Design of Experimental Teaching Content of Medical Molecular Biology

Ying LIU\textsuperscript{a}, Chun-Jing ZHANG\textsuperscript{*}, Zheng-Lin ZHAO\textsuperscript{b}, Han GAO\textsuperscript{c} and Jing XU\textsuperscript{d}

Department of Biochemistry and molecular biology, Qiqihar Medical University, Qiqihar 161006, Heilongjiang, China

\textsuperscript{a}396163658@qq.com, \textsuperscript{*}cjzhang2005@163.com, \textsuperscript{b}522883595@qq.com, \textsuperscript{c}55353703@qq.com, \textsuperscript{d}627768395@qq.com

Keywords: Biochemistry and molecular biology experiments; Teaching content design; Inspirer; Speculation; Interaction.

Abstract. It is necessary to improve the design strategy of biochemistry experiment to further improve the teaching quality of Biochemistry and molecular biology experiment course and cultivate students' comprehensive quality, innovative ability and scientific research thinking. The Enlightenment could be enhanced by introducing the frontier technology of biochemistry and applying the problem-based teaching strategy. The speculation could be improved by introducing comprehensive experiments, mind mapping model and applying the concept of "knowledge application and knowledge innovation" to establish a scientific assessment system. The interaction could be increased by introducing discussion-based teaching. The students' interest and initiative in learning biochemical experiments, understanding and mastery of experimental theory, and experimental skills could be mobilized by enhancing the enlightenment, speculation and interaction of experimental teaching, then students' innovative ability and rigorous scientific research thinking could be cultivated.

Introduction

Biochemistry and molecular biology is an important basic course in modern medical education. Its principles, techniques and methods have been applied to various disciplines in the field of life science \cite{1}. Biochemistry and molecular biology experiment is an important and indispensable part of "biochemistry and molecular biology." Biochemistry and molecular biology experiment which plays an important role in training students' experimental operation skills and scientific research style has strong practicality and comprehensiveness.

However, biochemistry and molecular biology are considered as one of the most difficult courses for students to master because of its objective characteristics, such as abstract concept, relatively boring content, scattered knowledge points, etc. Therefore, the core of biochemistry and molecular biology experiment teaching is how to enhance the inspiration, speculation and interaction of teaching content design to improve students' interest in learning, then strengthen students' ability of practice and innovation, and cultivate students' scientific research thinking.

Enhancing the Inspiration of Experimental Teaching

The experimental teaching content of Biochemistry and molecular biology is mostly confirmatory experiment. The traditional experimental teaching mode is difficult to bring up the students' interest in experimental learning, so the students' practical ability and problem-solving ability have not been fully improved. Therefore, how to increase the inspiration of experimental teaching content and then mobilize the students' enthusiasm, initiative and creativity is particularly important in experimental teaching.

Introduction of Cutting-edge Technology

Biochemistry and molecular biology, as the frontier of life science, have the characteristics of rapid renewal and strong foresight \cite{2}. In teaching, there is a lack of the embodiment of the frontier
achievements in the field of scientific research, which leads to the serious disconnection between the knowledge learned by students and the practical application.

At the beginning of the experimental class, 5-10 minutes is used to introduce a new technology related to the experiment of this class, and the application of this technology in solving practical problems through multimedia and network, such as PCR, gene mutation, gene cloning and gene sequencing; protein determination, expression, purification and protein chip. These cutting-edge knowledge will provide a large knowledge background for the experimental course to be carried out in this lesson, so that students not only have access to the cutting-edge knowledge of biotechnology, but also understand the technical principles that promote the progress of life science research. For example, in the "extraction and identification of plasmid DNA" experiment, the method of plasmid extraction kit in the laboratory is used in the experiment class. The use of plasmid extraction kit could make students connect with the training of scientific research laboratory, and make a technical transition for future research and study. At the same time, the explanation of the experimental principle in the teaching ingeniously combines the traditional alkaline lysis method, which could make the students fully realize that any advanced technical method originates from the classic, and only by consolidating the foundation could there be innovation.

