

Construction and Implementation of a Case Library for the Molecular Pathology and Histopathology of Aquatic Animals Course

Yucong HUANG, Junhui LI, Shuanghu CAI, Huanying PANG*

Fisheries College, Guangdong Ocean University, Zhanjiang 524025, China

Abstract Given the challenges associated with the molecular pathology and histopathology of aquatic animals course, namely its highly theoretical nature, complex content, limited teaching resources, and the ineffectiveness of traditional lecture-based methods, an analysis of the course's background and practical requirements was conducted. Subsequently, a teaching case library was developed, and case-based teaching practices were implemented. The evaluation of the application effects indicated that the case library effectively stimulated students' interest and initiative in learning, enhanced their theoretical understanding, problem-solving abilities, and clinical practice skills. Furthermore, the overall performance of students utilizing this case library was significantly superior to that of those in traditional teaching settings. The development and implementation of this case library offer a viable approach and serve as a reference framework for the reform of postgraduate course teaching in aquaculture.

Key words Molecular pathology and histopathology of aquatic animals, Case library construction, Case-based teaching, Postgraduate education

0 Introduction

As China's aquaculture industry progressively advances toward greater scale, intensification, and industrialization, breeding densities have increased, and cross-regional circulation has become more frequent. These changes have contributed to the recurrent emergence of single or mixed infectious diseases, which are characterized by "sudden onset, rapid transmission, and substantial economic losses". Annually, disease-related losses exceed 50 billion yuan, making diseases a critical constraint on the high-quality development of China's aquaculture industry. The diagnosis of traditional diseases mainly relies on the observation of clinical symptoms and empirical judgment, which is prone to misdiagnosis and missed diagnosis. The combination of molecular pathology and histopathology is the core technical means to achieve precise disease diagnosis and plays an irreplaceable role in the prevention and control of diseases in aquaculture.

Aquatic animal histopathology elucidates the etiology, pathogenesis, and outcome patterns of diseases through the examination of cellular morphological structures and lesion characteristics in aquatic animal tissues^[1-2]. Molecular pathology investigates the etiology, pathogenesis, morphological alterations, and functional impairments of diseases in aquatic animals at the level of biological macromolecules, including nucleic acids and proteins, thereby offering valuable insights for clinical diagnosis, treatment, and prognosis evaluation^[3]. This discipline expands traditional patho-

logical morphology observations to the molecular level, offering a novel perspective for understanding diseases. Molecular pathology and histopathology of aquatic animals serve as essential bridging courses in postgraduate education related to aquatic animal medicine and aquaculture. They hold a central role in the training of master's degree students specializing in aquaculture and animal medicine at agricultural and forestry colleges and universities.

This course is distinguished by its highly theoretical nature, complex content, and limited class hours, making it one of the more challenging courses within the postgraduate curriculum. Furthermore, the course currently lacks dedicated teaching materials, with existing resources being scarce and dispersed. The predominant reliance on teacher-centered, one-way lectures hampers student engagement and enthusiasm, thereby adversely affecting the overall effectiveness of teaching. Case-based teaching involves using real or highly simulated practical cases as the central medium, effectively integrating theoretical knowledge with practical problems. This approach facilitates the internalization of knowledge and the enhancement of skills by encouraging students to engage in independent analysis, group discussions, and collaborative exploration^[4]. It has demonstrated positive teaching outcomes and is currently widely implemented across various courses. The molecular pathology and histopathology of aquatic animals course has been offered in China for a relatively brief period, and there are currently no nationally designated postgraduate textbooks available. Much of the theoretical content in these courses is adapted from human medicine and veterinary medicine, with a notable scarcity of relevant case materials. Consequently, the development of a specialized case resource library has become a critical priority to effectively implement case-based teaching in this discipline.

To this end, the present study collected, organized, and classified case materials pertinent to the course, thereby constructing a teaching case library. This library was subsequently integrated into the instruction of postgraduate courses for the profes-

Received: January 10, 2026 Accepted: March 13, 2026

Supported by Postgraduate Education Innovation Program of Guangdong Ocean University "Postgraduate Excellent Case Library Construction Project" (202410).

