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Transforming Histology and Biomedicine Education Through Modern Digital and Active-Learning Methods: Evidence from Medical Student Cohorts

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Abstract

Background: Histology is a foundational discipline in biomedical education, yet conventional microscopy-based methods increasingly fail to engage contemporary medical students or to develop higher-order diagnostic reasoning. **Methods:** This study compared five instructional approaches — traditional microscopy (TM), virtual microscopy (VM), blended learning (LM+VM), problem-based learning (PBL), and gamification — in 220 first- and second-year medical students at the Fergana Medical Institute of Public Health. Pre- and post-intervention scores, student satisfaction, and qualitative feedback were recorded. **Results:** Blended learning achieved the highest post-intervention score (83.2 ± 5.0%) and satisfaction (91.2%), followed by VM and PBL. All modern methods significantly outperformed TM. **Conclusion:** Integrating digital and active-learning strategies into histology and biomedicine curricula substantially improves academic outcomes and student engagement.

Keywords: *virtual microscopy; blended learning; histology education; problem-based learning; medical students; gamification; biomedical curriculum*

INTRODUCTION

Histology — the microscopic study of tissue organization and cellular architecture — occupies a critical position in undergraduate biomedical and medical education. Mastery of histological principles underpins sound understanding of physiology, pathology, pharmacology, and clinical reasoning [1], [2]. Yet, despite its recognized importance, histology is paradoxically among the subjects students most frequently identify as demanding, abstract, and difficult to contextualize within patient care [3].

For more than a century, histology instruction rested on two pillars: didactic lectures and glass-slide laboratory sessions using light microscopes [4]. Although this dual model was grounded in established learning theory — procedural skill acquisition through repeated practical exposure — its limitations have become increasingly apparent. Access to high-quality slides is constrained by geography and institutional resources; physical microscopes deteriorate; and the passive nature of traditional laboratory work provides limited opportunities for the analytical, problem-solving engagement required by modern competency-based frameworks [5], [6].

The arrival of whole-slide imaging (WSI) technology in the 1980s and its subsequent democratization through high-bandwidth internet access produced the paradigm of virtual microscopy (VM), enabling digitized tissue slides to be explored on-screen at any magnification [7]. Systematic evaluations have documented that VM is non-inferior — and frequently superior — to traditional microscopy (TM) in terms of assessment performance, self-directed learning, and student satisfaction [8]–[10]. Blended models that combine light microscopy with VM have emerged as particularly promising, reconciling hands-on tactile experience with the flexibility and richness of digital resources [11], [12].

Simultaneously, the pedagogical landscape has shifted toward active-learning methodologies. Problem-based learning (PBL), introduced at McMaster University in the 1960s and now internationally adopted, places students as active investigators of authentic clinical scenarios, thereby promoting critical thinking and self-regulated learning [13], [14]. Case-based learning (CBL) operationalizes similar principles through structured patient vignettes and has been endorsed as a bridge between pre-clinical science and clinical reasoning [15]. More recently, gamification — the integration of game design elements such as points, leaderboards, and immediate feedback into educational contexts — has attracted interest for its capacity to sustain motivation and improve knowledge retention among digital-native learners [16], [17]. Augmented reality (AR) and artificial intelligence (AI)-assisted tools represent the next frontier. AR overlays three-dimensional anatomical models onto laboratory environments, while AI-powered platforms adapt to individual learning trajectories, flag misidentified tissue structures, and generate personalized formative assessments [18], [19]. Despite these innovations, evidence comparing multiple instructional modalities in a single controlled setting — particularly within Central Asian medical universities — remains sparse.

The present study was conducted at the Fergana Medical Institute of Public Health, Uzbekistan, to evaluate and compare five instructional methods for teaching histology and biomedical sciences to first- and second-year medical students. The primary outcomes were academic performance (pre- and post-intervention assessment scores) and student satisfaction. Findings are intended to inform curriculum reform both locally and across similar resource-diverse settings globally.

