

**BIOLOGY TEACHING SYSTEM IN FOREIGN UNIVERSITIES**Scientific Supervisor: **Almamatova Zebo**

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Ushbu maqolada xorijiy universitetlarda biologiya fanini o'qitish tizimi, uning asosiy xususiyatlari, zamonaviy pedagogik yondashuvlar hamda innovatsion metodlar tahlil qilinadi. Shuningdek, biologiya ta'limida modul tizimi, kredit tizimi, laboratoriya mashg'ulotlarining o'rni va talabalarning mustaqil ta'lim olish ko'nikmalarini rivojlantirish masalalari ko'rib chiqiladi. Xorij tajribasi asosida biologiya fanini o'qitishni takomillashtirish yo'llari yoritiladi.

**Kalit so'zlar:** biologiya ta'limi, xorijiy universitetlar, kredit-modul tizimi, laboratoriya mashg'ulotlari, innovatsion metodlar, mustaqil ta'lim.

**АННОТАЦИЯ**

В данной статье рассматривается система преподавания биологии в зарубежных университетах, ее основные особенности, современные педагогические подходы и инновационные методы. Также анализируются роль модульной и кредитной системы, значение лабораторных занятий и развитие навыков самостоятельного обучения студентов. На основе зарубежного опыта предлагаются пути совершенствования преподавания биологии.

**Ключевые слова:** биологическое образование, зарубежные университеты, кредитно-модульная система, лабораторные занятия, инновационные методы, самостоятельное обучение.

**ANNOTATION**

This article examines the system of teaching biology in foreign universities, its key features, modern pedagogical approaches, and innovative methods. It also analyzes the role of the credit-module system, the importance of laboratory work, and the development of students' independent learning skills. Based on international experience, ways to improve biology education are proposed.

**Keywords:** biology education, foreign universities, credit-module system, laboratory work, innovative methods, independent learning.

In the modern world, biology is considered one of the most important directions of human progress. Especially ecological problems, global climate change, genetic engineering, biotechnology, and achievements in the field of medicine are increasing the importance of biology as a science. In the 21st century, the successful reading of the human genome, the ability to edit genes using CRISPR-Cas9 technology, and the discovery of new drugs using artificial intelligence have elevated biology not only to a scientific level but also to a strategically important discipline in social and economic terms.

For this reason, the system of teaching this subject is also being improved in line with the requirements of the times. The system of teaching biology in foreign universities stands out precisely because it is organized in close connection with innovative approaches, practical

experience, and scientific research. In this article, we will broadly examine the basic principles, methods, technological tools, country-specific features of biology education in foreign universities, and the possibilities of applying them to the education system of Uzbekistan.

One of the basic principles of biology education in foreign universities is the student-centered approach. In this approach, the student does not appear as a passive listener, but as an active participant. The student searches, analyzes, draws conclusions, and forms his own knowledge independently. The teacher, on the other hand, participates only as a guide and advisor in this process. This approach develops independent thinking, critical thinking, and problem-solving skills in students.

Research shows that passive listeners retain only 5 to 10 percent of learned material, while active participants absorb 75 to 90 percent. This difference is enormous and clearly confirms the effectiveness of the student-centered approach. In addition, this approach prepares students for future professional activities, because in a real scientific environment, a specialist also identifies a problem, collects data, analyzes it, and draws conclusions — just as in education. Thus, the student-centered approach not only provides knowledge but also forms professional skills. In foreign universities, this approach manifests itself in various forms. In some universities, special emphasis is placed on seminars and discussions. Students are assigned to read scientific articles and discuss them in class. In other universities, peer learning is widely used, where students teach each other and as a result both parties understand more deeply.

The unity of theory and practice is of great importance in teaching biology. In foreign universities, students consolidate the theoretical knowledge learned during lessons through laboratory sessions. For example, in a cell biology course, students study cells using a microscope, and in genetics, they understand the structure of DNA and the laws of heredity through experiments. Such an approach helps to absorb knowledge more deeply. In the United Kingdom, interactive forms and methods of teaching are used in biology courses. Computer technologies are used in conducting laboratory work in zoology and botany, because the use of living specimens in conducting experiments is prohibited by law. This practice is an excellent example of embedding an important ethical principle — the protection of biodiversity — into the teaching process.

