Exploration and Practice on Curriculum Ideological and Political Construction of Microbiology: A Case Study of the Class "Nutrients for Microorganisms and Their Functions"

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Abstract Microbiology is an important basic course in life science, which contains many ideological and political elements. In this paper, a teaching case was designed with "Nutrients Microorganisms and Their Functions" as the content to explore curriculum ideological and political elements in the course. According to the classroom teaching objectives of this class, this paper combed the professional knowledge points and explored ideological and political elements with the theme of "enhancing ecological connotation and feelings for agriculture, rural areas and farmers". The depth and breadth of teaching content were expanded by extending knowledge points and typical characters' deeds, and ideological and political elements were integrated into classroom teaching by various teaching methods. The implementation of the case has improved teachers' awareness and ability of ideological and political education in professional courses, and improved the level of ideological and political education construction in *Microbiology*. The ideological and political materials in the case can be used as a reference for other teachers.

Key words Microbiology; Curriculum ideological and political education; Classroom teaching

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In 2016, General Secretary Xi Jinping emphasized at the National Conference on Ideological and Political Work in Colleges and Universities that we should make good use of classroom teaching as the main channel, adhere to the central link of establishing moral integrity and educating people, and integrate ideological and political work into the entire process of education and teaching, so as to meet the needs and expectations of students' growth and development[1]. *Guiding Outline of Curriculum Ideological and Political Construction in Colleges and Universities* issued by the Ministry of Education in 2020 pointed out that it is necessary to comprehensively promote curriculum ideological and political construction, integrate value shaping, knowledge imparting and ability training, and build a comprehensive pattern of whole-process and all-round education[2]. At present, China's higher education has entered a new era of building curriculum ideological and political construction in an all-round way. It requires teachers to constantly update educational concepts, improve teaching methods, and strive to combine ideological and political education with professional education, so that students can receive good ideological and political education while receiving professional knowledge.

Microbiology plays an important role in the field of life science, and it mainly studies the law of microbial life activities and its related applications in production and life. It is not only a basic discipline with strong theory, but also an important cornerstone of frontier disciplines such as modern molecular biology, modern genetics and modern biotechnology. It is also an applied and practical subject related to hot issues such as environmental protection, food safety and green agriculture[3-4]. No matter for scientific research or social service, there are many typical cases and representatives of people with the significance of ideological and political education in microbiology courses, which involve ideological and political elements such as patriotism, national responsibility, scientific spirit, awareness of agriculture, rural areas and farmers and environmental protection, and provide good materials for curriculum ideological and political education[5-6]. Therefore, the specialized courses of microbiology should pay attention to the imparting and application of knowledge, and pay more attention to the excavation and guidance of value, so as to implement the educational purpose of specialized courses. In this paper, taking the content of "Nutrients for Microorganisms and Their Functions" in Xin Mingxiu's *Microbiology* (4th edition) as a teaching case, professional knowledge and ideological and political learning content were designed based on teaching objectives, and typical characters' deeds and cutting-edge scientific applications were utilized to enable students' analysis on microbial functions and their practical applications in production and life, enhance integration of theory, practice, and scientific research and enable students to apply what they have learned. It is hoped that through the design and implementation of curriculum ideological and political teaching mode of microbiology, students' professional quality and scientific spirit are improved, and ecological connotation and feelings for agriculture, rural areas and farmers are enhanced. The implementation of this case can also provide reference for the research work of ideological and political education reform in related courses.

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Classroom Teaching Objectives

Knowledge objective: Students can master the concepts and

functions of microbial carbon source, nitrogen source, inorganic salts and growth factor. They should be familiar with the types of carbon and nitrogen sources commonly used in industrial production. They should understand the important role of water in microbial cells.

Ability goal: Students should be able to analyze the common types of carbon and nitrogen sources in life and production using the characteristics of microbial nutrition, and have the ability to understand and design related topics.

Emotional goal (ideological and political education goal): We aimed to cultivate students' sense of national pride and foster the patriotic sentiment of "caring about agriculture, rural areas and farmers and revitalizing China" and the sense of responsibility for the times. Though analysis and teaching of classic cases, we aimed to cultivate students' awareness of ecological and environmental protection, and encourage them to become practitioners of the saying 'lucid waters and lush mountains are invaluable assets'. We also wanted to cultivate students' scientific thinking and critical thinking ability, and enhance students' sense of teamwork and initiative thinking ability.