Application of Problem-based Teaching Strategy

By introducing the problem-based teaching strategy in the experimental class, we could link the abstract and boring experimental content with the practical problems of life, make the knowledge concrete and visualized, which could greatly improve the enthusiasm of students' learning, broaden their knowledge, and strengthen their understanding and mastery of basic knowledge [3]. On the one hand, it is necessary to strengthen students' preview: students need preview with questions and feed back self-study questions to experimental teachers before class; Secondly, under the premise of full preview, the heuristic teaching method is adopted. The students in the experiment class are asked more "why" by the teacher, so as to promote the students to think more about the knowledge they will have learned. The principles of biochemistry and molecular biology are widely used in our daily work and life. Therefore, we could combine the life experience to introduce life examples in the process of explaining the experimental principles in class to inspire students to think actively. For example, "why does one have a bad appetite when having a fever?" could be set as a question in the "salivary amylase optimal pH measurement" experiment, and "how to obtain the target protein in engineering bacteria?" could be set as a question in the experiment of “purification and identification of serum gamma globulin,” so as "how to distinguish the inferior milk powder from the superior milk powder” could be set to question or explain the "toxic milk powder event" caused by cyanuric chloride in the "protein content test of biuret" experiment.

Strengthen the Speculation of Teaching Content

Most of the basic experimental courses are only designed for some experimental technology. In the experimental course, the training of experimental operation were accepted by students passively. Students do not know the circumstances in which to use these experimental technologies, nor what kind of scientific problems these technologies could solve. Moreover, it is impossible to integrate theory with practice and integrate knowledge [4]. Therefore, to increase the speculation of experimental teaching content will undoubtedly help to improve students' ability to apply biochemical and molecular biology experimental skills and enhance students' more comprehensive and in-depth understanding of theoretical knowledge.

Introduction of Comprehensive Experiments

Many experimental techniques involved in biochemistry and molecular biology experiments could be extended to many fields of life science. A complete scientific research project could be completed by using these technical methods [5]. Therefore, strengthening the relationship between seemingly isolated experimental techniques is helpful to improve students' ability of applying experimental skills.
Comprehensive experiments are composed of multiple single experiments with correlation. Comprehensive experiments focus on the practicability of technology, involving some relatively novel and commonly used technologies, and each experiment is not isolated, but one link one by one, and each step of operation should be careful, otherwise the final results will be affected. For example, the extraction and identification of plasmid DNA is accomplished by 3 small experiments: (1) the extraction of plasmid DNA; (2) the determination of plasmid DNA concentration using spectrophotometer; (3) the identification of plasmid DNA is agarose gel electrophoresis. This kind of continuous experiment design could let students fully understand the role of each step in the overall experiment, and whether the previous experiment is successful will directly affect the next experiment. The comprehensive experiment focuses on the training of students' basic experimental operation skills and the ability to solve practical problems by comprehensively using the learned theories and technical knowledge, and at the same time, it could stimulate students' enthusiasm for scientific research and innovation consciousness.

**Introduction of Mind Mapping Mode**

Biochemistry and molecular biology experiments cover a wide range of contents, involving different kinds of equipment and various experimental methods. Mind mapping helps students to sort out ideas and master knowledge system [6]. Take the experiment of "extraction and identification of plasmid DNA" as an example. First, take "extraction and identification" as the central theme, list the relevant knowledge points of nucleic acid chemistry around this center, such as the chemical composition, spatial structure, function and physical and chemical properties of nucleic acid. While combing the knowledge points, the experiment principle of this experiment course is introduced. The knowledge is connected in a reasonable way to form a map, and the appropriate experiment method is selected according to the actual situation. Second, we could expand the introduction of recombinant plasmids, such as "cut, connect, transfer and check," so that students could form a whole of the relationship between plasmids extraction and identification knowledge points, which is convenient for students to understand and master. In addition, the combination of theory learning and experiment could enhance students' comprehensive and in-depth understanding of theoretical knowledge.

**Establish Scientific Assessment System**

The establishment of a correct, comprehensive and scientific evaluation system of experimental course results plays an important role in mobilizing students' initiative and enthusiasm in learning [7]. The scientific assessment system based on the concept of "knowledge application and knowledge innovation" could strengthen students' understanding, application and innovation of the knowledge they have learned, enhance their speculation, and improve the effect of experimental teaching.