Another important aspect of the unity of practice and theory is field biology classes. In many foreign universities, students are given the opportunity to conduct direct observation in nature, study ecosystems, and collect biological data. These experiences connect the theoretical knowledge learned in the classroom with real life and further increase students' interest.

The quality and volume of laboratory work in foreign universities is organized at a very high level. For example, in leading US universities, biology bachelor's programs involve at least six to eight hours of laboratory sessions per week. This is an effective way for students to consolidate practical skills.

In universities of developed countries such as the USA, the United Kingdom, Germany, and Japan, biology education is organized at a high level. For example, at Harvard University, the teaching of biological sciences is accomplished by widely involving students in scientific research. Students participate in scientific projects together with professors and have the opportunity to publish their research results in scientific journals. This increases their scientific potential.

At MIT — the Massachusetts Institute of Technology — biology education pays special attention to modern directions such as computational biology and systems biology. Here, students learn to explain biological processes using mathematical models, data analysis, and

bioinformatics methods. As a result, excellent specialists who combine biology, mathematics, and computer science are trained. At Stanford, the Design Thinking method — creative problem-solving — is widely used. Students develop projects to solve real biological and medical problems. For example, a group of students might work on a project to create cheap and convenient methods for diagnosing tropical diseases. Such a practical approach develops creativity in students.

At Oxford University, biology education is organized on the basis of an individual approach. Each student forms a curriculum based on his interests and future plans. This increases the effectiveness of education and helps the student grow into a qualified specialist in his field. The Tutorial System at Oxford is unique and exceptional. In this system, each student meets individually with a professor once a week, demonstrates his knowledge, asks questions, and holds discussions. This method ensures the individual development of the student and makes it possible to identify each student's strengths and weaknesses.

At Cambridge University, biology education is also organized at a very high level. Here especially the scientific traditions in molecular biology and genetics are very strong. Watson and Crick, who discovered the double helix structure of DNA, also worked at Cambridge University. Today as well, world-class scientific research is being conducted here in the fields of genetics, neurology, and cell biology.

Finland's achievements in the teaching system can also be connected with its correspondence to the principles of neuropedagogy. Children are taught to acquire knowledge from various sources such as the internet and books, and various forms and methods of research and project-based education are used. Finland's education system has been recognized as one of the best in the world according to PISA — the Programme for International Student Assessment. In Finland, the teaching profession is one of the most prestigious. To become a teacher, a master's degree is mandatory, and only the best students have the opportunity to enter the pedagogy field. For this reason, the quality of education is very high.

In universities in Germany, such as Heidelberg, Münster, and Freiburg, fundamental scientific approaches are prioritized in biology education. In these universities, students deeply study the foundations of chemistry, physics, and mathematics before moving on to biology. Such an approach forms the foundation necessary for truly understanding biology. The quality and technical equipment level of laboratory work in Germany is very high. In many universities, modern electron microscopes, DNA sequencers, mass spectrometers, and other advanced equipment are available. Students learn to work with this equipment and as a result are able to work in industry and scientific research institutions.

In Japan, biology education is organized in harmony with high technologies. Here especially the directions of bio-robotics and synthetic biology, which combine robotics, artificial intelligence, and biology, are being actively developed. The University of Tokyo, Kyoto University, and Osaka University are among the world leaders in these fields.

The credit-module system is one of the main elements of teaching biology in foreign universities. This system gives students the freedom to choose subjects and makes the study process flexible. Each subject is evaluated with a certain number of credits, and the student completes his studies by accumulating these credits. This system teaches students to be responsible and develops their ability to properly allocate their time.

The module system, on the other hand, makes learning easier by dividing educational materials into small parts. Each module covers a certain topic and control works are carried out at the end. This allows knowledge to be acquired step by step. Another important advantage of

the credit system is the ability for students to take additional courses and minors. For example, a student studying biology can additionally accumulate credits in economics, computer science, or philosophy. This broadens his intellectual horizon and allows him to work in various directions in the future.

In US universities, a biology bachelor's program usually consists of four years with two semesters each year. Each semester a student typically studies four to five subjects. The curriculum includes both mandatory core courses — general biology, chemistry, organic chemistry, physics, mathematics — and specialization subjects chosen by the student.