Design of Combination Points of Ideological and Political Education in Class

The basic teaching content of the section "Nutrients for Microorganisms and Their Functions" in *Microbiology* (4th edition) includes the concepts and functions of carbon sources, nitrogen sources, inorganic salts, and growth factors required for microbial growth. Nutrients required for the growth, reproduction and completion of various physiological activities of different microorganisms are the basis for their practical application in production and life. Therefore, the teaching design of this lesson should focus on strengthening the integration of theory with practice and scientific research, so that students can apply what they have learned and skillfully integrate ideological and political elements. Therefore, according to the teaching objectives of this lesson, we deeply dug the ideological and political elements contained in the teaching content of this lesson, and adopted various teaching methods to organically integrate professional education with ideological and political education. For example, on the basis of teaching the basic content in the class, ideological and political elements are integrated in the way of extending knowledge points and typical characters' deeds, to implement the purpose of educating people in professional courses. The selection of ideological and political materials is mainly guided by concept put forward by General Secretary Xi Jinping that "lucid waters and lush mountains are invaluable assets", and takes "cultivating ecological connotation and caring for agriculture, rural areas and farmers" as the theme, and latest scientific research progress and typical case studies related to the basic knowledge content of the textbook are excavated to organically integrate ideological and political elements. In addition, in the design of classroom teaching methods, the combination of online and offline teaching is adopted. That is, students teach themselves online and discuss in groups offline, so as to cultivate students' sense of teamwork and ability of active thinking. The specific design of the combination points of ideological and political education in the class is shown in Table 1.

Table 1 Design of combining classroom ideological and political education with professional knowledge points

Teaching content	Integration points of ideological and political education	Integration mode	Teaching method	Ideological and political types
Types and functions of carbon sources	Application of microorganisms' carbon source utilization characteristics in carbon neutrality and bacterial protein production: *Clostridium autoethanogenum* utilizes one-carbon gases to produce high-protein biomass by fermentation.	Frontier cases of science	Teaching, inspiration and induction by teachers	National pride and the consciousness of ecological environment protection
Types and functions of nitrogen sources	Nitrogen-fixing microorganisms use N_2 to provide nitrogen for plants. They provide green nitrogen fertilizer and promote the sustainable development of agriculture.	Typical characters' deeds	Teaching by teachers and case analysis	Patriotic feeling of "caring about agriculture, rural areas and farmers and revitalizing China" and sense of responsibility for the times
Inorganic salts and growth factors	Teamwork for in-class discussion of part content and online self-study	Group discussion among students	Inspiration and induction and flipped classroom	Teamwork consciousness and active thinking ability
Functions of water	Playing a publicity video about water shortage and pollution	Playing video cases	Teaching by teachers	Strengthening environmental awareness and encouraging students to be practitioners of "lucid waters and lush mountains are invaluable assets"

Details of Classroom Activities

Classroom teaching consisted three parts: classroom introduction, classroom activities and class summary. The specific process is as follows:

Classroom introduction

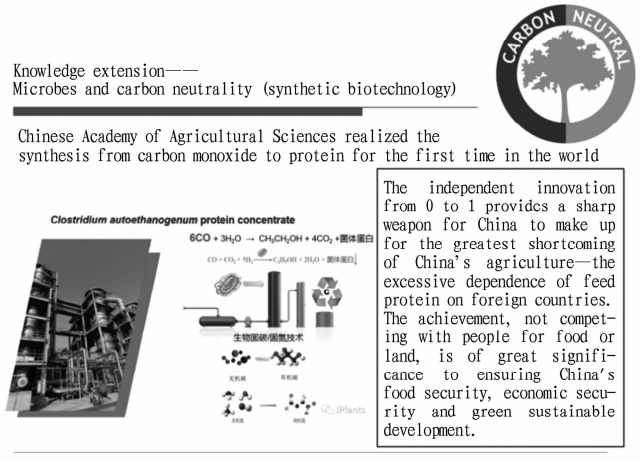
Students are enlightened by the saying that man is iron and

