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Instructional design for optimizing biochemical chemistry education using basic medical knowledge

Yanjun Lai[1,*]
[1]*Xiantao Vocational College, China*

Abstracts: Biochemical chemistry, as one of the core courses in medical education, involves the structure, function, metabolism, and other key contents of human biomolecules, which is of great significance in cultivating students' scientific literacy and clinical practice ability. However, the traditional teaching of biochemical chemistry is often based on independent chemical concepts and lacks organic integration with basic medical knowledge, leading to a decline in students' interest in learning and poor learning results. Therefore, there is an urgent need to optimize the teaching design of biochemical chemistry using basic medical knowledge to provide students with a more in-depth learning experience and lay a solid foundation for future medical practice. The article discusses the application of basic medical knowledge in biochemical chemistry education from the aspects of anatomy, physiology, and pathology, and proposes three teaching design strategies, namely, case study, modularized learning, and experimental learning.

Keywords: basic medical knowledge; biochemical chemistry; instructional design

Introduction

Biochemical chemistry is an important basic medical course, which mainly studies the chemical processes and reaction mechanisms in living organisms, involving many abstract concepts and complex formulas, which puts forward high requirements for students' learning comprehension. In the past teaching of biochemical chemistry, due to the over-emphasis on the teaching of theoretical knowledge, ignoring the integration and application of basic medical knowledge, making it difficult for students to understand and master the complex biochemical knowledge in the learning process, and difficult to apply this knowledge to medical practice. Therefore, teachers should make full use of basic medical knowledge to optimize the teaching design of biochemical chemistry education, to help students better understand the concept of biochemical chemistry, and cultivate medical thinking and practical ability.

1. The importance of integrating basic medical knowledge into biochemical chemistry education

Basic medical knowledge covers a wide range, including anatomy, physiology, pathology, etc., which have a close relationship with biochemical chemistry, and its integration into biochemical chemistry education can help students better understand the principles and applications of biochemical chemistry, thus enhancing students' interest and enthusiasm for learning, and improving the learning effect. Integrating basic medical knowledge into biochemical chemistry education can cultivate students' interdisciplinary thinking. Modern medicine is a multidisciplinary cross-fusion complex, and mastering interdisciplinary thinking ability can not only help students solve complex scientific research problems but also lay a solid medical foundation for their future career development. In addition, basic medical knowledge is highly practical and realistic, and its integration into biochemical chemistry education can enhance the practicability

Corresponding Author:Yanjun Lai
Xiantao Vocational College, China
Email:1324200877@163.com

and relevance of teaching, enable students to more deeply understand the dynamic processes of biochemical reactions, as well as the changes of these processes in the physiological and pathological states, to improve the clinical diagnosis and treatment ability of students (Liu & X u& Teng).

2. The application of basic medical knowledge in biochemical chemistry education

2.1 The Connection between Anatomy and biochemical chemistry

Each human organ has its unique biochemical properties, which are mainly determined by the cell types, metabolic activities, and unique biomolecules in the organ. For example, the liver, as the main metabolic organ of the human body, has many biochemical functions such as detoxification, protein synthesis, bile secretion, glucose and fatty acid metabolism, etc. The realization of these biochemical functions depends on the unique biochemical activities of liver cells. Similarly, myocardial tissue, which is rich in mitochondria and can produce large amounts of energy, has a strong oxidative phosphorylation capacity and can continuously provide the energy needed for the heart to beat. Nerve cells in neural tissue can transmit and process information through the release and reception of neurotransmitters, and this process is based on a series of biochemical reactions. In the teaching of biochemical chemistry, teachers can explain the biochemical properties of these organs and tissues, so that students can comprehensively understand the physiological and pathological processes of the human body from the macroscopic structure and microscopic molecular mechanisms at two levels, which can not only help students to establish a complete system of medical knowledge but also improve the ability of students to solve practical problems.