Yucong HUANG, doctoral degree, associate professor, research fields: teaching and research on the prevention and control of aquatic animal diseases.

* Corresponding author. Huanying PANG, doctoral degree, professor, research fields: teaching and research on the prevention and control of aquatic animal diseases.

sional degree in aquaculture. Concurrently, the case library was refined and enhanced based on feedback from teaching practice. This research not only facilitates postgraduate students' mastery of relevant theories and skills in molecular pathology and histopathology, thereby improving the quality of postgraduate training, but also enriches the resources available in the postgraduate degree teaching case library at Guangdong Ocean University. Ultimately, it aims to provide a valuable reference for scholars in this field.

1 Critical importance of developing a case library for the molecular pathology and histopathology of aquatic animals course

1.1 Fostering students' interest and enthusiasm for learning

In the conventional teaching of the molecular pathology and histopathology of aquatic animals course, teachers primarily employ one-way lecturing, systematically presenting the material chapter by chapter. Given the course's highly theoretical and abstract nature, this lecture-based teaching approach often proves insufficient for facilitating students' comprehension, mastery, and flexible application of the knowledge. To address this teaching challenge, the integration of practical cases closely aligned with the course content is recommended within the teaching process. Employing vivid and illustrative cases enables students to engage actively with the underlying pathological issues, encouraging independent consultation of relevant literature and resources, as well as the pursuit of solutions through analytical and exploratory activities. This teaching approach effectively enhances students' motivation and autonomy, facilitating a transition from passive reception of knowledge to active knowledge construction, thereby promoting a deeper comprehension and mastery of the course's knowledge points.

1.2 Enhancing the effectiveness of teaching and improving students' learning abilities

By screening representative cases and systematically designing inquiry-based questions aligned with course content, students are encouraged to engage in theoretical learning with a questioning mindset. This approach facilitates the deep integration and meaningful connection between theoretical knowledge and specific cases. Through case analysis and problem-solving activities, students' critical thinking skills are systematically developed, and their comprehensive practical abilities to identify, analyze, and resolve problems are progressively cultivated. Therefore, both the teaching effectiveness of the course and the students' overall learning capabilities are significantly enhanced.

1.3 Improving the teaching quality and level of teachers

To establish a comprehensive case library for molecular pathology and histopathology of aquatic animals, it is essential to collect a substantial number of high-quality cases that fulfill teaching requirements. This endeavor necessitates teachers possessing not only deep theoretical expertise but also extensive practical teaching experience, enabling the integration of theoretical knowledge with practical application. Meanwhile, it is imperative to remain abreast of disciplinary advancements, regularly update teaching materials, and continuously optimize teaching thoughts. In addition,

in the process of screening and organizing cases, teachers should extensively review pertinent domestic and international literature and materials. They are also encouraged to actively gather clinical cases and related information on various aquatic animal diseases during their routine internship teaching and research activities. This approach serves to expand teachers' knowledge boundaries, enhance their professional competencies, foster comprehensive development of their professional skills, and consequently contribute to the overall improvement of course quality and teaching effectiveness.

1.4 Strengthening the interaction and communication between teachers and students

Following the integration of the case library into course teaching, the dynamic between teachers and students has evolved from a unidirectional transmission of knowledge to a complementary and collaborative teaching relationship characterized by mutual support. As the primary body of learning, students actively engage in case interpretation, analysis, and classroom discussions, thereby fully exercising their subjective initiative. Teachers assume the role of "director" throughout the case-based teaching process; they are responsible not only for carefully selecting high-quality cases that align with teaching objectives but also for evaluating classroom dynamics during discussions and providing appropriate guidance. This approach effectively stimulates each student's enthusiasm for participation, enabling them to fully demonstrate their capabilities and optimize learning outcomes. Therefore, the application of the case library in practical teaching significantly enhances bidirectional communication and fosters deeper interaction between teachers and students, thereby substantially enriching the classroom learning environment. This benefit is markedly superior to that of traditional lecture-based teaching.

