vinnytsia (University website → General Information → Key Documents → Code of Academic Integrity). In the event of a violation of academic integrity principles, appropriate measures shall be taken in accordance with the applicable regulatory documents.

Compliance with VNMU Internal Regulations and Safety Requirements during Practical Classes. At the first practical class, the instructor provides a safety briefing on appropriate conduct on the Department premises, informs students of the location of the shelter and the evacuation route to the shelter in accordance with the approved evacuation plan, explains the rules of conduct while proceeding to and remaining in the shelter, and provides instructions on all actions stipulated by the Emergency Response Plan (pursuant to Order No. 505 dated 30 August 2023). In the event of an air raid alert or any other emergency warning signal, the instructor suspends the class. The instructor and students proceed together to the shelter and remain there until the warning signal is cancelled. Once the alert has been lifted, the instructor and students either resume the class in the Department's classrooms or students independently complete the remaining learning material, which is subsequently assessed at the next class.

Requirements for Preparation for Practical Classes

Students are required to participate actively in the educational process: attend classes and come adequately prepared; complete the test tasks related to the current topic in their workbooks

and fill in the required diagrams and tables; actively participate in discussions of the class topic; complete all assignments specified in the programme; search for additional information relevant to the topic and present it to their peers.

Students are expected to arrive at classes on time. Late arrival is not permitted in accordance with the Internal Regulations for Students of VNMU. A student who arrives more than 10 minutes late is not admitted to the class and is required to make up the missed class in accordance with the established procedure.

For specialties within Field of Study I “Healthcare and Social Security”, students are required to wear a medical coat during practical classes. Students who fail to comply with this requirement are not admitted to the class.

Students are expected to be polite, courteous, and respectful in their interactions with teaching staff, other University employees, fellow students, and other persons studying at VNMU. Students must maintain a quiet and orderly environment and demonstrate appropriate conduct on the Department premises.

In its activities, the Department adheres to the principles of mutual respect and tolerance. Students are expected to uphold the same principles.

Students must comply with safety regulations while on the Department premises.

When working in teaching and research laboratories, students must comply with the applicable safety regulations (published on the website of the **Department of Pharmacy**). When completing practical assignments, students must keep their workstations clean and orderly and leave them tidy upon completion of the practical work.

Use of Mobile Phones and Other Electronic Devices. The use of mobile phones and other electronic devices during classes is not permitted, except for emergency calls or when such devices are used to present supplementary materials relevant to the topic of the class.

Absence from Classes. Missed classes must be made up in accordance with the current Regulations on the Organisation of the Educational Process at VNMU ([https://www.vnmue.edu.ua/downloads/other/polog_organiz_ocv_proc\(2026\).pdf](https://www.vnmue.edu.ua/downloads/other/polog_organiz_ocv_proc(2026).pdf)), at the times specified in the make-up schedule published on the Department of Pharmacy website, either with the instructor on duty or with the student’s regular instructor. Students must complete the assignments for the missed topic in accordance with the requirements of the discipline.

Mastery of lecture topics is assessed during practical classes, seminars (including the assessment of practical skills), and final assessment, in accordance with the Regulations on the Organisation of the Educational Process at National Pirogov Memorial Medical University, Vinnytsia ([https://www.vnmue.edu.ua/downloads/other/polog_organiz_ocv_proc\(2026\).pdf](https://www.vnmue.edu.ua/downloads/other/polog_organiz_ocv_proc(2026).pdf))

Admission to Final Assessment. The procedure for admission to final assessment in the discipline is set out in the current Regulations on the Organisation of the Educational Process at National Pirogov Memorial Medical University, Vinnytsia ([https://www.vnmue.edu.ua/downloads/other/polog_organiz_ocv_proc\(2026\).pdf](https://www.vnmue.edu.ua/downloads/other/polog_organiz_ocv_proc(2026).pdf)).

Students are admitted to final assessment provided that they have no outstanding academic requirements: the average grade for ongoing assessment must be at least 3.0 (72 points on the 120-point scale); all final sessions for the content modules must have been completed with a passing grade (“3” or higher); and all missed practical classes must have been made up with a passing grade (“3” or higher). Otherwise, the student must improve their average grade by making up unsatisfactory grades and must make up all missed classes.

Additional Points for Individual Assignments. Students may receive additional points in the discipline for the successful completion of individual assignments, the content of which is published on the Department’s website as part of the teaching and learning materials for the discipline. The number of points awarded is determined based on the results of the individual assignment in accordance with the current Regulations on the Organisation of the Educational Process at National Pirogov Memorial Medical University, Vinnytsia. ([https://www.vnmue.edu.ua/downloads/other/polog_organiz_ocv_proc\(2026\).pdf](https://www.vnmue.edu.ua/downloads/other/polog_organiz_ocv_proc(2026).pdf)).

