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Current trends in the teaching of pathomorphology in medical universities: a comparative analysis of Ukrainian and European educational standards

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Pathomorphology remains a fundamental component of medical education, providing an essential understanding of the structural basis of disease and fostering clinical reasoning skills. In modern medical education in both Ukraine and Europe, curricula are being transformed in line with the principles of a competency-based approach, requiring revision of content, teaching methods, and learning formats. The relevance of this study lies in the need to harmonize Ukrainian educational standards with European frameworks, identify strengths and weaknesses of national medical training, and implement innovative technologies in the teaching of morphological disciplines. The COVID-19 pandemic and the ongoing war have accelerated the digital transformation of medical education, particularly through distance learning, virtual microscopy, interactive case studies, and simulation-based methods.

Aim – to conduct a comparative analysis of approaches to teaching pathomorphology in medical universities of Ukraine and the European Union, to assess the compliance of Ukrainian curricula with international standards, and to develop recommendations for modernization.

Comparative, content, expert evaluation, system-structural, and descriptive statistical methods were applied. European universities operate within clearly defined competency frameworks encompassing knowledge, practical skills, communication abilities, and clinicopathological integration. Digital pathology, simulation training, and e-learning platforms play a crucial role. In Ukraine, pathomorphology has a strong theoretical foundation, but limited integration of digital tools and practical training. The main challenges include excessive theoretical focus, lack of interactive learning, and absence of unified assessment criteria for practical skills.

Conclusions. Modernization of pathomorphology teaching in Ukraine should involve the introduction of virtual microscopy, creation of a national competency framework aligned with European standards, updating course content with molecular pathology and digital medicine, development of simulation technologies, and expansion of academic mobility. These steps will enhance medical education quality and promote integration of Ukrainian pathology schools into the European educational space.

The authors declare that there is no conflict of interest.

Keywords: pathomorphology, medical education, competency-based approach, digital pathology, virtual microscopy, European standards, curriculum harmonization, distance learning, theory-practice integration.

Сучасні тенденції викладання патоморфології у медичних університетах: порівняльний аналіз українських та європейських освітніх стандартів

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Патоморфологія залишається фундаментальною складовою підготовки лікарів, забезпечуючи розуміння структурних основ хвороби та формування клінічного мислення. У сучасній медичній освіті України та Європи відбувається трансформація навчальних програм відповідно до принципів компетентнісного підходу, що потребує оновлення змісту, методів і форм викладання. Актуальність дослідження зумовлена необхідністю гармонізації українських освітніх стандартів із європейськими, визначенням сильних і слабких сторін системи підготовки майбутніх лікарів та впровадженням інноваційних технологій у навчання морфологічних дисциплін. Пандемія COVID-19 і воєнний стан прискорили цифрову трансформацію освіти, зокрема розвиток дистанційного навчання, віртуальної мікроскопії, інтерактивних кейсів і симуляцій.

Мета – здійснити порівняльний аналіз підходів до викладання патоморфології у медичних університетах України та Європейського Союзу, оцінити відповідність вітчизняних програм міжнародним стандартам і сформувати рекомендацій щодо модернізації.

Використано порівняльно-аналітичний, контент-аналіз, метод експертних оцінок, системно-структурний і статистичний методи. Європейські університети діють у межах competency frameworks, що охоплюють знання, практичні навички, комунікацію й клініко-патологічну інтеграцію. Значну роль відіграють цифрова патологія, симуляційне навчання та навчальні платформи. В Україні патоморфологія має потужну теоретичну базу, але рівень інтеграції цифрових інструментів та практичної підготовки залишається обмеженим. Основні проблеми - надмірна теоретизація, нестача інтерактивних методів, відсутність уніфікованих критеріїв оцінювання практичних навичок.

Висновки. Модернізація української патоморфологічної освіти має відбуватися через впровадження віртуальної мікроскопії, створення компетентнісної рамки, оновлення змісту курсу з урахуванням молекулярної патології та цифрової медицини, розвиток симуляційних технологій і академічної мобільності. Це забезпечить якісну підготовку лікарів та інтеграцію української медичної освіти в європейський простір.

