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PATHOMORPHOLOGY EDUCATION IN WARTIME UKRAINE: EDUCATIONAL NEEDS OF MEDICAL STUDENTS IN KYIV

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Medical education is undergoing substantial transformation under the influence of digital technologies, molecular medicine, and artificial intelligence. Pathology, traditionally centered on morphological analysis, is increasingly developing into an integrated discipline that combines morphological, molecular, and computational approaches. In Ukraine, this transformation is unfolding under conditions of prolonged wartime disruption, which affects access to clinical training and educational resources.

Objective. To assess the educational needs of medical students during pathology training and to evaluate changes in the perception and delivery of pathology education under wartime disruption in Kyiv, Ukraine.

Methods. A cross-sectional descriptive study was conducted using a structured questionnaire administered to third-year medical students at Bogomolets National Medical University (Kyiv, Ukraine) during the 2022/2023 and 2024/2025 academic years. The study included 514 participants. The questionnaire addressed learning resources, perceived effectiveness of educational methods, use of digital tools, and the perceived role of pathology in professional training. Data were analyzed using descriptive statistics and Pearson's χ^2 test.

Results. Pathology remained an important discipline; however, the proportion of students identifying it as a key component of medical education decreased from 78.3% to 62.2% ($p < 0.001$), while uncertainty increased. Students consistently prioritized competencies related to critical thinking, communication, and decision-making under uncertainty. Traditional learning resources remained predominant, whereas digital tools were used only moderately. Reported barriers included insufficient educational materials and limited integration of modern technologies into the educational process.

Conclusions. Pathology education in Ukraine is shifting toward a hybrid model that combines traditional and digital approaches. Although the perceived centrality of the discipline has declined, its contribution to the development of core clinical competencies remains substantial. Stronger integration of morphological, clinical, and digital components is needed to align pathology education with contemporary healthcare demands under conditions of prolonged disruption.

Key words: Education, Medical, Undergraduate, Students, Medical, Pathology, Warfare, Needs Assessment, Surveys and Questionnaires, Ukraine.

Діброва В'ячеслав, Кузик Петро. Викладання патоморфології в умовах війни в Україні: освітні потреби студентів-медиків у Києві

Медична освіта зазнає системних змін під впливом цифрових технологій, розвитку молекулярної медицини та впровадження інструментів штучного інтелекту. Патоморфологія, що історично базувалася на морфологічному аналізі тканин, трансформується в інтегровану дисципліну патологію, яка поєднує морфологічні, молекулярні та комп'ютерні підходи до діагностики й інтерпретації патологічних процесів. В Україні ці трансформації відбуваються в умовах тривалої війни, що впливає на доступ до клінічної практики, матеріально-технічну базу та безперервність освітнього процесу.

Мета дослідження – оцінити освітні потреби студентів під час вивчення патоморфології та визначити зміни у сприйнятті дисципліни й організації навчального процесу в умовах війни.

Методи. Виконано перехресне описове дослідження із застосуванням структурованої анкети серед здобувачів вищої освіти магістерського рівня третього курсу Національного медичного університету імені О.О. Богомольця (Київ, Україна) у 2022/2023 та 2024/2025 навчальних роках. Загальна кількість респондентів становила 514 осіб. Анкета включала блоки, присвячені використанню навчальних ресурсів, оцінці ефективності освітніх методів, застосуванню цифрових інструментів та визначенню ролі патоморфології у професійній підготовці. Статистичний аналіз проводили із застосуванням описової статистики та критерію χ^2 Пірсона.

Результати. Патоморфологія зберігала високу освітню значущість, однак частка студентів, які визначали її як ключову дисципліну медичної підготовки, зменшилася з 78,3% до 62,2% ($p < 0,001$). Паралельно збільшилася частка невизначених відповідей, що може відображати зміну освітніх пріоритетів або невизначеність щодо професійної ролі дисципліни. Серед компетентностей, які студенти вважали найбільш релевантними, домінували критичне мислення, клінічна комунікація та здатність до прийняття рішень в умовах невизначеності. Традиційні освітні ресурси залишалися основним інструментом навчання, тоді як цифрові технології застосовувалися обмежено. Ключовими бар'єрами визначено недостатню забезпеченість навчальними матеріалами та недостатню інтеграцію сучасних цифрових рішень у навчальний процес.