Resolution of Conflict Situations

In the event of misunderstandings or concerns regarding the quality of educational services, assessment of academic performance, or other conflict situations involving an instructor, students should first raise their concerns directly with the instructor. If the issue remains unresolved, the student has the right to submit an appeal to the Head of the Department in accordance with the Regulations on the Consideration of Appeals from Higher Education Students at National Pirogov Memorial Medical University, Vinnytsia ([VNMU website → General Information → Key Documents](#)).

Students also have the right to contact the student self-government bodies, the administration of the Faculty (Institute), or the University administration, either directly or through the designated feedback channels (“trust boxes”), links and addresses for which are available on the official VNMU website.

The Department recognises that a student-centred approach entails students’ responsibility for the conscious and active acquisition of knowledge and for proper compliance with the rules and requirements established by applicable legislation and VNMU regulatory documents. The Department reserves the right to inform the relevant University bodies of any violations committed by students.

Policy on Blended Learning

The organisation of blended learning is governed by the Regulations on the Introduction of Elements of Distance Learning at National Pirogov Memorial Medical University, Vinnytsia ([VNMU website → General Information → Key Documents](#)). The main online learning platforms used for classes are Microsoft Teams and Google Meet.

The procedures for conducting practical classes, lectures, make-up classes, and consultations in the distance learning format are published on the Department’s webpage ([VNMU website → Department of Pharmacy → For Students/Postgraduate Students → Mode of Study → Year of Study → Teaching and Learning Materials](#)).

Communication with the Instructor. Students may contact the instructor via Microsoft Teams chat, messaging applications (Viber, Telegram, WhatsApp), or email, as determined by the instructor, during working hours.

9. LEARNING RESOURCES

Teaching and learning materials for the discipline are available on the Department’s website. The materials can be accessed via: [VNMU website → Department of Pharmacy → For Students/Postgraduate Students](#).

LITERATURE

Core Literature for Cell Biology:

1. Alberts, B., Heald, R., Hopkin, K., Johnson, A., Morgan, D., Roberts, K., and Walter, P. (2023). Essential Cell Biology. 6th ed. W. W. Norton & Company. [Publisher](#)
2. Pollard, T. D., Earnshaw, W. C., Lippincott-Schwartz, J., and Johnson, G. (2024). Cell Biology. 4th ed. Elsevier. [Publisher](#)
3. Alberts, B., Heald, R., Johnson, A., Morgan, D., Raff, M., Roberts, K., and Walter, P. (2022). Molecular Biology of the Cell. 7th ed. W. W. Norton & Company. [Publisher](#)

Supplementary Literature for Cell Biology:

1. Cooper, G. M., and Adams, K. W. (2023). The Cell: A Molecular Approach. 9th ed. Oxford University Press. [Publisher](#)
2. Lodish, H., Berk, A., Kaiser, C. A., et al. (2021). Molecular Cell Biology. 9th ed. Macmillan Learning. [Publisher](#)
3. Weinberg, R. A. (2023). The Biology of Cancer. 3rd ed. W. W. Norton & Company. [Publisher](#)

ELECTRONIC RESOURCES

University website: [National Pirogov Memorial Medical University, Vinnytsya](#)

Department website: [VNMU Departments](#) — **Department of Pharmacy**

University Library website: [VNMU Library](#)

National Scientific Medical Library of Ukraine: [National Scientific Medical Library of Ukraine](#)

World Health Organization: [World Health Organization \(WHO\)](#)

Ministry of Health of Ukraine: [Ministry of Health of Ukraine](#)

Public Health Center of the Ministry of Health of Ukraine: [Public Health Center of Ukraine](#)

English-language database of medical and biomedical literature: [PubMed](#)

English-language online resource for physicians and other healthcare professionals: [Medscape](#)

<http://www.morphology.dp.ua>

<http://library.vsmu.edu.ua>

<http://cells.at.ua>

<http://kladia.ru>

<http://nbuv.gov.ua>

www.Molbiol.ru

<http://jcb.rupress.org>

<http://www.nature.com>

<http://www.johnkyrk.com>

<http://www.biology.arizona.edu>

<http://mcb.asm.org>

The course syllabus for the academic discipline “Cell Biology” was discussed and approved at the meeting of the Department of Pharmacy (Minutes No. 1 dated 26 August 2026).

Course Coordinator:

Doctor of Biological Sciences, Professor

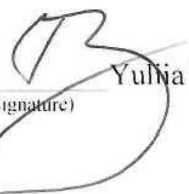


(Signature)

Viktoriia RODINKOVA

Acting Head of the Department of Pharmacy:

Candidate of Pharmaceutical Sciences, Associate Professor



(Signature)

Yulia TOMASHEVSKA