Автори заявляють про відсутність конфлікту інтересів.

Ключові слова: патоморфологія, медична освіта, компетентнісний підхід, цифрова патологія, віртуальна мікроскопія, європейські стандарти, гармонізація програм, дистанційне навчання, інтеграція теорії і практики.

Pathomorphology continues to occupy a leading position in the training of future physicians, as it provides a profound understanding of the morphological foundations of diseases and serves as a basis for clinical reasoning, diagnosis, and treatment. In most European countries, pathology curricula are being modernized in accordance with a competency-based approach and clearly defined learning outcomes, which contribute to the development of practically oriented skills in graduates [12].

In Ukraine, pathomorphology is also a mandatory component of medical education, implemented through departmental educational and working programs. At the same time, certain discrepancies are observed between Ukrainian medical universities' curricula and contemporary European models in terms of teaching hours, assessment approaches, and competency formation. This necessitates a systematic comparative analysis to identify gaps and determine ways to harmonize Ukrainian programs with European standards. In this context, not only updating the curriculum content but also enhancing the professional expertise of instructors implementing these programs is crucial. As noted by N.I. Elagina, the development of pedagogical competence and academic mobility of faculty members is an essential condition for the effective implementation of modern approaches to medical education, both in Ukraine and abroad [3].

Recent events (the COVID-19 pandemic and military aggression in Ukraine) have significantly accelerated the integration of distance and virtual technologies into pathomorphology education. The use of virtual microscopy, online lectures, and interactive clinical cases has transformed traditional practical approaches and emphasized the need to evaluate the effectiveness of new methods in ensuring the quality of student training. Simultaneously, the war and post-pandemic context impose additional requirements on the resilience of educational programs and flexibility of instruction [8]. This is confirmed by international studies, including the work *«E-learning and the virtual transformation of histopathology teaching during COVID-19»* (Griffith University, Australia), which demonstrated that a full transition to online formats not only did not reduce student academic performance but also lowered participation barriers and increased learning satisfaction [13].

Furthermore, a systematic review of virtual reality in medical education in Ukraine indicates the positive impact of virtual reality (VR) and augmented reality (AR) technologies on learning interactivity, while also highlighting technological, financial, and physiological challenges (e.g., visual strain) [9,10].

In the context of globalization of medical education and Ukraine's integration into the Bologna Process, there is a need to harmonize learning outcomes, ensure their comparability, and enhance the quality of the educational process, particularly in teaching pathomorphology as a core medical discipline. Conducting a comparative analysis of Ukrainian and European educational standards allows for the assessment of curricula alignment with key competencies, identification of areas for improvement, and formulation of practical recommendations to enhance the training quality of future physicians.

Therefore, the study of contemporary approaches to teaching pathomorphology is timely and crucial for the development of medical education in Ukraine, the preservation of national scientific traditions, and their integration into the European educational space.

The aim of this study is to conduct a comprehensive comparison of current approaches to teaching pathomorphology in Ukrainian and European medical universities with the objectives to:

– identify the core components of educational standards applied in European pathology programs;

– assess the alignment of Ukrainian pathomorphology curricula with international standards, highlighting strengths and gaps;

– determine trends and innovations in pathomorphology education, including distance and hybrid learning, virtual microscopy, simulation technologies, educational virtual cases, and interactive teaching methods;

– «develop recommendations for updating Ukrainian educational programs in pathomorphology.»

The study materials included the curricula and syllabi of pathomorphology courses from medical universities in Ukraine and European Union (EU) countries, educational standards and methodological guidelines, as well as the results of a survey of faculty members of departments of pathological anatomy. The research employed comparative-analytical methods, content analysis, expert evaluation, system-structural approaches, and descriptive statistical techniques.