food is steel and then what can microorganisms eat to grow. Students are guided to review and analyze the composition of cell elements in organisms and introduce nutrients needed by microorganisms. There is a "nutritional unity" among microorganisms, animals and plants. The classroom teaching content "nutrients required for microbial growth and their functions" is introduced. It is aimed to cultivate students' ability to integrate, analyze and solve problems. The teacher broadcasts CCTV news links and the report on Nature which described for the first time that bacterium (*Ideonella sakaiensis*) can "devour" PET, and it can degrade plastic waste at 30 ℃. The teacher explains latest literature research results of Nature, and further teaches that microorganisms can use plastics and emphasizes the universality of microbial recipes. Next, the teacher guides students to analyze what nutrients PET provides for this bacterium. It strengthens students' scientific thinking consciousness, and improves students' scientific thinking ability and inquiry ability.

New lesson teaching

Teacher's teaching link When the teacher teaches the knowledge points of carbon sources needed by microorganisms, the basic knowledge of the textbook is introduced with carbon-based life as the starting point. The emphasis is put on the concept of carbon source, and microorganisms are classified according to their characteristics of using carbon source. And the teaching focuses on introducing the types and functions of carbon source. Available carbon sources are mainly sugar, oil and fat, cellulose, hydrocarbons and alcohols, and CO_2. They can play the functions of removing three wastes and oil pollution. On this basis, students can form the knowledge of analyzing existing problems in the current environment by using the diversity characteristics of carbon sources utilized by microorganisms. Moreover, the teacher introduces latest scientific frontier reports on microbial utilization of carbon sources to introduce the application of microbial utilization of carbon sources in carbon neutrality and bacterial protein production, that is, the latest research achievement of China Academy of Agricultural Sciences, which is the first example to realize the synthesis of carbon monoxide to protein in the world. This achievement does not compete with people for food or land, and contributes to solving problems including environmental pollution, carbon neutrality and food crisis. It is also an independent innovation from 0 to 1, which is of great significance to ensuring China's food security and green sustainable development. This teaching content aims to enhance students' national pride and eco-environmental awareness (Fig. 1).

When introducing the basic knowledge of nitrogen sources, the teacher uses pictures of nitrogen source pollution crisis to guide students to think about the harm of nitrogen sources. The concept and types of nitrogen sources is then introduced. Next, taking the honor of microbiology as the topic, the teacher introduces a typical story, Academician Chen Wenxin (Fig. 2). The *Rhizobium* she discovered belongs to the fourth genus of rhizobia discovered by humans and has been officially named as *Sinorhizobium*. Students are guided to pay attention to microbial nitrogen fixation, which is an important subject in the field of biology. It provides "green nitrogen fertilizer" for crops and guarantees the sustainable development of agriculture, and is a hot spot of scientific research at present. This teaching content is helpful to cultivating students' patriotic feeling of "caring about agriculture, rural areas and farmers and revitalizing China" and sense of responsibility for the times.



The teaching materials are from Science and Technology Daily.