Висновки. Викладання патоморфології в Україні демонструє перехід до гібридної моделі, що поєднує класичні морфологічні підходи з цифровими інструментами. Зниження суб'єктивної оцінки центральності дисципліни не супроводжується зменшенням її значення у формуванні клінічного мислення. Подальший розвиток навчального процесу потребує системної інтеграції морфологічних, клінічних і цифрових компонентів з урахуванням обмежень, пов'язаних із тривалою війною на систему медичної освіти.

Ключові слова: додипломна медична освіта, студенти-медики, патологія, війна, освітні потреби, анкетування, Україна.

Introduction. Medical education is currently being reshaped by advances in digital technologies, molecular medicine, and the growing integration of artificial intelligence into clinical practice [1, 2]. These developments affect not only diagnostic workflows but also the principles of physician training, which is especially relevant for foundational disciplines such as pathology. In Ukraine and other Eastern European countries, this discipline has traditionally been referred to as pathomorphology, reflecting its historical emphasis on the morphological aspects of disease; in this article, the term pathology is used in accordance with international academic usage.

Pathological anatomy has long been regarded as a core medical discipline because it provides the structural basis for understanding disease. For decades, morphological analysis of tissues and organs remained the principal method for studying pathological processes and an essential component of clinical diagnostics. Classical approaches described in fundamental pathology textbooks [3] continue to underpin medical education. At the same time, contemporary pathology has evolved into an integrative discipline that combines morphological, molecular, and genetic approaches [4, 5].

The implementation of digital pathology has become one of the major drivers of educational change. Whole-slide imaging, telepathology, and artificial intelligence algorithms have considerably expanded the possibilities for histological specimen analysis [6–8]. Studies show that digital platforms improve access to educational materials and may enhance student engagement, although their effectiveness depends on how well they are embedded in the pedagogical model [6, 9].

Despite the rapid spread of digital technologies, traditional educational resources remain important. Even under conditions of digitalization, textbooks and classical microscopic analysis continue to serve as basic elements of the educational process [9, 10]. This suggests the emergence of a hybrid educational model in which conventional and innovative approaches coexist.

Another important dimension of this transformation is the integration of artificial intelligence into pathology. Machine learning algorithms show high efficiency in the diagnosis of pathological processes, which changes the role of the physician and creates new competency demands [2, 7]. In this context, critical thinking and the ability to interpret algorithm-assisted decisions become increasingly important.

In Ukraine, the transformation of pathomorphology teaching is taking place under significant external pressure. The COVID-19 pandemic was associated with a rapid expansion of distance learning [11, 12], while wartime conditions have restricted access to clinical practice and educational resources [13, 14].

Analysis of students' educational needs is an important tool for evaluating the effectiveness of the educational process. Studies indicate that adapting educational programs to student needs contributes to better training outcomes and supports the development of professional competencies [15, 16]. Assessment of these needs provides a practical basis for identifying directions for further development of pathomorphology teaching.

The aim of the study was to analyze the educational needs of medical students during the study of pathomorphology and to assess the transformation of pathology teaching under current conditions of medical education.

Materials and Methods. This study was designed as a cross-sectional descriptive survey, in line with contemporary approaches to the assessment of educational needs in medical education [13, 14].

The survey was conducted during two time periods reflecting different stages in the transformation of the educational process:

the first period – at the end of the 2022/2023 academic year (AY), characterized by the dominance of

post-pandemic educational practices and active use of distance-learning technologies;

the second period – at the end of the 2024/2025 AY, when the educational process was functioning under conditions of partial stabilization and further integration of digital tools into learning.

The study included 514 third-year students of Bogomolets National Medical University: 157 students in the first period and 357 in the second. All participants were enrolled in the specialties "Medicine" and "Pediatrics" and had completed the course "Pathomorphology".

