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Innovative Practices of Training Mode for Master's Degree Graduate Students in Biological and Pharmaceutical Sciences Majors with Integration of Industry and Education and Collaborative Training of Dual-Tutors

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Abstract: A prominent issue in current postgraduate education is the lack of essential differentiation between the training of professional degree postgraduates and academic degree postgraduates, which has led to a disconnection between professional postgraduate training and industry demands. To address this issue, this paper takes the Master's program in Biological and Pharmaceutical Sciences at Guangdong Pharmaceutical University as a case study. Targeting the urgent needs of the high-quality development of the biopharmaceutical industry, and aiming to strengthen students' professional competence and sustainable development capabilities while focusing on improving their practical and innovative abilities, this study explores implementation paths for integrating industry, education, and research with a dual-tutor collaborative training model. These include the development of a dual-tutor team, curriculum system optimization, the improvement of a quality assurance system, and the construction of practical training platforms. The paper demonstrates the outcomes of this model and proposes strategies for promotion and future outlooks, offering new ideas for training high-quality talent in the biological and pharmaceutical fields.

Keywords: Biological and pharmaceutical sciences; Integration of industry and education; Dual-tutor collaboration; Pharmaceutical universities

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1. Introduction

There is a significant talent gap in the biological and pharmaceutical sectors, with growing demand for skilled professionals. In recent years, especially following the three-year pandemic, "health" and "life" have become global focal points [1]. As a vital segment of the global pharmaceutical industry, biopharmaceuticals have

emerged as a sunrise industry. With rapid advancements in science and technology, accelerated industrial transformation, technological convergence, and the implementation of national strategies such as "Healthy China" and "Innovation-Driven Development", the upstream and downstream biopharmaceutical industry chain is undergoing vigorous development. The rising demand from enterprises for R&D and production support in biopharmaceuticals has pushed suppliers of processes and consumables to constantly innovate and expand their capabilities. However, due to the industry's high barriers and developmental characteristics, there exists a pronounced shortage of professionals, particularly high-level, application-oriented talents with strong theoretical foundations and the ability to solve practical problems.

Professional degree postgraduate education is centered on professional practice and serves as a vital part of the higher education system. With distinct application- and career-oriented features, it plays a unique role in meeting the industry's demand for high-quality talent. Although China has implemented a professional degree education system for over three decades, during which degree categories have diversified and the scale of education has expanded, the prevailing emphasis on academic over professional degrees persists, with a lingering trend of homogenized development. The main causes are: (1) curricula are overly theoretical and insufficiently aligned with practice, impeding students from applying knowledge to real-world problems; (2) research training is disconnected from industry needs, with topics often confined to academic domains and lacking practical relevance; (3) industry-academia collaboration is shallow, with limited enterprise participation in talent training, and students lack authentic industry exposure [1]. It is thus urgent to promote differentiated postgraduate education to better support high-quality development [2].

In 2023, the Ministry of Education issued the "Opinions on Deepening the Differentiated Development of Academic and Professional Graduate Education", advocating for distinct pathways for academic and practice-oriented innovative talent. The policy emphasizes that "professional degrees should reinforce integration between industry and education, aligning training closely with employment needs, constructing joint training bases, and improving alignment with relevant professional certifications", providing guidance for professional degree education in universities.

Guangdong Pharmaceutical University's Master's program in Biological and Pharmaceutical Sciences, leveraging the Greater Bay Area's economic advantages and favorable environment, has established three research directions, namely the Pharmaceuticals and Cosmetics, Biotechnology and Engineering, and Food Engineering. The program adheres to a "teaching research industry application" integration philosophy, addressing pressing industry challenges through project-based talent training tailored to industrial needs. It provides intellectual support for the biomedical industry in Guangdong-Hong Kong-Macao and enhances competitiveness in the health sector. The program has long cooperated with enterprises to co-construct a postgraduate training system. In 2023, it was approved as Guangdong Province's Demonstrative Industrial College of Cosmetics, the only provincial-level demonstration institution in this field in China.

This paper introduces the beneficial explorations and innovative practices of the dual-tutor, industry-education-research-integrated model in enhancing professional applicability and career orientation, hoping to offer references for the connotative development and distinctive advancement of professional degree education in other universities.

2. Implementation of the dual-tutor system: Enhancing internal and external faculty collaboration

The dual-tutor system plays a crucial role in this model. University faculty are responsible for theoretical

instruction and research guidance, while industry experts focus on practical skill development and the dissemination of cutting-edge industrial knowledge. The synergy between both parties enables an organic combination of theoretical teaching and practical training, thereby enhancing students' comprehensive capabilities. It also promotes deep integration of industry, academia, and research, facilitating the transformation and application of research outputs. For instance, our university has issued several regulatory documents such as the "Management Measures for the Dual-Tutor System for Professional Graduate Education", which provide institutional support for the implementation of this model [3].

External mentors must undergo strict selection and be hired on a merit basis. The program emphasizes selecting mentors from collaborative enterprises that serve as joint training bases. Based on established partnerships, the program proactively reaches out to qualified industry experts. Internal faculty is encouraged to recommend experts with a willingness and capability to engage in collaborative research and training. Industry mentors are integrated into the unified construction of the mentoring team, with roles defined by demand, selection by merit, unified development, and dynamic adjustment. Industry mentors are assigned substantive tasks aligned with training needs, and are subject to performance evaluations and political-ethical assessments throughout the process.