Fig. 1 PPT picture of knowledge point extension teaching

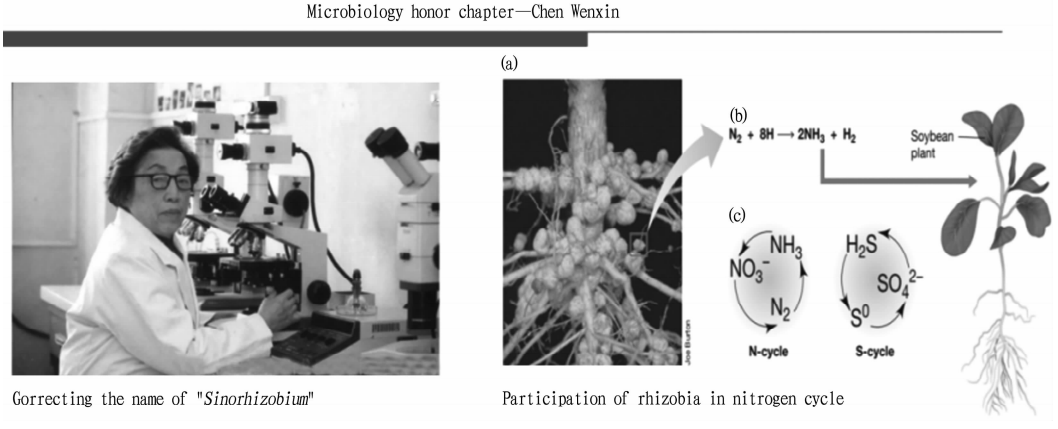


Fig. 2 PPT pictures for teaching of microbiology honor chapter

Diversified teaching links The practice of course ideological and political education is reflected in the teaching content, but also

runs through all aspects of teaching[7]. The combination of diversified teaching methods can make ideological and political elements smoothly and silently integrated into the classroom teaching of microbiology. In addition to normal teaching led by the teacher, the teacher can also adopt diversified teaching methods in classroom teaching of microbiology. When teaching the knowledge points of inorganic salts and growth factors, combined with the online open platform of microbiology that our course team has already built, teaching tasks are assigned in advance, and students are divided into groups to study this part of the content themselves. In class, the teacher plays a movie, analyzes the importance of inorganic salts to life, and introduces inorganic salts needed by microorganisms. Taking iron required for microbial growth as an example, the functions of inorganic salts and the ways of their utilization by microorganisms are introduced. Then, flipped classroom teaching is used to guide students to report the rest of growth factors or inorganic salts needed for microbial growth in groups. The interactive discussion and exchange between teachers and students not only gives students the space to explore and improves the enthusiasm of in-depth study, but also explores the internal motivation of students to explore in depth. It can also cultivate students' teamwork spirit and active thinking ability.

When teaching the functional knowledge of water, the teacher first explains the basic role of water in the growth of microorganisms. Various factors existing in water source have great influence on microbial fermentation and metabolism. Then, Moutai is taken as an example to show that clean and constant water source is very important for microbial fermentation plants. Finally, the teacher plays a propaganda video of water resources to let the students know the importance of water resources. It is necessary to guide students to realize that water ecological environment is an important part of economic output. Students' environmental awareness and sense of responsibility is thus stimulated in a manner of moistening things silently.

Class summary and homework

The course is summarized by answering questions. In addition, the teacher assigns tasks for students to consult the relevant literature on the frontier application of microorganisms in environmental protection. According to what they have learned, students talk about what they can do for the construction of ecological civilization. Moreover, students study in groups, and write a report according to clarifying goals, assigning special topics, reasonably dividing labor, searching data and uploading the paper to the Wisdom Tree Classroom. Such tasks can help students to consolidate the theoretical knowledge learned in class and simultaneously integrate theory with practice. Students' ability to use knowledge is thus enhanced, and their awareness of environmental protection is further strengthened. In addition, curriculum ideological and political education is extended outside the classroom.

Teaching Summary and Reflection

In this teaching case, the section "Nutrients for Microorganisms and Their Functions" was selected, and professional knowledge and ideological and political learning content were designed according to the teaching objectives, with emphasis on imparting and applying knowledge, and more importantly, on excavating and guiding values. In the aspect of achieving the ideological and political goals, the rational use of the ideological and political elements contained in the content itself is considered to avoid turning specialized courses into ideological and political courses. The characteristic methods of "microbiology honor" and "academic education" are adopted as the starting point of curriculum ideological and political education. Taking relevant frontier topics as the carrier of ideological and political education, they not only improve students' professional quality and scientific spirit, but also integrate ideological and political elements quietly and invisibly. In terms of teaching methods, online and offline teaching methods are adopted. By assigning homework after class, students can complete it in groups and upload the homework to the Wisdom Tree Classroom, thereby extending the ideological and political education from in class to out of class. The purpose of educating people by specialized courses is well implemented. Further, the goal of "guarding a section of the canal and planting responsible fields" is truly achieved. In addition, although ideological and political elements are integrated in the course of teaching, it is necessary to evaluate teachers' teaching in time. In the assessment of ideological and political courses, there is still a lack of "smooth and silent" assessment methods.

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