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THE USE OF ARTIFICIAL INTELLIGENCE IN TEACHING BIOCHEMISTRY

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Abstract: the article examines the possibilities of applying artificial intelligence (AI) in teaching biochemistry. The main directions of AI implementation in the educational process are analyzed, including personalized learning, visualization of biochemical processes, virtual laboratories, automated assessment of knowledge, and support for students' research activities. Particular attention is paid to the advantages of intelligent technologies, such as increasing students' motivation, developing digital competencies, and improving the quality of mastering complex educational material. The paper also discusses existing challenges related to the integration of AI into education, including technical, methodological, and ethical issues. It is concluded that the most effective approach is the combination of artificial intelligence technologies with the professional expertise of teachers, which contributes to the creation of a modern educational environment in higher education institutions.

Keywords: artificial intelligence, biochemistry, digital education, personalized learning, virtual laboratories, educational technologies, data visualization, interactive learning, scientific research, higher education.

Introduction.

Modern education is rapidly transforming under the influence of digital technologies. One of the most significant areas of development is the integration of artificial intelligence (AI) into the educational process. The application of AI is particularly promising in the teaching of biochemistry, a complex interdisciplinary science that requires a deep understanding of molecular processes, the analysis of large volumes of information, and the development of practical research skills.

Artificial intelligence opens new opportunities for improving the quality of education, personalizing the learning process, and developing students' research competencies. The use of intelligent technologies makes the study of biochemistry more visual, interactive, and accessible.

The Role of Artificial Intelligence in Modern Education

Artificial intelligence represents a set of technologies capable of performing tasks that normally require human intelligence, such as data analysis, pattern recognition, natural language processing, forecasting, and decision-making. In the field of education, AI is used for:

-automated assessment of assignments;
-development of adaptive learning platforms;
-analysis of students' academic performance;
-creation of individualized learning trajectories;
-generation of educational materials;
-organization of virtual laboratories.

Unlike traditional teaching methods, AI-based systems can take into account the level of preparation of each student and select the most effective ways of presenting educational material.

Specific Features of Teaching Biochemistry

Biochemistry is considered one of the most challenging disciplines within the natural sciences. It combines knowledge from chemistry, biology, molecular biology, physiology, and medicine. The main difficulties in studying biochemistry are associated with the following aspects:

-a large volume of terminology;

-the necessity of understanding molecular mechanisms;
-the complexity of biochemical pathways and reactions;
-the need for process visualization;
-the requirement for laboratory research.

Traditional teaching methods do not always effectively explain dynamic processes occurring at the cellular and molecular levels. Therefore, AI technologies can significantly improve the effectiveness of teaching biochemistry.

Main Directions of AI Application in Teaching Biochemistry

1. Personalized Learning

AI enables the adaptation of the educational process to the individual characteristics of students. Intelligent educational platforms analyze:

-the speed of material comprehension;
-typical mistakes;
-the level of academic preparation;
-students' interests.

Based on this data, the system offers additional tasks, tests, and explanations for topics that cause difficulties. Such an approach contributes to a deeper understanding of biochemical processes.

For example, students experiencing difficulties with metabolism may receive interactive diagrams of the Krebs cycle, additional exercises, or video explanations.

2. Visualization of Biochemical Processes

One of the key challenges in teaching biochemistry is the abstract nature of many biochemical processes. AI technologies help create:

-three-dimensional protein models;
-animations of enzymatic reactions;
-interactive metabolic pathway diagrams;
-virtual cells and molecular structures.

Through computer modeling, students can observe molecular interactions in real time, which greatly facilitates the understanding of complex topics.

3. Virtual Laboratories

AI is actively used in the development of virtual laboratories. Such platforms allow students to conduct experiments in a digital environment without the need for expensive equipment and chemical reagents.

Advantages of virtual laboratories include:

-safety;
-accessibility;
-the possibility of repeated experimentation;
-cost reduction;
-remote access to learning.

Students can model biochemical reactions, analyze results, and learn to interpret data without the risks associated with real laboratory conditions.

4. Automated Knowledge Assessment

AI systems are capable of quickly and objectively evaluating tests, laboratory reports, and written assignments. Some systems can even analyze extended student responses by assessing:

-accuracy of terminology;
-logical consistency;
-completeness of the answer;

-scientific correctness.

This allows teachers to devote more time to academic supervision and individualized work with students.

5. Support for Research Activities

AI plays an important role not only in education but also in biochemical research. Students can use intelligent systems for:

-analysis of biochemical data;
-searching scientific literature;
-predicting protein structures;
-processing experimental results;
-modeling molecular interactions.

Thus, students acquire skills in working with modern technologies that are highly demanded in science and medicine.

Advantages of Using AI in Teaching Biochemistry

The application of artificial intelligence offers several significant advantages.

Increased Student Motivation

Interactive technologies make the learning process more engaging and stimulating.

Individualized Approach

Each student receives educational materials corresponding to their level of preparation.

Improved Visualization

Visualization of complex processes facilitates better understanding of educational material.

Development of Digital Competencies

Students learn to work with modern scientific technologies.

Time Efficiency for Teachers

Automation of routine tasks enables educators to focus on the substantive aspects of teaching.

Problems and Limitations

Despite its numerous advantages, the use of AI in education is associated with several challenges:

- insufficient technical infrastructure of educational institutions;
- high cost of certain software solutions;
- the necessity of teacher training;
- the risk of excessive dependence on technology;
- issues related to personal data protection;
- the possibility of obtaining inaccurate information from AI systems.

Moreover, AI cannot completely replace teachers, since education involves not only the transmission of knowledge but also the development of critical thinking, scientific ethics, and communication skills.

Future Prospects

In the future, the role of AI in teaching biochemistry is expected to increase significantly. The following developments are anticipated:

- intelligent educational platforms;
- fully interactive virtual laboratories;
- automated scientific consulting systems;
- augmented and virtual reality technologies;
- digital biochemical simulators.

Education is likely to become more flexible, personalized, and practice-oriented.

Conclusion

The use of artificial intelligence in teaching biochemistry represents a promising direction in the development of modern education. AI contributes to improving the quality of learning, making complex biochemical processes more understandable and accessible, and supporting the development of students' research skills.

Despite existing limitations, intelligent technologies are capable of significantly transforming the educational process. However, the most effective approach is the combination of AI tools with the professional expertise of teachers. Only under such conditions is it possible to create a modern educational environment that meets the demands of science and society in the twenty-first century.

References

1. Anisimov A. M. *Artificial Intelligence and Modern Educational Technologies*. Moscow: Yurait Publ., 2022. 214 p.
2. Baranov A. V., Kuznetsova E. I. Digitalization of education and the application of artificial intelligence. *Higher Education in Russia*, 2023, no. 5, pp. 45–53.
3. Green N., Stout W., Taylor D. *Biology*. Vol. 1. Moscow: Mir Publ., 2019. 368 p.
4. Lehninger A. *Principles of Biochemistry*. Moscow: Laboratory of Knowledge, 2021. 1328 p.
5. Petrova N. S. Artificial intelligence in the higher education system. *Pedagogy and Informatics*, 2022, no. 4, pp. 18–26.
6. Russell S., Norvig P. *Artificial Intelligence: A Modern Approach*. 4th ed. New York: Pearson, 2021. 1136 p.
7. Sychev Yu. I., Orlova T. P. Virtual laboratories in natural science education. *Modern Educational Technologies*, 2021, no. 7, pp. 62–69.