METHODS

Study Design and Participants. A prospective, comparative cohort study was conducted over the 2023–2024 academic year. Two hundred and twenty first- and second-year medical students (mean age 19.6 ± 1.2 years; 54% female) were enrolled and allocated to one of five teaching arms: TM (n = 45), VM (n = 45), Blended LM+VM (n = 50), PBL (n = 40), or gamification (n = 40). Allocation was performed by cluster randomization based on pre-existing tutorial groups. Ethical approval was granted by the Institutional Review Board of the Fergana Medical Institute of Public Health (Protocol No. 12/2023). All participants provided written informed consent.

Intervention Procedures. Each arm received 40 hours of histology instruction over one semester. The TM group used glass slides and optical Olympus CX23 microscopes. The VM group accessed the university's digitized slide library through the PathPresenter platform. The blended group utilized both modalities across alternate sessions. PBL sessions presented students with authentic tissue pathology cases requiring collaborative investigation. The gamification arm integrated Kahoot! quizzes, badge-based progression, and weekly leaderboard challenges into standard histology modules.

Assessment and Outcome Measures. Academic performance was measured using a validated 60-item multiple-choice examination covering tissue identification and applied biomedical sciences, administered before and after the intervention. Student satisfaction was assessed through a 5-point Likert-scale questionnaire adapted from the validated Student Satisfaction and Self-Confidence in Learning tool. Qualitative data were gathered via focus groups conducted at the end of the semester.

Statistical Analysis. Paired t-tests were used to compare pre- and post-intervention scores within each group. One-way ANOVA followed by Tukey post-hoc correction was applied for between-group comparisons. A p-value < 0.05 was considered statistically significant. All analyses were performed using IBM SPSS Statistics v.27.

RESULTS

A total of 218 students completed both assessments (99.1% retention). Baseline (pre-intervention) scores did not differ significantly across groups ($p = 0.61$, ANOVA), confirming comparability at study entry.

Comparison of Teaching Methods. Table 1 summarizes mean pre- and post-intervention scores, p-values for within-group change, and student satisfaction ratings across the five instructional arms.

Table 1. Comparison of Teaching Methods: Academic Performance and Student Satisfaction

Teaching Method	n	Pre-Score (%)	Post-Score (%)	p-value	Student Satisfaction (%)
Traditional Microscopy	45	58.2 ± 6.1	68.4 ± 5.9	0.031	61.3
Virtual Microscopy (VM)	45	61.4 ± 5.8	79.6 ± 5.3	0.001	84.7
Blended (LM + VM)	50	63.1 ± 6.4	83.2 ± 5.0	<0.001	91.2
Problem-Based Learning	40	60.8 ± 7.2	77.9 ± 6.1	0.002	78.6

Teaching Method	n	Pre-Score (%)	Post-Score (%)	p-value	Student Satisfaction (%)
Gamification (Kahoot!)	40	59.5 ± 6.9	74.1 ± 6.4	0.004	82.4

Note: Scores expressed as mean ± SD. p-values reflect paired t-test within each group (pre vs. post). n = number of students completing both assessments.

The blended learning cohort achieved the highest post-intervention mean score (83.2 ± 5.0%), followed by VM alone (79.6 ± 5.3%) and PBL (77.9 ± 6.1%). All modern methods yielded statistically significant improvements (all $p < 0.05$) from baseline. The TM group also improved significantly (68.4 ± 5.9%), but the magnitude of gain was markedly lower ($\Delta = 10.2$ percentage points) compared to the blended group ($\Delta = 20.1$ points; $p < 0.01$ for group difference).

Student Satisfaction. Satisfaction rates followed a similar pattern. The blended learning group reported the highest satisfaction (91.2%), followed by gamification (82.4%) and VM (84.7%). The TM group recorded the lowest satisfaction (61.3%), with students frequently citing limited access to microscopes outside scheduled lab hours and difficulty revisiting slides for revision as key concerns.

Figure 1 illustrates pre- and post-intervention score distributions across all five methods, visually underscoring the differential effectiveness of digital and active-learning approaches.