In most European universities, clear competency frameworks have been developed for each discipline, including pathomorphology, which define the expected knowledge, skills, and abilities of students. These frameworks cover understanding morphological changes in tissues, proficiency in working with histological specimens, skills in microscopic diagnostics, analysis of histopathological images, and interdisciplinary collaboration with clinical specialists (e.g., according to the «Consensus Guidelines for Practical Competencies in Anatomic Pathology») [11].

A key component of modern teaching is the implementation of innovative technologies (virtual microscopy, digital platforms, online courses, and simulation methods), which enhance the development of practical skills and the assessment of students' knowledge. The European Society of Pathology (ESP) actively supports these approaches by organizing webinars, interactive courses, and educational modules in both online and in-person formats. Particular attention is paid to quality assurance in education through standardized examinations, self-assessment systems, regular feedback, and continual updates of course content in accordance with current scientific advances [5].

Against this background, the Ukrainian system of pathomorphology education demonstrates certain specific features and differences.

In Ukraine, pathomorphology is included among the mandatory disciplines for the training of future physicians and is taught according to the curricula and syllabi of university departments. However, some discrepancies can be observed between domestic programs and modern European standards regarding the structure of academic workload, approaches to assessment, and the scope of competencies developed. This highlights the need for a systematic comparative analysis to identify gaps and harmonize Ukrainian educational practices with European requirements.

Typically, curricula of Ukrainian medical universities are based on standard programs provided by the Ministry of Health of Ukraine, but they often include fewer practical sessions and insufficiently cover modern areas of the discipline, such as histochemical and molecular pathology techniques.

In terms of modern technology implementation, some departments actively use Learning Management Systems (LMS) platforms (such as Moodle), multimedia materials, and electronic microphotograph albums. Nevertheless, the utilization of virtual microscopy and digital images in the educational process remains limited. For example, the Departments of Pathological Anatomy at Bukovinian State Medical University [2] and Kharkiv National Medical University (KhNMU) implement contemporary educational initiatives, including the creation of electronic microphotograph albums, while at KhNMU, additional textbooks have been developed for English-speaking students. These initiatives indicate the gradual modernization of teaching and alignment of the educational process with international standards.

Particular challenges have arisen under conditions of martial law, which have limited access to laboratory facilities, complicated the use of material and technical resources, and necessitated a shift to distance or hybrid learning formats. In such circumstances, the development of digital educational tools, the adoption of flexible teaching approaches, and the creation of effective student support systems become especially important. Similar challenges have been highlighted in international studies, such as a publication in Diagnostics (MDPI, 2022) [7], which emphasized that one of the main barriers to virtual pathology education is limited access to laboratory equipment and the difficulty of acquiring practical skills in a remote format.

The Table presents a comparative analysis of the strengths and weaknesses of the pathomorphology teaching system in Ukraine.

The strengths of Ukrainian pathology programs include a solid theoretical foundation based on the classical school of pathological morphology, access to material and technical resources such as histology laboratories, and the high scientific level of the academic staff. An important positive aspect is the use of English in teaching, which facilitates the integration of international students and enhances the global attractiveness of Ukrainian medical education. The availability of methodological materials and manuals ensures a systematic approach to conducting practical sessions.

At the same time, several weaknesses have been identified, including insufficient implementation of innovative technologies, such as digital pathology or virtual microscopy, and limited use of interactive and problem-based learning methods. The assessment system remains predominantly theoretical, while students' practical skills are evaluated less systematically. There is also a lack of unified competency standards across different universities, which complicates the standardization of learning