Data were collected using a structured questionnaire implemented through Google Forms. The questionnaire included items on sources of educational information, the perceived effectiveness of different teaching methods, the use of modern educational resources, and the perceived role of the discipline in the professional training of a future physician. Some questions allowed one or more response options, whereas others used a five-point Likert scale to assess students' attitudes toward particular aspects of the educational process.

The survey link was distributed to students after completion of the course, allowing retrospective evaluation of their learning experience. Participation was voluntary and anonymous. Data were collected automatically in electronic form and exported for statistical analysis.

Content validity was ensured through analysis of current literature in medical education and expert review by pathomorphology faculty. The questionnaire was pilot-tested in a group of students to verify the clarity of wording and the logical sequence of items, after which several formulations were refined. Internal consistency of the scale items assessing attitudes toward the educational process was evaluated using Cronbach's α coefficient ($\alpha = 0.82$), indicating adequate reliability of the survey instrument.

Descriptive statistical methods were used for data analysis. Categorical variables were presented as absolute values and percentages with 95% confidence intervals. Pearson's χ^2 test was used to compare the distribution of responses between groups. Differences were considered statistically significant at $p < 0.05$. Statistical processing was performed using SPSS, and the results were presented in tables.

The study was conducted in accordance with the principles of the Helsinki Declaration, with due regard for academic integrity, confidentiality, and voluntary participation. Ethical approval was not required under local regulatory requirements because the study was based on an anonymous survey and did not involve intervention in health or the processing of personal data.

Results. The distribution of respondents by specialty is presented in Table 1.

The sample structure was generally stable across both periods: students in the specialty "Medicine" predominated in each cohort (81.5% versus 82.9%; $p = 0.803$), whereas the proportion of "Pediatrics" students decreased from 18.5% to 10.4% ($p = 0.022$) (Table 1).

According to the survey results, interest in the development of cognitive and adaptive competencies remained consistently high. Students most frequently selected critical thinking, the ability to work under pressure, and communication skills. No statistically significant changes were identified in these indicators, which suggests that they remained stable priorities regardless of educational circumstances (Table 2).

Other competencies were also selected by a substantial proportion of students. Interest in time management was reported by 44.6% of respondents in 2022/2023 AY and 43.7% in 2024/2025; responsibility by 37.6% and 39.8%; and independent decision-making by 31.8% and 30.3%, respectively. Smaller proportions of respondents emphasized teamwork, leadership, and conflict resolution (Table 2).

During preparation for classes and assessment activities, students used a range of educational resources (Table 3).

The most frequently used source of educational information remained educational literature, including textbooks and manuals, used by 86.0% of students in 2022/2023 AY and 81.8% in 2024/2025. Use of departmental methodological materials decreased from 70.1% in the first period to 57.7% in the sec-

Table 1

Characteristics of respondents by specialty

Specialty	2022/2023 AY N=157		2024/2025 AY N=357		p-value
	n	% P (95% CI)	n	% P (95% CI)	
Medicine	128	81.5 (75.1 – 87.2)	296	82.9 (78.8 – 86.6)	0.803
Pediatrics	29	18.5 (12.8 – 24.9)	37	10.4 (7.4 – 13.7)	0.022*

*Note: * p < 0.05 indicates statistical significance*

Table 2

Social skills (soft skills) of greatest interest to students

Social skills	2022/2023 AY N=157		2024/2025 AY N=357		p-value
	n	% P (95% CI)	n	% P (95% CI)	
Communication skills	79	50.3 (42.5 – 58.1)	168	47.1 (41.9 – 52.2)	0.555
Leadership skills	42	26.8 (20.1 – 33.9)	97	27.2 (22.7 – 31.9)	0.992
Sense of responsibility	59	37.6 (30.2 – 45.3)	142	39.8 (34.8 – 44.9)	0.712
Ability to work under pressure	85	54.1 (46.3 – 61.9)	172	48.2 (43.0 – 53.4)	0.251
Conflict resolution skills	26	16.6 (11.2 – 22.8)	50	14.0 (10.6 – 17.8)	0.542
Teamwork skills	37	23.6 (17.3 – 30.5)	102	28.6 (24.0 – 33.4)	0.281
Time management skills	70	44.6 (36.9 – 52.4)	156	43.7 (38.6 – 48.9)	0.928
Decision-making skills	50	31.8 (24.8 – 39.3)	108	30.3 (25.6 – 35.1)	0.795
Critical thinking skills	87	55.4 (47.6 – 63.1)	196	54.9 (49.7 – 60.0)	0.992