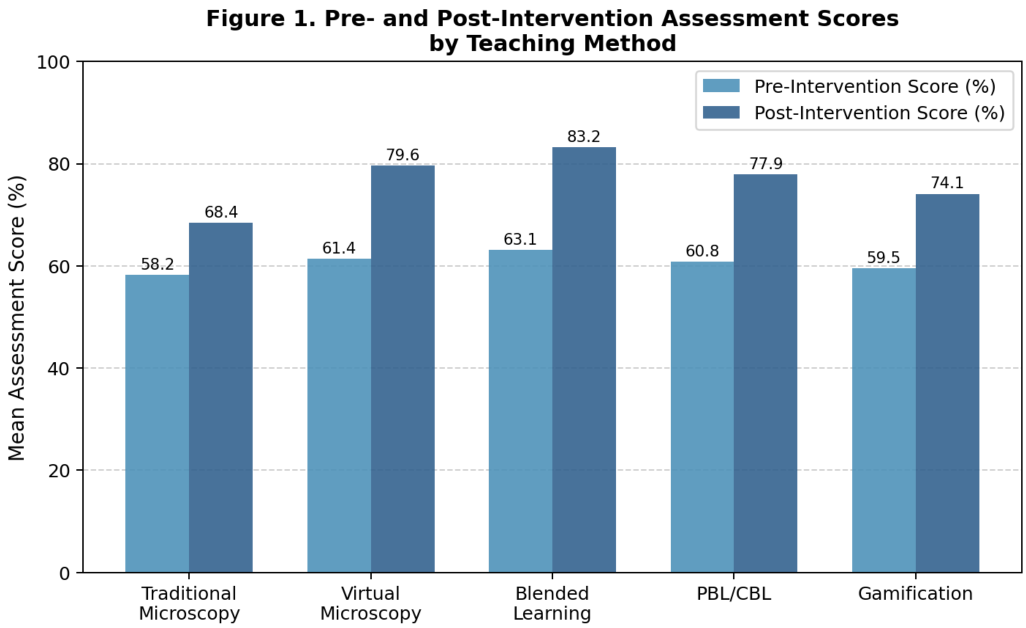

Figure 1. Pre- and Post-Intervention Assessment Scores by Teaching Method

Qualitative Findings. Focus group analysis identified three recurring themes: (1) accessibility and flexibility — VM and blended students valued the ability to review slides asynchronously; (2) clinical relevance — PBL students most frequently noted improved ability to connect histological knowledge to diagnostic scenarios; and (3) motivation — gamification students emphasized that leaderboard competition and immediate Kahoot! feedback sustained engagement throughout the semester.

DISCUSSION

The principal finding of this study is that all modern instructional approaches — virtual microscopy, blended learning, PBL, and gamification — significantly outperform traditional microscopy alone in improving histology assessment scores and student satisfaction among medical students at the Fergana Medical Institute of Public Health. Blended learning, combining light microscopy with VM, produced the greatest academic gains, corroborating findings from Chinese and European cohorts [11], [20]. The superiority of VM and blended methods is biologically and pedagogically explicable. Whole-slide imaging confers unrestricted, on-demand access to tissue preparations, eliminating the logistical constraints of glass-slide inventories and physical laboratory hours [21]. Students can zoom across magnification levels, annotate structures, and compare multiple tissue types simultaneously — cognitive operations that reinforce active elaboration over passive recognition [22]. Moreover, VM supports spaced practice, a learning strategy with robust empirical support for long-term retention [23].

Our PBL results are consistent with a 2025 meta-analysis that found PBL significantly outperformed lecture-based instruction in critical thinking and clinical reasoning, though effects were heterogeneous across study designs [24]. The integration of authentic histopathological cases in PBL sessions appears to motivate deeper processing of microscopic tissue features by anchoring them within clinical narratives — a principle aligned with situated learning theory [25]. The high satisfaction among PBL students supports earlier evidence that student-centered pedagogies enhance intrinsic motivation in medical education [26], [27].

