

Teaching Design and Practice of Cell Biology Experiments in Open Experimental Mode

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Abstract: Talent training is the top priority of high-quality development of universities, and university laboratories are important bases for practical teaching and cultivating innovative talents. As one of the important disciplines in the field of life sciences, cell biology has the characteristics of novel content, mature methods and diversified technical means in the design and implementation of the open experiment “Basic Technology and Application of Animal Cell Culture”, which is student-oriented, guided by cultivating students' comprehensive quality and innovation ability. The teaching effect shows that the development of this open experiment is indeed effective in cultivating students to explore the laws of life activities, stimulate their interest in scientific research, and improve their innovative scientific thinking, which lays a foundation for the school to cultivate comprehensive innovative talents.

1. Introduction

In the early days of university education, supporting students to engage in practical activities or participate in scientific research is an important way to cultivate top-notch innovative talents. The laboratory is an important base to achieve this goal and a cradle for colleges and universities to incubate innovative talents. Laboratories should break down barriers and build an open experimental platform for students, fully mobilize students' interest in learning, improve students' knowledge structure, stimulate students' innovative thinking, and cultivate students' practical innovation ability^[1].

With more than 30 years of experience in open laboratories, our university has taken it as its responsibility to improve students' practical ability and innovative quality cultivation in various laboratories at all levels, and the university has also provided strong support from various aspects such as system guarantee, information management, and platform construction^[2].

Cell biology is an experimental and comprehensive basic discipline. On the one hand, it is an important frontier discipline in modern life sciences, gradually penetrating into multiple branches such as immunology, genetics, molecular biology, and pharmacology^[3]. On the other hand, as an important hub, it is also intersecting with other disciplines. Cell biology experiments are essential skills for biotechnology students in our university, but in the context of the cultivation of major categories and the implementation of general education, how to train students to explore the laws of

life activities, stimulate their interest in scientific research, and improve their innovative scientific thinking through the experimental teaching of this course is an important and arduous task^[4]. We combined the important cell biology experimental technology, cell culture technology and the determination of cell proliferation, and opened an open experiment “Basic Technology and Application of Animal Cell Culture” for all undergraduates. The design of experimental teaching should be student-oriented, and ultimately cultivate students' comprehensive quality and innovation ability, which can not only cover the basic knowledge of cell biology, but also teach students basic experimental skills, and insist on linking theory with practice.

2. Design and implementation of open experiments

The openness of the laboratory is not only reflected in the openness of experimental projects and equipment, but also the openness of laboratory time and space. We need to take into account the laboratory conditions while completing the goal of cultivating students' comprehensive innovation ability. The author designed the open experiment into five modules: biosafety, basic techniques of animal cell culture, the effect of antitumor drugs on cell proliferation, virtual simulation experiments, and writing a summary report. In general, it has the characteristics of novel content, mature methods, and diversified technical means.

2.1. Biosafety education

University laboratories play an important role, but possible safety accidents also greatly threaten the personal safety of teachers and students. Laboratory safety has received much attention, and safety education and training is the most important part of laboratory work^[5]. The students who participated in the open experiment came from different colleges across the university, with different professional orientations, covering liberal arts and sciences, and most of them were freshmen. The vast majority of them are entering the laboratory for the first time, and in order to make up for the gaps in students' safety knowledge, laboratory safety access training is the first link^[6].

The instructor first takes the safety accident case as the starting point to let the students understand and pay attention to the importance and necessity of laboratory safety access training. Then, the laboratory related equipment such as the autoclave is used as an example to introduce the general safety knowledge of the laboratory, including the classification and disposal of laboratory garbage, the storage and use of chemical reagents, and the wearing and facilities of personal protection. Due to the particularity of biological experiments, the course focuses on explaining biosafety, the hazards of biological laboratories and the routes of exposure. The teacher guided the students through the layout of the laboratory and related facilities, such as cell culture rooms, ultra-clean workstations or biological safety cabinets, and explained the hierarchical management system of the biological laboratory and the treatment of exposure hazards.

2.2. Basic techniques of animal cell culture

In vitro culture of animal cells is one of the most basic and important techniques for cell biology experiments. The open experiment designed experimental techniques such as cell recovery and cryopreservation, subculture, cell counting, and cell plating, involving the operation training of autoclaves, ultra-clean workbenches, carbon dioxide incubators and gas cylinders, micropipettes, ultra-low temperature freezers, liquid nitrogen tanks and other equipment. Through a series of strict and standardized training, students are trained to have a rigorous scientific attitude and scientific thinking. The implementation of these experimental techniques requires considerable perseverance and patience on the part of the participants in order to "live" and "well" the cells. If teachers only

teach students mechanical operations, it will greatly reduce students' enthusiasm and interest in learning, which is contrary to the original purpose of education.