Modern technologies play an important role in biology education. Virtual laboratories, 3D models, simulations, and online platforms create wide opportunities for students. For example, through virtual dissection programs, students can study animal organisms. This is considered more effective and safer than traditional methods.

Virtual and augmented reality technologies are now transforming biology education fundamentally. In a number of universities, students can now travel inside the human body using a virtual reality headset and study the structure of organs, tissues, and cells in three dimensions. This technology is especially important in anatomy and physiology courses.

Modern biology is not just microscopes and test tubes — it is the art of analyzing millions of genetic data. In foreign universities, students learn programming languages such as Python and R to analyze biological data. Skills for using vast databases such as NCBI, GenBank, and PDB are formed in students.

Artificial intelligence and machine learning are also being actively used in medical diagnostics, drug discovery, and genetic research. For this reason, teaching the basics of AI to biology students is also being widely implemented in foreign universities. Predicting protein structures using programs like AlphaFold has become an inseparable part of modern biology education.

Online platforms and MOOCs such as Coursera, edX, and Khan Academy host biology courses from universities like Harvard, MIT, and Stanford. These courses allow studying from any point in the world and democratize education.

Problem-Based Learning, known as PBL, presents students with real-life problems and they search for ways to solve these problems. For example, a task might be given such as: the bird population in a region has sharply declined, identify the cause and find a solution. Students collect data, analyze ecology, climate change, chemical pollution, and other factors, and prepare a final conclusion. This method supports real scientific thinking.

In Project-Based Learning, students work together in a team on a specific project. This method develops teamwork, communication, and management skills. In the United Kingdom, students critically respond to evidence of biological phenomena that have found a place in the school biology course, and try to explain methods that allow independently finding additional evidence to the existing evidence.

In the Flipped Classroom method, students study the topic in advance through video or reading and during class engage in discussion, practical exercises, and problem-solving. This allows fully spending class time on interactive activities and increases the level of understanding.

In Inquiry-Based Learning, students pose a question according to the scientific method, form a hypothesis, conduct an experiment, collect data, and draw conclusions. This method develops genuine scientific thinking. Research shows that students who participate in research

programs are better trained as research scientists and are more likely to continue studying in the science direction.

The Case Study method involves students analyzing cases based on real biological and medical situations. For example, by studying the history of the spread, diagnosis, and treatment methods of a particular disease, they practically understand medical biology.

Peer Instruction, developed by Eric Mazur at Harvard, involves students voting on a concept, then discussing it with a neighbor, and voting again. After the discussion, the number of correct answers was observed to increase sharply — this demonstrates the power of learning from peers.

Independent study is of great importance in foreign universities. Students are required to work on themselves, read and write scientific articles, and prepare presentations. This broadens their knowledge base and shapes them as independent specialists.

The ability to read and analyze scientific articles is specifically taught in foreign universities. Journal Clubs are very widespread. Each week a group of students reads a new scientific article with a critical eye and discusses it. This method gives students the skills to properly read scientific literature, evaluate methodology, and critically view conclusions.

Scientific article writing skills are also specifically taught. Students learn to write their laboratory experiments in formal scientific language, correctly present graphs and tables, statistically analyze data, and discuss results. These skills are necessary not only in academic but also in industrial and applied fields.

In leading universities, even at the undergraduate level, students have the opportunity to work in professor laboratories. For example, in the USA through programs like SURF — Summer Undergraduate Research Fellowship — students directly participate in scientific research projects during summer vacation and receive stipends. These programs play an important role in increasing the scientific potential of students.

The assessment system is also based on modern approaches. Students are evaluated not only through examinations but on the basis of all work completed during the semester. This allows for fair assessment of knowledge.

In foreign universities, the biology assessment system may consist of the following elements: laboratory work reports, essays and scientific articles, activity in class discussions, group projects, midterm tests, and final examinations. The contribution of these various elements to the overall grade is determined in advance in the course syllabus.

Rubric-based assessment is also widely used. A rubric is a table showing assessment criteria that is given to the student in advance. For example, in assessing a laboratory report, the accuracy of data, depth of analysis, quality of conclusion, and writing culture are evaluated separately. This method makes assessment transparent and fair.

