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Teaching Exploration and Practice of Microbiology Engineering Course Focused on Biotechnology Specialty with Medical Background

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Abstract: Training applied talents suitable for microbial fermentation production in the field of biomedicine is the main goal of the microbial engineering course for biotechnology majors in medical colleges and universities. This paper summarizes our exploration and practice of teaching reform in microbial engineering course, mainly including reorganized teaching content, introduced the online and offline mixed teaching mode, optimized assessment system, which comprehensively improved the students' practical and innovative application abilities. It provides reference for the establishment and improvement of microbiology engineering courses in medical colleges.

Keywords: Microbiology engineering course; Teaching exploration and practice; Medical University

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With the increasingly extensive application of microbiological engineering in the field of biomedicine, many medical colleges and universities have begun to offer courses of microbiological engineering in the fields of biotechnology and bioengineering. The field of medicine and health is the most widely used, the most significant achievements, the most rapid development and the greatest potential field of microbial engineering. The use of microbial engineering technology can improve the production of medicine from all aspects, develop new biological drugs, improve medical means, improve the level of social medical treatment. However, the teaching content and system of microbial engineering, which is applied in the field of biomedicine, should be different from that of light industry, food and agriculture. Therefore, it is imperative to reform the teaching content and system of Microbial Engineering in combination with professional background and characteristics. This paper summarizes the personal experience engaged in the microbial engineering course teaching in medical university.

1. Evolution and development of microbial engineering course

The engineering that originally utilized microbial producing was included in the scope of fermentation engineering. However, with the development of multidisciplinary cross-infiltration arises, the understanding of many new functions has been deepened, people greatly have been expanding the scope of production with microorganisms (such as microbes can be applied to environmental protection and biometallurgy), and fermentation engineering has gradually developed into microbial engineering. Modern microbial engineering is a technical system that combines traditional fermentation technology and new technologies such as modern genetic engineering, cell engineering, metabolic engineering, bioinformatics engineering and computer control. Microbiology engineering courses involve many theories and techniques, and due to historical reasons, many textbooks tend to be more food-oriented in content

arrangement. Therefore, the focus of the teaching reform of microbiology engineering courses in medical specialty lies in the choice of teaching content.

2. Set teaching content and system reasonably combining medical speciality characteristics

Taking into account the differences in the characteristics of different majors, the teaching content and teaching resources used mainly from light industry and food speciality are obviously lacking in pertinence. Through the reform of teaching content and course system and the construction of course website, we have established the course content and resource system of "Microbial Engineering" with biomedical products as the core, highlighting the course characteristics of "Microbial Engineering" for medical biotechnology and biopharmaceutical majors.

2.1 Emphasize the importance of microbial fermentation in the bio-pharmaceutical industry from the introduction

From the developing history of microbial engineering, although people began to understand the phenomenon of fermentation from natural unconscious brewing, the development of the second-generation microbial fermentation technology (large-scale deep culture technology) was derived from the production of penicillin during the Second World War and from biomedical research. The vast majority of the more than 6,000 antibiotics discovered today are produced by microorganisms. Biological amino acids, vitamins, steroid hormones, medicinal enzymes, enzyme inhibitors, and some biological products such as vaccines and genetic engineering drugs are derived from the fermentation production of microorganisms. It can be said that today's biomedical production and microbial fermentation engineering are inextricably linked. The output of main products will increase from 26.29 million tons in 2016 to 31.413 million tons in 2020, with an average annual increase of 4.6%. There are over 18000 microbial fermentation production enterprises in China, and the output value of China's biological fermentation industry is 249.68 billion yuan in 2020. After obtained introductory of the course, the students realize the close relationship between their majors and microbiology engineering, thus stimulating their enthusiasm and activity for studying microbiology engineering courses.

2.2 Guide students to deeply understand the industrial fermentation strains in the field of medicine

Most of the students in medical schools initially know microbes from pathogenic microorganisms. In the microbiology engineering curriculum, teachers should make students recognize the two sides of microbes, that is, although some pathogenic microorganisms can cause human diseases, many microorganisms are beneficial to humans. For example, many kinds of strains producing drugs are from nature. As long as people select suitable microbial species, they can make use of them to produce many drugs and biological products that can be used in clinical practice. With the integration of molecular biology and genetics, genetically engineered bacteria like E.coli and yeast can be constructed by genetic engineering, which in turn produces the products we need. In teaching, teachers can also combine work experience to introduce students to the traditional methods of screening beneficial strains from nature. For example, we have used conventional methods to screen out a kind of microbe from the soybean meal, which can produce plasmin to treat cardiovascular disease. Mastering the knowledge of genetic engineering and molecular biology is very important for students in medical colleges. Strengthening the teaching of genetic engineering bacteria will not only help students truly understand microbes, but also help students master and consolidate genetic engineering and molecular biology.