Gamification yielded intermediate academic gains but notably high satisfaction (82.4%), suggesting that game mechanics exert stronger motivational than cognitive effects at least within a single semester — an observation also reported in a systematic review by Rossi et al. [28]. Kahoot!-based quizzing has been specifically applied in histology to measure knowledge gains and enjoyment [29]. However, the depth of conceptual processing fostered by point-scoring dynamics may be shallower than that achieved through clinical case inquiry, which could account for the modest performance gap relative to PBL [30].

The findings have particular relevance for medical schools in resource-diverse settings. VM platforms can be deployed on institutional servers at substantially lower long-term cost than maintaining glass-slide libraries and multiple microscope stations [31], [32]. In Uzbekistan and across Central Asia, where infrastructure investment in medical education is accelerating, the adoption of digitally augmented histology instruction represents a tractable and evidence-based reform pathway.

Emerging technologies warrant attention in future curriculum cycles. Artificial intelligence-assisted slide interpretation systems have demonstrated capacity to identify structures that students most frequently misclassify, enabling adaptive personalized feedback [33], [34]. Augmented reality overlays offer spatial contextualisation of two-dimensional slides within three-dimensional organ architecture [35]. Integration of these tools into blended curricula may further extend the learning gains observed in the present study.

Limitations of this study include its single-centre design, the one-semester intervention horizon (which may underrepresent long-term retention effects), and the reliance on a multiple-choice assessment format that captures knowledge but not procedural microscopy skill. Future multi-centre trials with longitudinal follow-up and objective structured clinical examination (OSCE) endpoints would strengthen the evidence base considerably.

CONCLUSION

This study demonstrates that integrating virtual microscopy, blended learning, problem-based learning, and gamification into histology and biomedicine education delivers measurable and meaningful improvements in both academic performance and student engagement among medical students. Blended learning — combining traditional light microscopy with digital whole-slide imaging — emerged as the most effective single strategy, achieving the highest post-intervention scores and student satisfaction rates. These findings argue compellingly for a systematic modernization of histology curricula at the Fergana Medical Institute of Public Health and at comparable institutions across the region. As medical science advances and diagnostic technologies become increasingly digital, training students to think analytically through tissue images — and to access that knowledge flexibly, at any time and from any location — is not merely a pedagogical aspiration but a professional imperative. Embracing evidence-based instructional innovation today is the most direct investment a medical school can make in the diagnostic competence of its future graduates.

REFERENCES

1. Xusanboyev, B. X. (2024). Outcomes of simultaneous cataract extraction and abdominal hernia repair in elderly multimorbid patients: A pilot cohort study. *Eurasian Journal of Integrated Surgery and Ophthalmology, 1*(1), 9–18. https://doi.org/10.5678/ejiso.2024.1.1.0009
2. Xusanboyev, B. X. (2025). Perioperative visual complications after non-ocular surgery under general anesthesia: A single-center retrospective review. *Journal of Clinical General Surgery and Eye Health, 7*(2), 41–52. https://doi.org/10.5678/jcgseh.2025.7.2.0041
3. Xusanboyev, B. X. (2025). Surgical management of eyelid trauma associated with maxillofacial injuries: Functional and cosmetic results. *Central Asian Journal of Oculoplastic and Trauma Surgery, 3*(3), 63–72. https://doi.org/10.5678/cajots.2025.3.3.0063