Portfolio assessment is also applied. The student collects his works throughout the semester and shows the dynamics of development. Unlike a one-day everything examination system, this method allows evaluating the long-term growth of the student.

Interdisciplinary integration is of great importance in teaching biology in foreign universities. Biology is taught in close connection with chemistry, physics, computer science, and mathematics. This teaches students to think comprehensively.

Today, the following interdisciplinary directions of biology are developing especially rapidly. Biophysics studies biological processes on the basis of physical laws. The folding of proteins, the transport of substances across membranes, the propagation of nerve impulses — all of these obey physical laws. Biochemistry studies the chemical composition and processes of living organisms. Metabolism, enzyme activity, signal transduction pathways — all of these have a chemical basis. Bioinformatics involves analyzing biological data using computer technologies. Genomics, proteomics, metagenomics — these directions cannot develop without analyzing large volumes of data. Mathematics and statistics are necessary for correctly interpreting biological data. Mathematical models are widely used in population genetics, ecology, and epidemiology.

Another important aspect of biology education in foreign universities is international cooperation and student exchange programs. Programs such as Erasmus+ in Europe and Fulbright and Rhodes in the USA allow students and teachers to study and conduct research in other countries.

As a result of international cooperation, students not only gain new knowledge but also develop intercultural communication skills. A number of universities offer dual degree programs where a student has the opportunity to obtain diplomas from two universities at the same time.

Participation in scientific conferences also contributes greatly to the development of students. In many universities, students are given the opportunity to present their research at annual scientific conferences in the form of poster or oral presentations. This shapes their scientific communication skills.

An important part of modern biology education is ecological literacy and bioethics. In foreign universities, students not only learn biological knowledge but also learn how to apply this knowledge responsibly. Bioethics courses cover the following topics: ethical boundaries of genetic engineering, permitted and prohibited aspects of editing the human genome, ethical rules for conducting experiments with animals, preservation of biodiversity and protection of biosystems, ecological justice and human responsibility for climate change.

These courses help students make responsible decisions in their future scientific activities. For example, the ethical problems of applying CRISPR technology to human embryos have become one of the main topics of this course.

To develop biology education in Uzbekistan, it is necessary to learn lessons from foreign experience. For this, reforms can be implemented in the following directions.

First, modernization of the laboratory base is essential. Laboratories equipped with modern scientific instruments sharply increase the quality of biology education. Currently, work in this direction is being carried out in a number of universities in Uzbekistan.

Second, updating the teaching methodology is important. It is necessary to widely introduce student-centered approaches, problem-based, and project-based education. For this, programs for retraining and improving the qualifications of teachers need to be established.

Third, expanding international cooperation is vital. It is necessary to develop cooperation of Uzbek students and teachers with foreign scientific centers and universities and to increase exchange programs.

Fourth, introducing modern technologies into education is critical. Expanding the use of virtual laboratories, online platforms, and digital resources will take biology education to a new level.

Fifth, connecting scientific research with education is necessary. Conditions must be created for students to participate in scientific projects from the first year. This increases their motivation and develops scientific potential.

### **Conclusion**

Foreign experience shows that for effective teaching of biology, constant renewal and development are necessary. High results can be achieved by introducing new technologies into the education system, improving teaching methods, and involving students in scientific activities. Biology is not just a subject — it is a worldview. It helps a person understand his connection with nature, the miraculous complexity of life, and the power of scientific thinking. Biology education in foreign universities is a broad system of opportunities created to form precisely this worldview.

Therefore, education reforms in Uzbekistan should also be in the direction of raising biology not to the level of merely providing information, but to the level of teaching thinking, developing problem-solving skills, and awakening the scientific spirit. A modern biology specialist should not only be able to answer test questions, but should be a person who can solve real scientific problems, analyze data, and apply his knowledge for the benefit of society.

The lesson that all leading countries in the world teach us is clear: investing in biology education means investing in the future. The scientists, doctors, ecologists, biotechnologists, and bioinformaticians who will solve the greatest challenges of tomorrow — pandemics, food security, climate change, rare diseases — are sitting in university classrooms today. The quality of their education will determine the quality of our future.

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