2 Construction of the case library

2.1 Collection of case materials

The project team has developed collaborative partnerships with several large-scale breeding bases, aquatic disease detection centers, and aquatic technology promotion stations. Through these partnerships, the team has acquired case resources accumulated from commercial detection services, including pathological reports, molecular detection data, and prevention and control recommendations for samples submitted by clients, thereby enhancing the authenticity of the cases. Meanwhile, based on epidemiological and other scientific research conducted by the research group, relevant faculty members were organized to engage directly with grassroots levels. Their focus was on high-incidence diseases in aquaculture, involving the collection of clinical disease samples, documentation of symptomatic manifestations in affected aquatic animals, and acquisition of videos and photographs of disease sites. Additionally, they gathered production data, including aquaculture density, water quality parameters, disease onset timing, mortality rates, diagnostic reports, as well as information on prior prevention and control measures and their effectiveness. During the annual production internship of undergraduate students at the breeding farm, students were instruct-

ed to collect materials related to disease onset and subsequently submit these materials to the project team for centralized organization following the internship. The project team also employed on-line resources and literature databases to gather representative cases published in prominent domestic and international journals, including *Aquaculture* and *Acta Fisheries Sinica*, thereby further enhancing the case repository.

2.2 Sorting and classification of case materials To maximize the value of the case library as a guidance tool, the project team systematically selected and categorized the collected materials in accordance with the course syllabus and teaching objectives. The chosen cases were required to meet three criteria: authenticity (supported by clear sources and data), scientific validity (aligned with pathological theory and industry standards), and representativeness (encompassing key knowledge points)^[5]. Materials containing ambiguous data or unrelated to the teaching objectives were excluded.

2.3 Compilation of the case library The carefully selected cases were standardized in their written presentation, with uniformity in both content and format as follows: case name, background information pertinent to the case, teaching content and associated chapters, main body of the case, key knowledge points for student mastery, discussion and analysis, related questions, references, and corresponding answers to the questions^[6]. The scope of topic selection for the case library should encompass the principal chapters of pathology, including cellular and tissue injury, tissue repair, compensation and adaptation mechanisms, circulatory disorders, inflammation, neoplasms, stress, diseases of the cardiovascular system, musculoskeletal and respiratory system disorders, digestive system diseases, urinary system diseases, nervous system diseases, visual system diseases, *etc.* As an illustration, the case of streptococcosis in fish is presented.

Case name: Streptococcosis in tilapia

Case background: In an intensive tilapia culture pond located in Guangdong, covering an area of 1.6 ha with an average water depth of 1.8 m, the stocking density was 5.25 fish/m². Each fish weighed between 250 and 300 g. In mid-June, several fish were observed swimming alone, either circling or wandering near the water surface. Some of the affected fish exhibited protruding and reddened eyeballs, while others presented with white and opaque corneas. The autopsy revealed congestion and redness of the liver and brain, as well as enlargement and congestion of the spleen and kidneys. The intestines appeared transparent and were filled with pale yellow fluid. During the initial stage of the disease, approximately 100 fish died daily, with mortality peaking at 200 to 450 fish per day. Three affected fish were selected for microscopic examination to identify parasites. Samples from the liver, spleen, internal organs, and brain were inoculated into BHI medium for bacterial isolation and culture. Besides, tissue samples were collected for the detection of Nervous Necrosis Virus, Tilapia Lake Virus, Parvovirus, and Iridovirus. Microscopic examination revealed a small quantity of *Trichodina* sp. Fluorescence quantitative PCR analysis demonstrated that all the aforementioned viruses

tested negative. Following incubation at 28 °C for 36 h, numerous milky white colonies were isolated in all samples. These colonies exhibited positive Gram staining and displayed an oval bacterial morphology. Based on the combined results of colony morphology, Gram staining, bacterial morphology, and 16S rDNA sequence analysis, the isolated bacteria were preliminarily identified as *Streptococcus agalactiae*. Drug sensitivity assays performed on the isolated bacterial strains indicated susceptibility to antibacterial agents including florfenicol, enrofloxacin, doxycycline, and amoxicillin. Histopathological analysis demonstrated vacuolar degeneration of hepatocytes, congestion within the splenic blood sinusoids, multifocal necrosis accompanied by numerous melanomacrophage centers, necrosis and desquamation of renal tubules, as well as meningitis, microthrombosis in cerebral blood vessels, epicarditis, endocarditis, and additional pathological lesions.