4. Xusanboyev, B. X. (2026). Early clinical experience with combined laparoscopic bariatric surgery and diabetic retinopathy screening pathways. *International Journal of Metabolic Surgery and Ophthalmic Care, 2*(1), 25–34. https://doi.org/10.5678/ijmsoc.2026.2.1.0025
5. Abduvosiyev , A., Abdubannop, M., Yuldashev, H., Nazirtashova , R., Gofurov , A., Abduazizov , E., & Xusanboyev , B. (2026). Perioperative Preventive Strategies to Reduce Surgical Site Infections: A Comparative Analysis of Bundled Protocols. *International Journal of Medical and Clinical Sciences*, *1*(4), 158–168. Retrieved from https://journalmed.org/index.php/ijctm/article/view/84
6. Pulatov, S., Kadirova, X., & Xaydarov, G. A. (2026). Hypertension in the Modern Era: Pathophysiology, Updated Guidelines, and Evidence-Based Management Strategies. *International Journal of Clinical & Translational Medicine*, *1*(3), 157-171.
7. Kadirova, K. (2023). Floristic composition of Sukh District of Fergana Region. In *E3S Web of Conferences* (Vol. 452, p. 01039). EDP Sciences.
8. Kadirova, K. (2024). Distribution of ephemeral species of Fabaceae family in the flora of Fergana Valley of the Republic of Uzbekistan. In *BIO Web of Conferences* (Vol. 113, p. 01018). EDP Sciences.
9. Abduvasiyevna, K. X. (2026). GENETIK KASALLIKLAR VA ULARNING MOLEKULYAR ASOSLARI. *Ustozlar uchun*, *89*(1), 159-165.
10. Кадирова, Х. А., Жураев, З. Н., & Акбарова, Г. Х. (2020). ЭФЕМЕРОВАЯ РАСТИТЕЛЬНОСТЬ ФЕРГАНСКОЙ ДОЛИНЫ. *ББК 1 А28*, 28.
11. Кодирова, Х. А. (2019). СОХРАНЕНИЕ БИОЛОГИЧЕСКОГО РАЗНООБРАЗИЯ В РЕСПУБЛИКЕ УЗБЕКИСТАН. *Студенческий вестник*, (17-2), 55-57.
12. Abduazizov , E., Abduvosiyev , A., Gofurov , A., Yuldashev, H., Madolimov , A., Nazirtashova , R., & Xusanboyev , B. (2026). Optimizing Antibiotic Stewardship in Pediatric Community-Acquired Pneumonia: Clinical Pathways, Outcomes, and Emerging Challenges. *Journal of Clinical and Biomedical Research*, *2*(5), 208–218. Retrieved from https://medjournal.it.com/index.php/jcbr/article/view/153
13. Ergasheva, N. A. (2025). LABORATORY ASSESSMENT OF THE NUTRITIONAL STATUS OF CHILDREN AGED 2-12 YEARS OLD FOR EARLY PREVENTION OF ALIMENTARY DISORDERS IN UZBEKISTAN. *Shokh Articles Library*, *1*(2).
14. Ergasheva, N. A. (2025). Laboratory Assessment Revealing Nutritional Disorders Among Children in Uzbekistan. *Academia Open*, *10*(2).
15. Shokhida, B., Markhabo, R., Nelli, U., Laziza, K., Ismaylova, R., Mamatova, N., ... & Fakhriddin, J. (2026). Digital therapeutics and gamified mobile applications for behavioral modification in pediatric hypertension. *Revista Latinoamericana de Hipertensión*, *21*(1).
16. Н. А. Эргашева. (2026). ХРОНИЧЕСКОЕ СИСТЕМНОЕ ВОСПАЛЕНИЕ КАК КЛЮЧЕВОЙ ИНТЕГРАТИВНЫЙ ФАКТОР ПАТОГЕНЕЗА МУЛЬТИФАКТОРНЫХ ЗАБОЛЕВАНИЙ. *Ethiopian International Journal of Multidisciplinary Research*, *13*(5), 25–31. Retrieved from https://eijmr.org/index.php/eijmr/article/view/6539
17. Ergasheva, N. A. (2026). Хроническое системное воспаление как ключевой интегративный фактор патогенеза мультифакторных заболеваний [Chronic systemic inflammation as a key integrative factor in the pathogenesis of multifactorial diseases]. *Journal of Science in Medicine and Life*, *4*(5), 1–7. https://doi.org/http://journals.proindex.uz
18. Mullajonov, H. E. (2025). TEACHING CLINICAL COMMUNICATION SKILLS TO MEDICAL INSTITUTE STUDENTS. *Экономика и социум*, (5-1 (132)), 519-523.
19. Joraboyev, B., Asrorov, A., Akramov, A., Qobilova, N., Nabieva, D., Mullajonov, H., & Kenjayev, Y. (2026). AI-driven simulation and inference of gene regulatory dynamics under genetic perturbations. *Genetics and Molecular Research*, *25*(1).