Table 3

Educational resources and assessment of the significance of the discipline “Pathomorphology”

Indicators	2022/2023 AY N=157		2024/2025 AY N=357		p-value
	n	% P (95% CI)	n	% P (95% CI)	
Educational materials (textbooks, manuals)	135	86.0 (80.1 – 91.0)	292	81.8 (77.6 – 85.6)	0.29
Departmental methodological materials	110	70.1 (62.7 – 77.0)	206	57.7 (52.5 – 62.8)	0.01*
Lecture notes	78	49.7 (41.9 – 57.5)	212	59.4 (54.2 – 64.4)	0.053
Online discipline-specific resources	78	49.7 (41.9 – 57.5)	161	45.1 (40.0 – 50.3)	0.39
Sample tests and assessment tasks from previous years	61	38.9 (31.4 – 46.6)	159	44.5 (39.4 – 49.7)	0.268
Scientific literature (monographs, articles)	13	8.3 (4.5 – 13.1)	27	7.6 (5.1 – 10.5)	0.92
Pathomorphology is important for the future profession	123	78.3 (71.6 – 84.4)	222	62.2 (57.1 – 67.1)	<0.001*
Pathomorphology is not important for the future profession	11	7.0 (3.6 – 11.5)	28	7.8 (5.3 – 10.9)	0.881
Undecided	23	14.6 (9.6 – 20.6)	107	30.0 (25.3 – 34.8)	<0.001*
Students receive information about assessment criteria, rules, and procedures	114	72.6 (65.4 – 79.3)	254	71.1 (66.3 – 75.7)	0.818
Only upon request from the instructor	32	20.4 (14.5 – 27.0)	81	22.7 (18.5 – 27.2)	0.639
No information provided	11	7.0 (3.6 – 11.5)	22	6.2 (3.9 – 8.9)	0.873

*Note: * – $p < 0.05$ indicates statistical significance*

Table 4

Factors complicating the educational process at the Department of Pathological Anatomy

Indicators	2022/2023 AY N=157		2024/2025 AY N=357		p-value
	n	% P (95% CI)	n	% P (95% CI)	
Lack of adequate learning conditions	36	22.9 (16.7 – 29.8)	52	14.6 (11.1 – 18.4)	0.034*
Insufficient educational materials	38	24.2 (17.8 – 31.2)	107	30.0 (25.3 – 34.8)	0.212
Outdated departmental information resources	36	22.9 (16.7 – 29.8)	108	30.3 (25.6 – 35.1)	0.106
Limited integration of information technologies and technical resources	30	19.1 (13.4 – 25.6)	84	23.5 (19.3 – 28.1)	0.313
Insufficient number of practical sessions	16	10.2 (6.0 – 15.4)	47	13.2 (9.9 – 16.9)	0.413
Lack of professionalism among instructors	11	7.0 (3.6 – 11.5)	14	3.9 (2.2 – 6.2)	0.219
No barriers to the learning process	66	42.0 (34.4 – 49.8)	152	42.6 (37.5 – 47.7)	0.984

*Note: * – $p < 0.05$ indicates statistical significance*

ond (p = 0.01), which may reflect a shift in learning strategies.

Lecture notes also remained a common source of information, used by 49.7% of students in 2022/2023 and 59.4% in 2024/2025. This likely reflects increased reliance on structured and condensed learning materials. The proportion of students using online resources, including electronic textbooks and discipline-specific platforms, was 49.7% in the first period and 45.1% in the second. In addition, 38.9% of students in 2022/2023 and 44.5% in 2024/2025 reported using sample tests and previous assessment tasks during preparation (Table 3). Some respondents also indicated a need for broader use of modern educational technologies, including digital pathology, interactive platforms, and visualization tools.