Related knowledge points: detection methods for *Streptococcus* pathogens, pathological characteristics of bacterial diseases, principles underlying the comprehensive prevention and control of bacterial diseases

Setting the fundamental questions:

(i) How can this condition be distinguished from other diseases based on clinical symptoms and pathological changes?

(ii) How can the pathogenic mechanisms of *S. agalactiae* infection be analyzed from a pathological perspective?

(iii) What role do environmental factors play in the incidence of streptococcosis?

(iv) How can a comprehensive prevention and control plan for this disease be formulated?

Key points of the corresponding answer:

Based on the students' responses during class, the teacher systematically summarizes and synthesizes the content of this case.

(i) Currently, the known pathogens affecting tilapia include Nervous Necrosis Virus, Iridovirus, Tilapia Lake Virus, Parvovirus, *Streptococcus*, *etc.* Although viral nervous necrosis presents with swirling symptoms, it does not cause exophthalmos or gill cover hemorrhaging. In contrast, bacterial sepsis is characterized by more extensive hemorrhaging but lacks typical exophthalmos or neurological symptoms. Initial differentiation can be achieved through clinical signs and pathological examination. Definitive diagnosis is further supported by smear tests, bacterial classification and identification, PCR, and other diagnostic methods.

(ii) *S. agalactiae* can invade tilapia through skin wounds, gills, or the digestive tract. Following invasion, the bacterium rapidly proliferates in the bloodstream and disseminates throughout the body by utilizing macrophages as "vehicles", thereby infecting immune organs such as the spleen and kidneys and inducing systemic infections. Meanwhile, *S. agalactiae* is capable of breaching the blood-brain barrier to invade brain tissue, resulting in neurological symptoms. *S. agalactiae* enhances its pathogenicity through multiple virulence factors. Capsular polysaccharides enable resistance to phagocytosis by phagocytes. Surface proteins facilitate adhesion and colonization. In addition, virulence factors such as the CAMP factor, hemolysin, and proteases contribute to

red blood cell lysis, degradation of host immune proteins, and promotion of tissue invasion. Furthermore, this bacterium is capable of surviving and replicating within the cytoplasm of macrophages. It inhibits the fusion of phagosomes and lysosomes, thereby acting as a "Trojan horse" by migrating with macrophages and breaching the blood-brain barrier. The bacterium induces apoptosis in cerebral vascular endothelial cells by degrading tight junction proteins such as ZO-1 and Occludin, which leads to the formation of microthrombi and subsequently causes meningitis. Exposure to high-temperature environments (28 – 37 °C) significantly enhances the invasiveness and toxin production of the bacterial strains, while concurrently inhibiting the activity of antioxidant enzymes, impairing the complement system function in fish, and diminishing non-specific immune responses.

(iii) Continuous exposure to elevated temperatures (above 30 °C), high-density aquaculture practices, deteriorating water quality, and other environmental stressors can compromise the immune function of tilapia, thereby increasing their susceptibility to disease. Meanwhile, elevated temperatures directly facilitate bacterial proliferation, while excessive stocking densities exacerbate stress responses, creating favorable conditions for pathogenic bacterial invasion.

(iv) Prevention and control efforts should adhere to the principle of "prioritizing prevention while integrating both preventive and control measures". These measures include strengthening water quality management, maintaining optimal water conditions, ensuring appropriate stocking densities, and regularly administering immune polysaccharides and traditional Chinese herbal immune enhancers to improve the fish's resistance. Early stage diagnosis is essential, followed by the implementation of a comprehensive treatment plan that combines both internal and external therapies. Moreover, vaccination should be promoted in high-incidence areas to establish an effective immune protection barrier.