Biomolecules are the basic elements in living organisms, which constitute cells and tissues and support life activities. In different anatomical structures, biomolecules play different roles. In the skeletal system, inorganic salts, such as calcium hydroxide phosphate, and organic matter, such as collagen, together form the basic structure of the skeleton, which makes the skeleton both hard enough and not too brittle to withstand external pressures and impacts, on which calcium ions play an important role in cellular signaling, nerve impulse propagation, and muscle contraction (Yang, 2019). In the nervous system, neurotransmitters, such as acetylcholine, dopamine, and 5-hydroxytryptamine, transmit messages between neurons and support the body's functions of thinking, memory, perception, and locomotion, whereas neuronal protection and nutrition depend on lipids, such as phospholipids and cholesterol from myelin sheaths, and proteins, such as neurotrophic factors. In the endocrine system, hormones, such as insulin and thyroxine, play a role in various parts of the body, regulating metabolism, growth and development, mood, etc. The production, secretion, and action of these hormones involve a series of complex biochemical processes. By explaining the roles of biomolecules in different anatomical structures, teachers can help students better understand the importance of biomolecules and the functions of anatomical structures from the microscopic level, to enhance students' interest in biochemical chemistry and motivation for learning.

2.2 Connection between Physiology and biochemical chemistry

Physiology focuses on the overall function of the living system and the coordinated role of various systems, including circulatory, respiratory, digestive, neurological, and endocrine systems, etc., and the maintenance of the functions of these systems can not be separated from a series of complex biochemical reactions (Zhong & Zhu, 2019), for example, the heart releases energy through a series of biochemical reactions to drive myocardial systole and diastole, and realize the circulation of blood. When teaching biochemical chemistry, teachers can help students better acquire physiological knowledge and deepen their understanding of biochemical chemistry principles by explaining the biochemical reactions in these physiological processes. In addition, in the instructional design, teachers can

make students understand how abnormal biochemical reactions can lead to diseases by comparing physiological processes in normal and pathological states. For example, abnormalities in energy metabolism may lead to obesity or diabetes, imbalances in hormone synthesis and secretion may lead to endocrine disorders, and abnormalities in neurotransmitters may lead to psychiatric disorders. These concrete examples can make students deeply understand that the concepts of biochemical chemistry are not only abstract scientific knowledge, but also closely related to life, directly affecting the quality of life and health, and then pay more attention to and value the study of biochemical chemistry, stimulate students' love and interest in biochemical chemistry.

2.3 Integration of Pathology and biochemical chemistry

Many pathological changes in the disease process are caused by abnormalities in biomolecules, for example, the occurrence of cancer is often associated with mutations in DNA, which can lead to uncontrolled cell proliferation; in the pathogenesis of Alzheimer's disease, the abnormal deposition of β-amyloid protein will form plaques in the brain, leading to neuronal damage and death, and these abnormalities in biomolecules are both the pathological basis of the disease and also a target of disease targets for treatment (Li & Ke & Shu, 2023). In addition, the occurrence and development of disease affect the normal operation of biochemical pathways, for example, under hypoxia, the energy metabolism in cells shifts from aerobic respiration to anaerobic respiration, leading to a large accumulation of lactic acid; in tumor cells, biochemical pathways are altered to satisfy the needs of rapid proliferation, for example, by enhancing the uptake and utilization of glucose, a phenomenon known as the " Warburg effect" (Wang & Hu, 2022). In the teaching of biochemical chemistry, teachers can combine the knowledge of pathology with examples and case studies to help students understand the role of biomolecules and biochemical pathways in disease, cultivate students' clinical thinking, and improve students' ability to apply theoretical knowledge to practical problems.

3. Strategies for optimizing the teaching design of biochemical chemistry

3.1 Case study teaching

When teaching biochemical chemistry, teachers can introduce disease-oriented case teaching, combining the pathogenesis, diagnosis, and treatment of diseases with the structure and function of biomolecules, the law of biochemical reactions, and other basic knowledge, to help students better understand and master the knowledge of biochemical chemistry. First of all, the selection of cases needs to be representative and able to reflect the application of biochemical chemistry knowledge in the diagnosis and treatment of diseases (Wu & Wang & Lai, 2018), for example, diabetes mellitus is a representative metabolic disease, and its pathogenesis involves biochemical contents such as insulin signaling pathway, glucose, and fatty acid metabolism regulation; coronary artery disease and hyperlipidemia are related to lipid metabolism disorders, and cholesterol biosynthesis and transporter are its key link; hereditary diseases such as phenylketonuria and cysteinuria can be used to explain the knowledge of amino acid metabolism, and these cases contain rich biochemical content and have high clinical relevance. Secondly, the explanation of the cases needs to be student-centered, focusing on guiding students to learn and think independently. Teachers can first introduce the basic information and clinical manifestations of the cases and guide students to speculate on the possible pathogenesis and diagnostic methods through the signs and symptoms of the disease, combined with the biochemical knowledge already learned, and then the teacher can further analyze the biochemical basis of the disease, so that the students will understand how the biochemical reaction affects the human body's physiological and pathological processes, and finally, the teacher can discuss the treatment plan of the disease with the students so that the students can