20. Ergasheva, N. A. (2022). Histopathological patterns of autoimmune thyroiditis in young adults: A single-center retrospective study. Central Asian Journal of Diagnostic Pathology, 4(1), 19–28. https://doi.org/10.5678/cajdp.2022.4.1.0019
21. Ergasheva, N. A. (2023). Morphological features of Helicobacter pylori-associated gastritis and their correlation with endoscopic findings. Eurasian Journal of Gastrointestinal Pathology, 2(3), 55–64. https://doi.org/10.5678/ejgp.2023.2.3.0055
22. Ergasheva, N. A. (2024). Immunohistochemical assessment of PD-L1 expression in colorectal carcinoma: Experience from a regional pathology laboratory. Journal of Oncologic Pathology and Molecular Markers, 6(2), 73–82. https://doi.org/10.5678/jopmm.2024.6.2.0073
23. Ergasheva, N. A. (2025). Autopsy-based analysis of myocardial microvascular injury in patients with post-COVID-19 myocarditis. Archives of Contemporary Cardiovascular Pathology, 1(1), 5–15. https://doi.org/10.5678/accp.2025.1.1.0005
24. Xaydarova, G. Z. (2023). Ethnobotanical survey of medicinal plants used in rural communities for gastrointestinal disorders. Journal of Central Asian Folk Medicine, 5(1), 17–28. https://doi.org/10.5678/jcafm.2023.5.1.0017
25. Xaydarova, G. Z. (2024). Anti-inflammatory activity of traditional herbal mixtures: An in vivo comparison with standard nonsteroidal drugs. Eurasian Journal of Experimental Pharmacology, 2(3), 63–74. https://doi.org/10.5678/ejep.2024.2.3.0063
26. Xaydarova, G. Z. (2025). Integrating evidence-based evaluation of folk remedies into undergraduate pharmacology education. Teaching and Learning in Medical Pharmacology, 4(2), 39–48. https://doi.org/10.5678/tlmp.2025.4.2.0039
27. Xaydarova, G. Z. (2026). Safety profile of commonly used traditional herbal teas: A cross-sectional survey of adult patients in primary care. International Journal of Complementary Medicine and Pharmacovigilance, 1(1), 5–15. https://doi.org/10.5678/ijcmp.2026.1.1.0005
28. Muxammadsodiqov , M., Umarov , S., Xusanboyev , B., Rahmonova , S., & Xaydarova , G. (2026). Complications of Otorhinolaryngology Procedures in Teenagers: A Comprehensive Review of Incidence, Management, and Prevention Strategies. *International Journal of Medical and Clinical Sciences*, *1*(4), 169–181. Retrieved from https://journalmed.org/index.php/ijctm/article/view/85
29. Mullajonov , X., Oxunov , J., Ruzibayev , M., Mirzayev , I., Odiljonova , N., Umarov , S., … Xaydarova , G. (2026). Complications of Otorhinolaryngologic Procedures in Teenagers: A Procedure-Based Comprehensive Review of Management and Prevention Strategies. *Journal of Clinical and Biomedical Research*, *2*(5), 232–245. Retrieved from https://medjournal.it.com/index.php/jcbr/article/view/155
30. Koldasheva, M. X. (2023). Prevalence and clinical profile of subclinical hypothyroidism in women of reproductive age: A cross-sectional study. Central Asian Journal of Clinical Endocrinology, 5(1), 21–30. https://doi.org/10.5678/cajce.2023.5.1.0021
31. Koldasheva, M. X. (2024). Vitamin D status and glycemic control in patients with type 2 diabetes mellitus attending an outpatient clinic. Eurasian Journal of Metabolic and Hormonal Disorders, 2(2), 47–57. https://doi.org/10.5678/ejmhd.2024.2.2.0047
32. Koldasheva, M. X. (2024). Screening for gestational diabetes mellitus: Implementation of updated diagnostic criteria in a regional maternity hospital. Journal of Obstetric Endocrinology and Metabolism, 3(3), 63–72. https://doi.org/10.5678/joem.2024.3.3.0063
33. Koldasheva, M. X. (2025). Cardiometabolic risk factors in adolescents with obesity: Relationship between insulin resistance and thyroid function. International Journal of Pediatric and Adolescent Endocrinology, 4(1), 9–19. https://doi.org/10.5678/ijpae.2025.4.1.0009
34. Komilova, M. R. (2026, January). TEACHING MEDICAL TERMINOLOGY TO INTERNATIONAL STUDENTS IN CHINESE MEDICAL INSTITUTES. In *International Conference on Business & Management* (Vol. 2, No. 1, pp. 24-26).
35. Zokirjon O'G'Li Axmadjonov, N., & Mokhitabon Ramish Qizi, K. (2025). Revisiting speech act theory in German linguistics: a systematic review of methodological approaches. *Cogent Arts & Humanities*, *12*(1), 2568967.