2.4 Teaching practice and improvement of the case library

The students were organized into study groups consisting of five to six members each. Prior to class, the cases to be studied, along with corresponding targeted questions, were distributed to the students. This approach encouraged them to review the relevant chapter content, consult pertinent literature, and engage in comprehensive discussions within their groups. In classroom instruction, the case method was employed to teach courses utilizing the established case library. Cases were presented through various media, including PowerPoint presentations, videos, and documents. Subsequently, key questions were posed, such as: "What are the potential pathogens responsible for this disease?" "What is the underlying mechanism of the pathological changes?" Following this, each group engaged in comprehensive discussions and subsequently presents their respective analyses, diagnostic approaches, and recommendations for prevention and control. Students and teachers engaged in reciprocal questioning, provide mutual feedback, and participate in brainstorming sessions that foster intellectual exchange. Subsequently, the teacher evaluated the perform-

ance of each group, organized the essential knowledge points, conducted an in-depth analysis of the pathological mechanisms, and summarized the critical aspects of diagnosis, prevention, and control.

Through the implementation of case-based teaching practices, both internal faculty members and external experts were invited to evaluate the case library. Student feedback was systematically analyzed to identify deficiencies within the case collection. Accordingly, cases addressing students' areas of weakness, such as the application of molecular pathology techniques, were incorporated. The content of the case library has been continuously optimized by actively integrating cutting-edge technologies related to tissue and molecular pathology and enhancing the depiction of industrial scenarios. Furthermore, the latest advancements in occupational diseases are closely monitored, with the case library being regularly updated and revised; approximately 10% to 15% of cases are added or replaced annually. Moreover, all cases are uploaded to the "Xuexitong" teaching platform database to facilitate students' autonomous study and review at their convenience.

3 Evaluation of the application effect of the case library

The evaluation of the teaching effectiveness of the case library constitutes a critical component in assessing its value within educational practice, optimizing instructional methods, and enhancing the quality of talent development. In this study, the established case library was implemented in case-based teaching. Master's students majoring in Aquaculture and Aquatic Animal Medicine from the 2024 cohort served as the experimental group, while the 2023 cohort, which received traditional teaching, functioned as the control group. The application effect of the case library was assessed through questionnaire surveys. A total of 56 questionnaires were distributed and collected, yielding a recovery rate of 100%. The results are presented in Table 1. Students generally perceived the development of a case library as highly significant. It effectively stimulated learning interest, enhanced the comprehension and mastery of knowledge, aided in improving problem analysis and solving skills, and contributed positively to the cultivation of innovative abilities.

Following the completion of the course, students' proficiency in pathological knowledge was evaluated through their course papers. Compared to traditional lecture-based teaching classes, the grades of students in case-based teaching classes were improved by approximately 15% to 20%. Additionally, by requiring students to compose case analysis reports to assess their capacity for practical problem analysis and resolution, the grades in case-based classes showed an improvement of 10% to 15%. Practical assessments, including pathological anatomy and pathogen detection, were employed to evaluate students' clinical skills, resulting in a 25% to 30% increase in the excellence rate among case-based teaching classes. Overall, the comprehensive academic performance of students taught using the case library approach was significantly superior to that of students receiving traditional lecture-based teaching.

Table 1 Evaluation of teaching effectiveness using the case library

(*n*, %)

Evaluation project	Experimental group (<i>n</i> = 30)	Control group (<i>n</i> = 26)
Fostering students' interest for learning	27 (90.00)	18 (69.23)
Enhancing the classroom learning environment	26 (86.67)	19 (73.08)
Improving the capability for autonomous learning	26 (86.67)	15 (57.69)
Improving learning efficiency	25 (83.33)	16 (61.54)
Deepening the understanding and mastery of theoretical knowledge	30 (76.67)	21 (80.77)
Expanding students' knowledge	27 (90.00)	15 (57.69)
Training innovative thinking skills and capabilities	25 (83.33)	18 (69.23)
Enhancing the capacity for problem analysis and resolution	26 (86.67)	17 (65.38)
Fostering a spirit of teamwork	24 (80.00)	17 (65.38)
Developing skills in communication and interpersonal exchange	28 (82.35)	20 (76.92)
Developing competencies in the application of theoretical knowledge and practical diagnostic skills	28 (93.33)	16 (53.85)

4 Conclusions

The development and implementation of a case library can assist students in constructing a comprehensive knowledge framework, addressing the deficiencies inherent in traditional teaching materials regarding theory and practice. This approach enhances the practical engagement and critical thinking within postgraduate teaching, thereby significantly improving students' abilities in theoretical application and diagnostic practice. Furthermore, this teaching method reinforces the interdisciplinary integration of molecular pathology and histopathology, fostering the cultivation of postgraduate students' innovative capacities and clinical competencies. Moving forward, it is imperative to further refine the development and utilization of innovative cases, which hold considerable potential for broader application in postgraduate aquaculture curricula.