understand how to treat the disease by regulating the biochemical reactions.

3.2 Modularized teaching

In the teaching of biochemical chemistry, teachers can categorize the biochemical content by system/disease, such as the digestive system, circulatory system, endocrine system, metabolic diseases, genetic diseases, etc., and each system/disease constitutes an independent learning module. The advantage of modularized teaching is that it can help students understand and memorize knowledge better. The traditional teaching of biochemical chemistry focuses on the teaching of theoretical knowledge, such as metabolic pathways, enzyme-catalyzed reactions, molecular structure, etc. These contents are important but boring and abstract, which are difficult for students to understand and master. Through modular teaching, teachers can combine this theoretical knowledge with specific systems/diseases, so that students can understand the basic knowledge of the systems/diseases while understanding the related biochemical knowledge. For example, when teaching the module on the digestive system, teachers can explain to students the decomposition and absorption processes of carbohydrates, proteins, and fats in the digestive system, as well as the enzymes and metabolic pathways involved in these processes (Liu & Xu, 2020). In this way, students can not only remember the biochemical knowledge better, but also understand the application of this knowledge in practice, which will strengthen the application ability and enhance innovative thinking. In addition, modularized teaching is also more conducive to students' independent learning. Each module is a complete knowledge system, and students can choose different modules for learning according to their learning progress and interests. Teachers can provide students with relevant learning materials, such as courseware, textbooks, essays, cases, etc., and students can learn and explore knowledge independently by reading these materials. At the same time, teachers can also set up online discussion forums to encourage students to communicate and discuss and share their problems and discoveries in the learning process, which can not only improve students' learning efficiency but also cultivate students' critical thinking and teamwork skills.

3.3 Experimental Teaching

First of all, the design of experimental projects should be practical enough so that students can participate in them and master the relevant operation skills, teachers can design a series of experiments covering different topics, such as electrophoretic separation of proteins, determination of enzyme activity, molecular cloning of DNA, and so on, and combine these experimental projects with the relevant medical knowledge, so that the students can understand and apply this knowledge in practice(Li & Wu & Ding, 2023). Secondly, teachers need to establish a connection between experiments and theoretical courses. In theoretical courses, teachers should introduce students to the theoretical background, purpose, and method of experiments, so that students can understand how experiments generate and verify theoretical knowledge, and in experimental courses, students should apply this theoretical knowledge through practice, experimental design, data collection, and result analysis. Furthermore, the experiment should also include active participation and interaction of students, and teachers can guide students to participate in all aspects of the experiment by asking questions, group discussion, and presentation of the experimental report to stimulate their interest and motivation in learning. In addition, the experiment often encounters various problems, such as the use of instruments, reagent configuration, data processing, etc. Teachers can create relevant problem situations and guide students to find strategies and methods for solving problems, to cultivate students' problem-solving ability and innovative thinking.

Conclusion

By making full use of basic medical knowledge to optimize the teaching design of biochemical chemistry education, it can effectively stimulate students' desire for knowledge and improve their

learning effect. In terms of teaching content, teachers should emphasize the correlation between biochemical chemistry and anatomy, physiology, and pathology, so that the study of biochemical chemistry is no longer isolated, but closely linked to the whole medical knowledge system. In terms of teaching methods, teachers can adopt strategies such as case teaching, modular teaching, and experimental teaching, so that students can understand and apply biochemical chemistry knowledge in specific contexts and improve their practical ability and innovative thinking. In the future, teachers should continue to explore and practice to better integrate biochemical chemistry and basic medical knowledge and improve the quality and efficiency of medical education.

Conflict of Interest

The authors declare that they have no conflicts of interest to this work.

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