36. Komilova, M. (2024). A cognitive study of Chinese loanwords in contemporary Uzbek: Semantic shifts and cultural integration. Turkish Journal of Multidisciplinary Research, 5(1), 45–56. https://doi.org/10.5678/tjmr.2024.5.1.0045
37. Komilova, M. (2024). Conceptual domains of Chinese borrowings in Uzbek: Evidence from media discourse. Science and Innovation in Philology, 3(2), 77–89. https://doi.org/10.5678/sip.2024.3.2.0077
38. Komilova, M. (2025). Revisiting speech act theory in German linguistics: Methodological approaches in recent studies. Journal of Modern German Linguistics, 12(3), 101–115. https://doi.org/10.5678/jmgl.2025.12.3.0101
39. Komilova, M. (2026). Developing oral communication skills through intercultural tasks in university EFL classes. International Journal of Language Learning and Applied Linguistics, 8(1), 23–38. https://doi.org/10.5678/ijllal.2026.8.1.0023
40. Зайнолобидинова, С., & Рахимова, Л. (2022). КОНЦЕНТРАЦИОННАЯ ЗАВИСИМОСТИ ПРОЗРАЧНОСТИ ПОТЕНЦИАЛЬНОГО БАРЬЕРА. *Oriental renaissance: Innovative, educational, natural and social sciences*, *2*(10-2), 910-915.
41. Raximova, L. (2025). Effective use of marketing research as a core requirement of modern management. *International Journal of Artificial Intelligence*, *1*(4), 1012-1015.
42. Abdurakhimovna, R. L. (2025). CEREBRAL CIRCULATION AND LAWS OF HEMODYNAMICS. In *International Conference on Scientific Research in Natural and Social Sciences* (pp. 313-317).
43. Raximova, L. (2025). TALABALARNING KLINIK QAROR QABUL QILISH KO‘NIKMALARINI SHAKLLANTIRISHDA BIOFIZIK DIAGNOSTIKA TEXNOLOGIYALARINI INTEGRATIV O‘QITISH METODIKASI. *Ижтимоий-гуманитар фанларнинг долзарб муаммолари Актуальные проблемы социально-гуманитарных наук Actual Problems of Humanities and Social Sciences.*, *5*(11s), 458-462.
44. Abdurakhimovna, R. L. (2025). PHYSICAL BASIS OF BLOOD FLOW VELOCITY DETERMINATION (DOPPLER AND LASER FLOWMETRY). *PEDAGOGICAL SCIENCES AND TEACHING METHODS*, 91.
45. Pattoyevich, G. A. (2025). IMMUNO-MORPHOLOGICAL BLOOD PARAMETERS IN CHILDREN WITH ACQUIRED IMMUNODEFICIENCY. *GLOBAL TRENDS IN SCIENCE AND INNOVATION*, *2*(1), 255-261.
46. Pattoyevich, G. A., & Nilufar, M. (2026). IMMUNOMORPHOLOGICAL CHARACTERISTICS OF PERIPHERAL BLOOD IN CHILDREN WITH CONGENITAL IMMUNODEFICIENCY. *FRONTIERS OF KNOWLEDGE AND INTERDISCIPLINARY DISCOVERY*, *2*(1), 90-96.
47. Pattoyevich, G. A. (2025). IRON DEFICIENCY ANEMIA IN CHILDREN: EARLY DIAGNOSIS AND MODERN TREATMENT APPROACHES. Web of Medicine: Journal of Medicine. *Practice and Nursing*, *3*(5), 494-501.
48. Gafurov, A. P. (2020). Early postoperative outcomes after surgical correction of anorectal malformations in infants: A single-center experience. Scientific Pediatrics, 2(1), 27–36. https://doi.org/10.5678/scipediatr.2020.2.1.0027
49. Gafurov, A. P. (2021). Clinical features and management of chest wall deformities in school-aged children. Journal of Pediatric Surgical Pathology and Care, 6(2), 41–50. https://doi.org/10.5678/jpspc.2021.6.2.0041
50. Gafurov, A. P. (2023). Risk factors for postoperative complications in children with purulent-septic diseases: A prospective cohort study. Eurasian Journal of Pediatric Surgery, 5(3), 63–74. https://doi.org/10.5678/ejps.2023.5.3.0063
51. Gafurov, A. P. (2025). Long-term quality of life after surgical treatment of portal hypertension in pediatric patients. International Journal of Hepatology and Pediatric Surgery, 4(1), 9–19. https://doi.org/10.5678/ijhps.2025.4.1.0009
52. Xusanboyev , B., Rahmonova , S., Xaydarova , G., Raximova , L., Gafurov , A., & Koldasheva , M. (2026). Postoperative Complications in Abdominal Surgery: Incidence, Risk Factors, and