Assessment of the perceived significance of "Pathomorphology" for future professional activity showed that 78.3% of students in 2022/2023 considered it important for physician training (Table 3). In 2024/2025, this proportion declined to 62.2% ($p < 0.001$). The proportion of students who considered the discipline unimportant remained low, at 7.0% in the first period and 7.8% in the second. At the same time, the proportion of respondents who were undecided increased from 14.6% to 30.0% ($p < 0.001$), indicating a less definite perception of the discipline's role in the contemporary educational context.

The survey also explored students' awareness of academic assessment criteria and procedures. Most students reported that they received information about the rules and criteria for assessment: 72.6% in 2022/2023 and 71.1% in 2024/2025. At the same time, 20.4% of students in the first period and 22.7% in the second stated that they received such information only after contacting the instructor directly. The proportion reporting no such information was 7.0% and 6.2%, respectively (Table 3).

Among the factors complicating learning at the Department of Pathological Anatomy, students most often identified an insufficient number of educational materials, outdated departmental information resources, inadequate learning conditions, and limited implementation of information technologies in the educational process (Table 4). Insufficient educational materials were reported by 24.2% of students in 2022/2023 and 30.0% in 2024/2025, whereas outdated departmental information resources were reported by 22.9% and 30.3%, respectively.

Inadequate learning conditions were reported by 22.9% of respondents in the first period and 14.6% in the second. The proportion drawing attention to insufficient use of information technologies and technical learning tools was 19.1% in 2022/2023 and 23.5% in 2024/2025 (Table 4).

Smaller proportions of students identified an insufficient number of practical sessions (10.2% and 13.2%, respectively) and lack of instructor professionalism (7.0% and 3.9%). At the same time, a considerable proportion of respondents reported that no factors complicated the learning process: 42.0% in 2022/2023 and 42.6% in 2024/2025 (Table 4).

Discussion. The findings suggest that pathology education in Ukraine is undergoing a measurable structural shift under conditions of prolonged wartime disruption. The decrease in the proportion of students

who explicitly identify pathology as a key discipline, together with the marked rise in uncertainty, appears to reflect a redistribution of perceived curricular relevance rather than a true decline in the value of the discipline itself. This trend is consistent with broader changes in medical education, where curriculum design increasingly emphasizes clinical exposure and applied competencies, sometimes making the role of foundational sciences less visible [15, 16].

At the same time, the structure of students' educational needs points to a stable demand for competencies that are closely linked to pathology training. Critical thinking, decision-making under uncertainty, and communication remained among the most frequently prioritized competencies, suggesting that pathology still functions as an important cognitive framework for clinical reasoning. This interpretation is supported by studies showing that pathology education contributes to diagnostic thinking and integrative clinical interpretation across disciplines [14, 17]. The gap between declining perceived importance and preserved functional relevance likely reflects a change in educational framing: students continue to value the competencies, even if they are less likely to associate them explicitly with the discipline.

Changes in the use of learning resources further support this interpretation. Although textbooks remain the dominant source of information, decreased reliance on departmental methodological materials and greater use of lecture-based and alternative resources suggest a move toward more individualized and adaptive learning strategies. Similar patterns have been described in studies of digitalization and student learning behavior, where learners increasingly combine multiple sources of information instead of following a single structured pathway [18, 19]. This does not suggest replacement of traditional resources; rather, it points to their repositioning within a more flexible learning environment.

Despite the global expansion of digital pathology, its integration into the educational process in this cohort remained incomplete. This differs from international trends, where digital tools are being progressively incorporated into both teaching and assessment [6]. Existing studies show that digital pathology platforms can improve accessibility, standardization, and student engagement, particularly in visually intensive disciplines [6, 8]. Their effectiveness, however, depends on structured pedagogical integration rather than simple availability [20]. The moderate uptake observed here suggests that implementation remains fragmented and has not yet become a coherent curricular component.