Clear division of responsibilities is maintained between internal and external mentors. Within one month of enrollment, each student selects dual tutors through mutual selection. Industry mentors are chosen from part-time supervisors affiliated with practical training bases. At least once per semester, each program holds mentor meetings to review student progress and coordinate guidance efforts. Master's theses are jointly supervised by both mentors.

To enhance mentorship quality, the program maintains a regular training system. Annual training is provided for new and incumbent mentors, covering topics such as moral education, mentoring responsibilities, and training standards. Mentors participate in academic seminars and exchanges and are encouraged to study at prestigious institutions domestically and abroad. In the past five years, 50 experts have been invited to campus for exchanges, and 12 faculty members have studied overseas [4].

3. Curriculum optimization and quality assurance enhancement

The core concept of the dual-tutor, industry-education integrated model is to transcend disciplinary boundaries by merging education, research, and industry resources into a cohesive training framework. This approach aligns education with industrial needs, driven by research and grounded in pedagogy, achieving a virtuous and integrated loop that fosters innovation and high-level talent.

Guided by practical applications in the biomedical industry and targeted at occupational demands, the program has constructed an advanced curriculum. While retaining essential theoretical foundations, it has expanded practice and frontier-oriented courses, incorporating interdisciplinary content linking biotechnology, pharmaceutical R&D, and production management. Industry experts contribute to course design and instruction, ensuring alignment with market needs. The curriculum emphasizes scientific inquiry, critical thinking, theoretical integration, and practical application. Teaching methods are diversified, utilizing group learning, case studies, on-site research, and simulation training to cultivate students' problem-solving skills [5].

Currently, the program offers 24 courses: 3 core public courses, 13 required specialized courses, and 8 elective courses. Enterprises deeply participate in textbook development and course planning, aligning content with industry standards, production procedures, and project requirements. Practical course components

constitute 53% of instruction, with medical, pharmaceutical, and chemical disciplines organically integrated. Practical sessions comprise 40% of the training. Students engage in enterprise-based R&D projects, aligned with industry needs, enhancing training relevance and achieving a university-enterprise-student win-win model.

Students must complete at least six months of practical training, engaging in multiple roles within the biomedical industry. A combined model of centralized and phased internships integrates professional practice with thesis writing. This dual-phase structure ensures comprehensive skill acquisition.

The program adopts a continuous quality assurance system, creating a closed-loop teaching quality framework. Diverse assessment metrics are used, including practical competence, innovation ability, and research output application. Industry and student feedback is regularly collected to refine the training plan. A graduate tracking mechanism evaluates long-term training effectiveness. Each course must define instructional requirements, develop teaching plans, and hold end-of-semester reviews. The Graduate School organizes teaching supervision mid-term to ensure quality. Practical training is conducted in professional enterprises or organizations and concludes with a learning report and assessment [6].

4. Strengthening university-enterprise collaboration and practical base construction

Practical base construction encompasses teaching, research, entrepreneurship, virtual labs, and on- and off-campus internships. The Greater Bay Area is a strategic stronghold for China's biopharmaceutical industry, with strong policy and locational advantages. The program upholds resource-sharing and complementarity, aiming to support regional biopharmaceutical development. It has built a collaborative talent training entity that integrates education, research, innovation, and entrepreneurship.

Each year, enterprises that match program needs, possess stable production capacity, good development prospects, and sufficient internship capacity are selected for long-term collaboration. Currently, over 30 enterprises and research institutions, including the Guangdong Academy of Sciences Institute of Biology and Medical Engineering, Guangzhou Quality Supervision and Testing Research Institute, Guangdong Perfect Life Health Technology Research Institute Co., Ltd., Guangzhou Huan Ya Cosmetics Co., Ltd., Guangdong Nancore Medical Technology Co., Ltd., Shenzhen Xianggen Biopharmaceutical Co., Ltd. and Juxiangyuan Health Foods (Zhongshan) Co., Ltd., serve as practical bases. The total practice area exceeds 30,000 square meters, with teaching and research equipment valued at over 30 million RMB [7].

Over the years, the program has established numerous platforms, including the Guangdong Demonstrative Industrial College of Cosmetics, the Provincial Cosmetics Engineering Center, the Provincial Key Digital Cosmetics Laboratory, and several joint industry-education laboratories. These platforms support innovation, scientific research, and high-level talent development. The faculty team has won two Guangdong Science and Technology Progress Awards, multiple provincial teaching awards, and students have received national and provincial honors in industry competitions.

4. Conclusion

The integration of industry and education, paired with the dual-tutor collaborative training model, has opened new avenues and infused fresh vitality into the cultivation of Master's students in Biological and Pharmaceutical Sciences. By deeply intertwining academia and industry, and synergizing campus and enterprise mentorship, the model provides multi-dimensional support for student development and offers an innovative pathway for elite

talent cultivation in the field. Future improvements should focus on sustained refinement of the model to meet the evolving demands of the biopharmaceutical industry [8]. With ongoing exploration and practice, this model will continue to yield high-quality professionals and contribute to industry innovation and advancement.

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