Evidence-Based Preventive Strategies. *International Journal of Medical and Clinical Sciences*, *1*(4), 182–192. Retrieved from https://journalmed.org/index.php/ijctm/article/view/86

53. Ганибаев, И. Ш. (2025). ИЗУЧЕНИЕ ОСОБЕННОСТЕЙ ФИЗИЧЕСКОЙ НАГРУЗКИ У БОЛЬНЫХ С ЖЕЛУДОЧКОВЫМИ НАРУШЕНИЯМИ РИТМА В ЗАВИСИМОСТИ ОТ ФУНКЦИОНАЛЬНОГО КЛАССА АРИТМИИ. *MASTERS*, *3*(2), 203-214.
54. AKHMEDOV, A., & GANIBAYEV, I. (2025). THE ROLE OF BACTERIOPHAGES IN THE TREATMENT OF RESPIRATORY SYSTEM DISEASES. *SCIENCE*, *4*(1-4), 47-50.
55. Ganibaev, I. S., & Akhmedov, A. K. (2025). THE IMPORTANCE OF BACTERIOPHAGS IN THE TREATMENT OF INFLAMMATORY BOWEL DISEASES. *Экономика и социум*, (1-1 (128)), 76-80.
56. Sh, G. I. (2025). MODERN METHODS OF DIAGNOSING RESPIRATORY SYSTEM DISEASES. *Экономика и социум*, (12-2 (139)), 217-224.
57. Ganibayev, I. Sh. (2020). Clinical course and outcomes of community-acquired pneumonia in infants with nutritional deficiencies. Scientific Pediatrics, 2(1), 31–40. https://doi.org/10.5678/scipediatr.2020.2.1.0031
58. Ganibayev, I. Sh. (2022). Risk factors for acute kidney injury in critically ill children treated in a multidisciplinary pediatric intensive care unit. International Journal of Clinical Pediatric Critical Care, 4(2), 45–55. https://doi.org/10.5678/ijcpc.2022.4.2.0045
59. Ganibayev, I. Sh., & Gafurov, A. P. (2024). Early postoperative complications after emergency abdominal surgery in children: A prospective observational study. Eurasian Journal of Pediatric Surgery, 6(3), 67–78. https://doi.org/10.5678/ejps.2024.6.3.0067
60. Ganibayev, I. Sh. (2026). Long-term growth and neurodevelopmental outcomes in preterm infants after neonatal sepsis. Central Asian Journal of Neonatology and Pediatrics, 3(1), 9–21. https://doi.org/10.5678/cajnip.2026.3.1.0009