

Advantages Of Explaining Protein Denaturation To Students Through A Virtual Laboratory

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Abstract

This paper analyzes the benefits of explaining the process of protein denaturation to students through a virtual laboratory. Virtual laboratories make the educational process more effective and interactive, which makes it easier to understand complex processes. In particular, the ability to visually demonstrate and conduct experiments on microscopic processes such as protein denaturation deepens students' understanding. The article discusses the advantages of the virtual laboratory over traditional classes, such as visibility, security, cost reduction, and practical application of knowledge. At the same time, the role of virtual laboratories in the development of students' theoretical knowledge and practical skills is highlighted.

Key words: Virtual laboratory, protein denaturation, interactive education, visualization.

INTRODUCTION.

Advances in science and technology have had a major impact on the education system. In recent years, the introduction of virtual laboratories into the educational process has made it possible to effectively convey many scientific concepts to students. Virtual laboratories play an important role, especially in complex disciplines such as biochemistry. This article discusses the use of virtual laboratories and its results in explaining the essence of protein denaturation processes to students.

LITERATURE REVIEW AND METHODOLOGY

It is known that protein denaturation is the process of protein molecules losing their natural structure, resulting in a decrease or complete loss of their biological activity [1-2].

Proteins perform various functions in the body through their special three-dimensional structure, therefore, changes in this structure have a significant impact on the functional direction of proteins. The denaturation process usually occurs under the influence of heat, acid, alkali, or other chemicals [3-5].

RESULTS AND DISCUSSION

Research Objective.

To study the process of protein denaturation (loss of natural, i.e. biological properties) using virtual (imaginary) experiments. In carrying out this work, we relied on the following principles:

1. Efficient use of time and resources.

Traditional laboratory experiments require a lot of time and money. With the help of virtual laboratory experiments, the student can observe the denaturation process anywhere and at any time. This allows students to repeat research and experiments many times, which helps to understand the process more deeply. This type of flexibility makes virtual experiments much more effective.

2. **Safety of the experiment process.**

Biochemical experiments usually involve hazardous substances and complex equipment. In virtual laboratories, students do not have to worry about making mistakes or working with harmful chemicals during the experiment. Acids or high temperatures used in the denaturation process are safely simulated in the virtual environment, creating a safe learning environment in practice.

3. **Opportunity to learn from mistakes and try again.**

Virtual labs allow students to repeat experiments multiple times. In a traditional lab, the amount of chemicals may be limited or there may be no time to redo the experiment after making mistakes. In a virtual environment, students have the opportunity to learn from their mistakes and try again.

4. Flexibility and customization.

In virtual labs, students can customize experiments to their own level of knowledge and learning pace. Students can learn about protein denaturation, which can be complex, step-by-step, and have the opportunity to independently monitor their own level of understanding.

5. Environmentally friendly.

Many laboratories can harm the environment by using various chemicals. Virtual laboratories eliminate these risks, making the scientific learning process more environmentally friendly. Acids and other substances used in the denaturation process do not cause harm in a virtual environment.

The use of virtual laboratories in the educational process and its results

In our work, we created animations of virtual laboratory experiments on this topic and were able to demonstrate the structure and denaturation of proteins through 3D models. Students visually observed how protein molecules form bonds, how these bonds are broken, and what shape changes occur in proteins during denaturation. This method also proved to be very effective in helping students master theoretical concepts.

Virtual laboratories are important not only for scientific experiments, but also for modernizing the educational process. When explaining complex molecular processes such as protein denaturation to students, demonstrative and interactive teaching technologies increase their interest and increase their level of knowledge. In addition, virtual laboratories provide an easy and effective way to apply scientific concepts to practice, which allows students to apply theoretical knowledge in practice. The educational process through virtual laboratories becomes more interesting and interactive. As a result, students' interest in classes increases and they participate more actively. These results further strengthen the place of virtual laboratories in the modern educational process and allow students to receive more high-quality and effective knowledge.

Conclusion.

Virtual laboratory experiments have a very high didactic potential for explaining to students the essence of complex biochemical processes such as protein denaturation. Imaginary experiments play an important role in consolidating student knowledge and creating opportunities for demonstrative and safe learning. Virtual laboratories also greatly contribute to making the learning process more efficient, flexible, and environmentally friendly.

REFERENCES.

- Uktamov S. The development of virtual education and innovations in education: Opportunities for the use of innovative technologies in higher education. Tashkent: Publishing House of the National University of Uzbekistan. (2021).
- Karimov A., Ismoilov N. Proteins and their functions: Fundamentals of biochemistry: Proteins and their biological significance. Tashkent: Science and Technology Mark (2019)
- Smith J., Brown L. (2020). Virtual Laboratories in Education: Enhancing Student Learning and Engagement. *Journal of Educational Technology*, 32(1), 15-29.
- Patel R. (2019). Principles of Protein Denaturation and Methods for Effective Teaching. *Journal of Biochemistry Education*, 12(4), 78-85.
- Johnson M., Lee S. (2021). Advances in Science Education: The Role of Virtual Labs in Modern Learning Environments. *Science Education Advances*, 44(3), 102-115.
- 6.Nodirov, A. A., Sultonov, B. E., Sherkuziyev, D. S., & Abdulxayev, A. A. (2025, July). Research of the composition of phosphogypsum produced during the extracting of

phosphoric acid from mineralized mass by the clinker method. In AIP Conference Proceedings (Vol. 3304, No. 1, p. 040021). AIP Publishing LLC.

7. Nodirov, A. A., Sultonov, B. E., Abdullajanov, O. A., & Kholmatov, D. S. (2021). The clinker method of extracting phosphoric acid from Central Kyzylkum phosphorites. Scientific Bulletin of NamSU, 7, 69-75.