The coexistence of traditional microscopy and emerging digital tools in this study supports the formation of a hybrid educational model. In such a model, conventional approaches provide the basis for morphological understanding, whereas digital platforms improve accessibility and scalability. Available evidence suggests that exclusive reliance on either modality may constrain learning outcomes, especially in disciplines requiring both visual interpretation and conceptual integration [9, 10]. The present data therefore favor gradual integration rather than substitution.

The increasing role of artificial intelligence adds another layer of complexity to pathology education. Although AI-based systems demonstrate high diagnostic performance [3,7], their incorporation into training environments raises legitimate concerns about automation bias and reduced analytical engagement [21]. Under these conditions, the ability to critically interpret algorithm-assisted outputs becomes an essential competency. The stable prioritization of critical thinking and decision-making in this study is therefore notable and may indicate that students already perceive, at least indirectly, the limits of automated systems in clinical reasoning.

The educational environment in which these changes occur is strongly shaped by external constraints. Wartime conditions impose continuing limitations on access to clinical training, infrastructure, and educational resources, affecting both learning opportunities and students' perceptions of disciplinary relevance. Previous studies have documented similar disruptions in medical education under crisis conditions, including reduced clinical exposure and fragmentation of training pathways [11, 12]. The present findings extend this evidence by showing how such constraints are reflected in measurable shifts in educational priorities and learning behavior.

The barriers identified by students, including insufficient educational materials and limited implementation of digital technologies, are in line with broader challenges associated with the digital transformation of higher education [17]. In addition, the absence of coordinated integration strategies likely reduces the educational value of available resources and may contribute to the fragmentation observed in the learning process [22]. These findings indicate that infrastructural limitations and pedagogical inconsistency remain important obstacles to the modernization of pathology education.

Taken together, these findings suggest that pathology education is in a transitional stage marked by the coexistence of established and emerging approaches. Although the explicit positioning of the discipline within the curriculum is changing, its contribution to the development of core clinical competencies

remains substantial. The central challenge is not to redefine the discipline, but to align its delivery with contemporary educational and clinical needs under conditions of systemic disruption.

From an educational perspective, these findings support stronger integration between pathology and clinical disciplines, as well as more structured incorporation of digital technologies into teaching. Interdisciplinary educational models have been shown to improve both learning outcomes and the perceived relevance of foundational sciences [19]. Likewise, digital and virtual microscopy can expand access to standardized materials and support skill acquisition in resource-constrained settings [23]. Evidence from histology and pathology education also suggests that blended learning models combining digital and traditional approaches offer an effective balance between flexibility and educational quality [24]. In parallel, the post-pandemic evolution of medical education indicates a sustained move toward technology-enhanced learning environments in which digital tools complement rather than replace established pedagogical frameworks [25].

This study has several limitations. The data were obtained from a single institution, which may restrict generalizability. In addition, the use of self-reported measures introduces the possibility of response bias. Even so, the consistency of findings across two independent time periods and the size of the sample support the reliability of the trends observed.

In conclusion, pathology education in Ukraine is being reconfigured under conditions of prolonged disruption. Although students' explicit evaluation of the discipline is changing, its role in the formation of essential clinical competencies remains evident. Future educational strategies should focus on integrating morphological, clinical, and digital components so that pathology can maintain its foundational role in medical training within rapidly changing environments.

Conclusions:

1. The study confirms that pathomorphology retains significance in the professional training of future physicians; however, the proportion of students who unequivocally regard it as a key discipline has decreased, while uncertainty has increased.
2. Traditional learning resources, including textbooks and microscopic analysis, continue to predominate, whereas the use of digital materials remains moderate, reflecting the emergence of a hybrid educational model.
3. Competencies related to critical thinking, communication, and the ability to function under conditions of uncertainty remain priorities for students, in line with the contemporary competency-based model of medical education.
4. Barriers to the educational process were identified, particularly the insufficient number of educational materials and limited implementation of digital technologies, both of which may reduce learning effectiveness.
5. The findings support further modernization of pathomorphology teaching through closer integration of morphological analysis, clinical reasoning, and digital tools.

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