Table

Comparison of strengths and weaknesses of pathomorphology teaching in Ukraine

Analysis criterion	Strengths of Ukrainian programs	Weaknesses of Ukrainian programs
Theoretical training	Well-developed theoretical foundation, in-depth study of classical pathological morphology	Excessive focus on theoretical knowledge, limited number of interactive tasks
Practical component	Availability of histology laboratories, opportunities to work with real microscopic specimens	Limited use of modern digital technologies (virtual microscopes, digital databases)
Teaching staff	High qualification level of instructors, scientific potential of pathology departments	Insufficient international experience exchange, need to improve the digital literacy of instructors
Language training	Active use of English in teaching, availability of courses for international students	Lack of standardized English-language materials, difficulties in translating terminology
Methodological support	Availability of methodological guidelines, albums of microscopic specimens, multimedia materials	Not all materials are updated according to new European requirements and standards
Educational technologies	Use of LMS platforms (Moodle, Google Classroom) for lectures and tests	Insufficient integration of innovative technologies (virtual cases, simulation-based learning)
Knowledge assessment	Structured systems for ongoing and final evaluation are in place	Mainly theoretical assessment, less focus on practical skills and clinical-pathological correlations
Student mobility	Potential to participate in international projects and exchange programs	Limited student participation in academic mobility programs due to differences in curricula
Standardization of competencies	Certain compliance with national educational standards of the Ministry of Health of Ukraine	Insufficient harmonization with European educational models and competency-based learning

outcomes. Additional challenges include limited student mobility and the non-recognition of some practical training completed abroad.

Collectively, these factors outline directions for further improvement of pathology education in Ukraine and its harmonization with European educational standards.

Trends and innovations. There is currently a growing role of distance and blended learning formats in teaching pathology, implemented through a combination of online lectures, video analysis of histological specimens, and the use of virtual laboratories. This approach has become especially relevant under martial law conditions, where conducting traditional laboratory sessions is often difficult or impossible [6].

Simultaneously, digital pathology is being implemented as an innovative educational tool, involving the use of scanned histological images and virtual microscopes. This allows students and instructors to analyze specimens collaboratively, both in-person and remotely, ensuring flexibility in the learning process. Such approaches fully align with the ESP recommendations regarding the digital transformation of medical education [4].

Methodologically, the importance of a competency-based approach is increasing, which entails clearly defined learning outcomes, transparent assessment criteria covering not only theoretical knowledge but also practical skills, clinical reasoning, and professional values. This is consistent with the concept of competency-based medical education (CBME) [13].

Moreover, curriculum development emphasizes an optimal balance between theoretical and practical components, with a growing need to increase laboratory hours, sectional courses, and clinical-pathological correlations that enable students to integrate theoretical knowledge with practical experience.

Recommendations:

– integrate virtual microscopy as an essential part of laboratory training in all medical universities;

– harmonize competency standards at the national level by developing competency frameworks modeled on European examples, with clearly defined requirements for theoretical knowledge, practical skills, digital literacy, and clinical orientation;

– systematically update educational content, considering modern advances in molecular pathology, histochemistry, medical informatics, and digital visualization;

– expand opportunities for students to undertake part of their practical training or internships in European institutions or under instructors with international experience to promote academic mobility;

– improve the professional competencies of instructors in distance learning technologies, digital pathology, the creation of educational digital materials, and the development of pedagogical resilience to work under stress or constraints (e.g., during wartime).

In summary, the strengths of Ukrainian pathology education provide a solid foundation that can be effectively modernized through the integration of innovative technologies, digital tools, and standardized competencies in line with European requirements.

Conclusions

According to the objectives of this study, the following conclusions were drawn.

1. Identification of educational standard components: European universities use clear competency frameworks encompassing knowledge of morphology, practical skills in handling histological specimens, microscopic diagnostics, and integration with clinical practice.

2. Compliance of Ukrainian programs with international standards: Ukrainian curricula provide basic theoretical training but have fewer practical sessions, limited use of digital technologies, and insufficient harmonization of competencies across universities.

3. Current trends and innovations: distance and blended learning formats, digital pathology, virtual microscopes, simulation technologies, interactive cases, and competency-based approaches are becoming key tools for modernizing pathology education.

4. Recommendations for updating Ukrainian programs: implementing virtual microscopy, harmonizing competency standards, regularly updating course content, promoting academic mobility, and enhancing instructor qualifications will help align the Ukrainian educational system with international standards.

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