References

[1] HUANG YC, CAI SH, YAN XY, *et al.* Exploration and practice on the

teaching reform of aquatic animal pathology[J]. *Journal of Anhui Agricultural Sciences*, 2016, 44(35): 242 – 243. (in Chinese).
 [2] YANG XZ, PANG YY, ZHENG ZY, *et al.* Ideological and political theories teaching in pathology of aquatic animal course[J]. *Education and Teaching Forum*, 2019, (51): 31 – 32. (in Chinese).
 [3] LIU XX, JIANG JF, GAO XT. Exploration of the reform of graduate molecular pathology laboratory course[J]. *Education and Teaching Forum*, 2025, (44): 51 – 54. (in Chinese).
 [4] WANG QM, ZHAO G. An overview on case method researches at home and abroad[J]. *Journal of Ningbo University (Educational Science Edition)*, 2009, 31(3): 7 – 11. (in Chinese).
 [5] GAO XT, WANG CY, LU XY, *et al.* Exploration on construction and application of pathology case database[J]. *Journal of Nongken Medicine*, 2024, 46(6): 556 – 559. (in Chinese).
 [6] LYU XL, ZHANG L, BAI R, *et al.* Exploration and practice on the construction of a case library for veterinary pathology course[J]. *Today Animal Husbandry and Veterinary Medicine*, 2022, 38(12): 130 – 131. (in Chinese).

(From page 50)

References

[1] SUN JH, YANG L, KONG YH, *et al.* Preliminary study on educational reform of Environmental Impact Assessment course [J]. *Guangzhou Chemical Industry*, 2022, 50(12): 196 – 198. (in Chinese).
 [2] JIANG ZM, CHEN YC. On teaching renovation of Environment Impact Assessment, a course for undergraduates[J]. *Journal of Southwest China Normal University (Natural Science Edition)*, 2013, 38(5): 177 – 180. (in Chinese).
 [3] WANG Q. On reform and practice of teaching of "Environmental Impact Assessment" course[J]. *Journal of Southwest China Normal University (Natural Science Edition)*, 2017, 42(1): 153 – 156. (in Chinese).
 [4] HAN Y, HE JY. Research on the reform of curriculum teaching method oriented to cultivate the innovation ability to solve complex engineering problems: Enlightenment from the discussion course teaching of Environmental Impact Assessment based on rain classroom[J]. *The Theory and Practice of Innovation and Entrepreneurship*, 2023(6): 52 – 54. (in Chinese).

[5] HU J, CHEN SY, CHEN F, *et al.* Problem-based Environmental Impact Assessment course teaching reform[J]. *The Light & Textile Industries of Fujian*, 2025(5): 67 – 70. (in Chinese).
 [6] WU S, SHI LX, LIU ZH, *et al.* Exploration on course teaching reform of "environmental impact assessment" under the background of "double carbon" and new engineering course[J]. *Science and Technology Wind*, 2025(9): 83 – 85. (in Chinese).
 [7] CAO SH, WANG HM, DING KQ. Exploration on teaching reform of Environmental Impact Assessment course under the big data of ecological environment[J]. *Education and Teaching Forum*, 2025(32): 89 – 92. (in Chinese).
 [8] FANG YY. The course teaching reform of "Environmental Impact Assessment" under the training mode of applied talents[J]. *Journal of Chizhou University*, 2024, 38(6): 132 – 135. (in Chinese).
 [9] FENG WQ, FENG T. Exploration on course teaching reform of Environmental Impact Assessment based on OBE[J]. *Journal of Higher Education*, 2023, 9(7): 137 – 140. (in Chinese).