2.3 Introduce the principle of fermentation production from pharmaceutical products

Different from other engineering colleges focusing on light industry, food and chemical energy, the focus of microbiology engineering courses in biotechnology specialty of medical colleges should be placed on the production principle of biomedical products. Many drugs and biological products are mostly products of secondary metabolism of microorganisms, so the introduction of the principle of fermentation production should focus on the production of secondary metabolites. Typically, secondary metabolites are produced when the microorganisms grow to a certain stage, and the primary metabolites are coupled to the growth of the microorganisms. When secondary metabolites are synthesized, rational fermentation production mode and process conditions can be used for optimal adjustment. In teaching, teachers can use the fermentation production process of antibiotics as an entry point. By comparing the fermentation methods of primary metabolites and secondary metabolites, students can grasp the characteristics of different fermentation methods and clarify the differences between different fermentation methods to better distinguish and use. In addition, teachers begin with the specific products and develop the principle of fermentation production in the classroom teaching, which is more able to attract students' attention and improve students' interest in learning.

2.4 Put emphasis on the application of microbial fermentation in the field of biomedicine

Microbial engineering is key to the process of biotechnology industrialization. The field of medicine and health is the field with the most extensive application, the most significant achievements, the fastest development and the greatest potential. The use of microbial engineering can improve the production of medicines from all aspects, develop new ones, improve medical treatment and thus improve the level of social medicine. Therefore, microbial engineering has broad developing prospects in the field of biomedicine. According to the characteristics of biotechnology and bioengineering, the focus of microbiology engineering courses should be based on the application of microbial fermentation in biomedicine. Microbial engineering courses generally arrange the content of the lectures with the main line of microbial strain selection, medium preparation, seed expansion and cultivation to the control of the fermentation process. At the end of the course, application examples of microbial fermentation production are usually arranged. The examples string the knowledge points students have learned together to form a system to deepen understanding and memory. When selecting application examples, teachers should fully consider the characteristics of the subject, highlight the professional characteristics of the course, and can choose antibiotics, medicinal vitamins, amino acids, etc.

3. Adopt diversified teaching methods to effectively improve teaching effectiveness

In the teaching process of microbial engineering course, we pay more attention to the comprehensive application of various teaching methods, which can achieve a multiplier effect. With the rapid development of information technology and means, we introduce Internet information technology into teaching, and establish and use online teaching resources to expand the effect has greatly improved. The establishment of Aike teaching support platform has become the main position of online classroom auxiliary teaching. The Wechat public account has become an auxiliary teaching platform for extracurricular knowledge expansion and interaction with students. Moreover, “Rain Classroom” embedded online teaching tool improves student participation in class. The establishment of network examination database system and the use of online test system realize the paperless mode for examination.

At present, Online and offline mixed teaching mode gives vigour to microbial engineering classroom. The arrangement of blended teaching is divided into three parts: pre-class, on-class and after class. Teachers publish independent learning goals and assign independent learning assignments on the online teaching support platform in pre-class stage. In on-class stage, the teacher explain the knowledge points in detail, directly invoke students’ initiative in studies, timely intersperse classroom discussions, skillfully use flipped classroom and diverse modes to improve the teaching effect. In after class stage the teachers publish analysis of key and difficult points and assign homework for students to review and consolidate on the online auxiliary teaching platform.Through online questionnaire and survey, our online and offline mixed teaching mode obtained more than 85% of the students support and recognition.

4. Pay attention to the improvement of students’ practical ability through combining theory with practice

The microbial engineering curriculum is closely related to the production practice. Teachers should try to introduce the production and application examples for biological products into the classroom during the teaching process. Additionally, because of microbial engineering course’s strong applied characters, the teaching of experimental course is the key to the combination of theory and practice. In order to improve the integrity, purpose and interest of experimental teaching, teachers can combine their research topics with student experiments. For example, in teaching practice, we involve students in the research-related experiments of “utilizing genetically engineered bacteria to produce interleukin-1 (IL-1)”, which is based on finding suitable fermentation conditions and parameters. It can make students familiar with the small-scale fermentation production process in the laboratory, master the use of small fermentors and optimization measures of fermentation production conditions, effectively stimulate students’ enthusiasm for learning and experimental interest, and improve students’ professional ability.

Additionally, we organized students to visit the factory, so that the theoretical knowledge that students learned in the classroom is combined with the actual production. Through the visit to the fermentation production plants, the students saw more than 10,000 tons of fermentation tanks, learned the scale of the factory’s fermentation production, and generally reflected that the visit was rewarding.

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