In the evaluation of biochemical experiment results, a multi-directional evaluation model should be adopted. The experiment assessment should be divided into three parts: theory assessment, operation assessment and result analysis assessment. Theoretical assessment mainly examines students' mastery of basic principles; operational assessment mainly examines students' mastery of experimental operations, including whether they could correctly use experimental instruments, whether they could carefully observe and record experimental phenomena in detail; results analysis assessment mainly examines students' ability to analyze experimental results and flexible application of knowledge. For example, two or three DNA bands will showed in many students' electrophoretic results in the "Plasmid Extraction and identification" experiment. The learned knowledge, literature, multimedia and network should be used to analyze the experimental results, such as "whether the experimental results of non single strip are credible" and "the reasons for non single strip" and the analysis contents need to be written into the experimental report. At the same time, the students are required to conclude the precautions in the experiment according to the operation process of the experiment. In addition, students are required to list 2-3 applications of experimental technology in scientific research about the knowledge they have learned in the experimental course by consulting materials.

Although the operation of the assessment method is relatively trivial, it can fairly, objectively and reasonably evaluate the students' experimental quality and skills. The assessment method improves
students’ ability of knowledge application and innovation, enhances students’ speculative ability, improves students’ experimental operation skills and comprehensive quality, and lays a foundation for future research work.

Enhance the Interaction of Teaching Content

Biochemistry and molecular biology experiment teaching is actually a face-to-face and close distance teaching process. Therefore, the application of discussion teaching to enhance the interaction of teaching content can fully mobilize the enthusiasm and exploration spirit of students [8].

Taking the comprehensive experiment as an example, teachers and students interact through discussion and questioning on the basis of preview. At the beginning of the experiment class, a practical problem which inspires the students to think about related to this experiment should be put forward by the teacher. And then students consider how to design experiments to solve this problem if they encounter it in the research. The solutions are put forward by group discussion of students who use their theoretical knowledge. Teachers and students discuss the feasibility of each method together, and choose the most suitable solution according to the existing experimental conditions of the laboratory. Then the experimental course is based on the textbook, but higher than the textbook. Taking the "salivary amylase optimal pH value measurement" experiment as an example, the teacher introduced the experimental items and objective requirements. The students are divided into several groups. Each group needs to design a reasonable and feasible experiment plan and operation steps. Then the teacher guides the plan and puts forward suggestions for improvement. After the experiment plan is passed, students can choose the experimental consumables, prepare the experimental reagents, and operate the relevant experimental instruments under the guidance of teachers. The whole experiment process not only improves the students’ ability of finding and solving problems by using what they have learned, but also stimulates the students’ enthusiasm for scientific research and innovation consciousness.

Conclusion

The goal of Biochemistry and molecular biology experiment teaching is to cultivate students’ innovative ability and scientific research thinking, fully mobilize students’ interest and initiative, and enhance students’ understanding and mastery of experimental theory and experimental skills. This has laid a solid foundation for students to understand and master the theoretical courses of Biochemistry and molecular biology.

Acknowledgement

This research was financially supported by the Key projects of Heilongjiang Institute of Higher Education (NO.16Z052).

References

[1] Y. Gao, M. Han and F.F. Li. Practice on the reform of biochemistry and molecular biology experimental teaching in medical colleges. J. Biol, 31 (2014) 103-105.
[2] X. Li, Y.H. Zhao and X.J. Li. Enforcing the laboratory construction to improve the teaching quality of molecular biology experiment. J. Res Explor lab, 35 (2016) 135-138.
[3] C.L. Xia, J. Zhang and Y. Wang. The application of "Problem-based Teaching" method in the experimental teaching of Biochemistry and molecular biology. J. Educ teach forum, 32 (2018) 277-278.
[4] S.M. Wang, L.F. Pan and H.X. Shao. Thoughts and suggestions on molecular biology teaching for students of preclinical medicine. J. China med educ tech, 28 (2014) 190-192.
[5] H. Rong, H.T. Liu and C.R. Wang. Integrating Scientific Research into Biochemical Experiment Teaching to Improve Students' Scientific Literacy. J. AnHui agr science bull, 24 (2018) 111-112.

[6] T.H. Yi, S.Y. Li and C.J. Zhang. Analysis of improvement method of teaching quality of biochemistry experiment. J. China heal ind, 17 (2017) 88-89.

[7] H.X. Jiang, F.Z. Wang and Z.X. Chang. Improve the teaching quality of biochemistry experiment to lay a perfect foundation for the professional knowledge of biotechnology students. J. Lab science, 21 (2018) 150-152.

[8] L.L. Xing and X.L. Fei. Research on the role transformation of teachers and students in the discussion teaching mode in the mixed teaching environment. J. Modern educ science, 3 (2019) 100-104.