Combined with the current research hotspots, the open experiment selected human cervical cancer cells HeLa as the experimental material. Abnormal cellular life activities are inextricably linked with the occurrence of diseases, and the two can be organically integrated in experimental teaching. Among them, cancer has always been one of the problems that need to be tackled urgently in the field of biological and medical research^[7]. The occurrence of cancer is related to the induction of external and internal adverse factors. In the implementation of open experiments, teachers should actively guide students to develop the fine habits of strict self-discipline, punctuality and orderliness, and step-by-step, and inspire students to establish a life outlook of respecting nature, revering life, and being grateful for life.

2.3. Detection of cell proliferation

The open experiment is open to the whole school, and the students who choose the course have different knowledge backgrounds, so it is necessary to take into account the general knowledge and specialization. In the open experimental design, celastrol, a pentacyclic triterpenoid monomer extracted from *Tripterygium wilfordii*, was selected as the research object. Studies have shown that it has significant antitumor activity^[8]. Our laboratory has done relevant experiments in the early stage, which confirmed that triptolide can inhibit the growth of HeLa cells in small doses, and the anti-tumor mechanism needs to be further studied. We designed the contents of establishing an in vitro model of tumor cells, using MTT method to detect the effect of drugs on cell proliferation, measuring and calculating cell survival rate, and statistical analysis of experimental results.

2.4. Virtual simulation experiment (optional)

According to the main content of the open experiment, relying on the MOOC of Chinese universities and the national virtual simulation experiment teaching project sharing service platform, the teaching resources are integrated, the knowledge graph is strengthened, and the relevant theoretical and practical teaching is carried out from the perspective of digitalization^[9].

2.5. Summary and assessment

The assessment of open experiments is mainly composed of two parts. The first is the students' performance in the experimental process, whether they have the innovative spirit of active exploration, whether they have a rigorous scientific attitude, whether they are standardized. Second, students are required to write a summary report of the experiment, so as to train their ability to consult the literature, organize the data, and logical and rigorous scientific thinking.

3. Effectiveness of open experiments

After three years of practice, the students can complete the experimental content systematically, in-depth and planned, and have received all-round training and training in experimental design, program implementation, and result analysis.

The students learn about relevant technologies and cutting-edge trends at home and abroad through literature research, which enhances their interest and enthusiasm for life sciences and cultivates their spirit of truth-seeking scientific exploration.

In the process of open experiment design and implementation, the main position of students is highlighted, the ability of students to think independently and analyze and solve problems is enhanced,

and the students' practical ability, engineering awareness and scientific literacy are improved. Bai of Information Science and Technology summarized in the report, "Through this open experiment, we use control variables, control and other methods to set up our experiments to obtain the results we need. These two experimental methods are what we need to master and be able to understand their connotations, and finally internalize them into our thinking, so that we can use this scientific thinking to abstract, analyze, and solve problems when analyzing problems in the future. We can feel the charm of biology in experiments, and at the same time, our own thinking, hands-on ability and operation ability have also been cultivated and exercised."

Through the extensive development of open experiments, it provides students with a more free and broad learning space, enhances the communication and understanding between teachers and students, and stimulates and mobilizes students from different disciplines to explore the field of life sciences. As Xiang from the Electronic Information Experiment Class wrote, "This is a very meaningful and fun experiment. If I had the opportunity, I would still choose experiments related to biology, which really gave me a lot of gains, and it will definitely be a very meaningful experiment that I encountered in my four years of college." Dong from the social science experimental class o, although she is a liberal arts major, still has a great enthusiasm for science, engineering, agriculture and medicine, and she believes that "open experiments make my knowledge no longer just stay in textbooks, but can also be applied to real life. Experiments should not only rely on interest and enthusiasm, but also have a rigorous experimental attitude. This experiment gave me a sense of satisfaction and pleasure in the application of theory, exercised my practical ability, and I will continue to participate in open experiments in the future!" Since then, she has participated in more experimental projects in the School of Life Science and won awards in the College Student Innovation and Entrepreneurship Training Program.

4. Outlook

At present, there are 26 open experiments in the School of Life Science, covering the comprehensive quality training of college students, students' participation in scientific research, and the application of large-scale instruments. Among them, there are 16 experiments in our teaching center, involving cell biology, microbiology, molecular biology, anatomy and physiology, etc. How to make use of the discipline and geographical advantages of the teaching center, integrate all directions of life science, build a knowledge map, benchmark first-class universities at home and abroad, conform to the trend of digital empowerment education and teaching, form a coherent and integrated life science practice education system, and achieve the goal of cultivating innovative talents is the direction we need to think about and improve in the next step.

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