Mini Review

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From industrial practice to biological discovery: reflections on the potential of research collaboration in life biological sciences

Abstract

Collaboration between universities and national research institutions plays an increasingly important role in strengthening life biological sciences and promoting innovation that benefits society and industry. This reflective article examines an industrial training experience conducted at the Life Science Centre, SIRIM Berhad, Shah Alam, Selangor, Malaysia, from 30 March 2026 to 26 July 2026, as an example of how academic and governmental partnerships can enhance biological education and research. The training provided broad exposure to histology, laboratory animal science, biosafety testing, toxicology, stem cell research, vaccine development, digital pathology, and Good Laboratory Practice (GLP), demonstrating how applied laboratory activities are firmly rooted in fundamental biological principles. Reflections from academic, industrial, and student perspectives indicate that such partnerships enrich learning experiences, stimulate scientific curiosity, and create opportunities for future collaborative research. Beyond strengthening technical competencies, these interactions encourage the translation of biological knowledge into practical applications that support biomedical research, environmental sustainability, and public health. The article highlights industrial training as a platform for cultivating future life scientists while reinforcing the value of sustained collaboration between universities and national research organisations.

Keywords: collaboration, good laboratory practice, histology, industrial training, laboratory animal science, life biological sciences, SIRIM Berhad

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Introduction

The advancement of life biological sciences has historically depended upon close interactions between observation, experimentation, and technological innovation. While universities have traditionally served as centres for fundamental scientific discovery, national research institutes and industrial laboratories increasingly contribute to biological research through specialised facilities, regulatory expertise, and translational research programmes.[1] As biological sciences continue to expand into multidisciplinary fields such as regenerative medicine, toxicology, molecular pathology, biotechnology, and biosafety, collaboration between academic institutions and government research agencies has become essential for sustaining scientific innovation.[2]

Industrial training is commonly regarded as a mechanism for developing workplace competencies and professional readiness. However, its educational value extends far beyond technical skill development. When students participate directly in laboratory operations, they encounter biological systems that stimulate scientific curiosity and generate research questions that may not emerge within conventional classroom environments. Rather than functioning solely as observers, students become active participants in the scientific process by witnessing how biological principles are translated into practical applications.

The industrial training undertaken at the Life Science Centre, SIRIM Berhad, provides an excellent example of such integration. The programme exposed the student to multiple components of life science research, including histology, laboratory animal studies, biosafety testing, toxicological pathology, digital microscopy, stem cell research, vaccine studies, and laboratory quality management conducted. These experiences illustrate that industrial laboratories are not merely testing facilities but also environments where biological knowledge continuously evolves through systematic observation, experimentation, and quality assurance.

This reflective article explores how collaborations between universities and national research agencies can strengthen life biological sciences by transforming industrial experiences into opportunities for biological discovery. The article argues that industrial training should be viewed as the beginning of long-term scientific partnerships rather than merely fulfilling academic graduation requirements.

Methodology

This reflective paper employed a qualitative narrative approach based on experiential learning to examine the educational and scientific value of an industrial training programme undertaken by the undergraduate student, Nur Athirah Rosdi, at the Life Science Centre, SIRIM Berhad, Shah Alam, Selangor, Malaysia. The industrial placement was conducted from 30 March 2026 to 26 July 2026 as part of the Bachelor of Science programme at Universiti Putra Malaysia (UPM). The narrative approach was selected because it enables the interpretation of learning experiences, professional development, and scientific understanding through critical reflection on authentic workplace activities rather than quantitative measurement.[3,4] This approach is particularly appropriate for exploring how industrial experiences contribute to the integration of biological knowledge with professional scientific practice.

The industrial training was supported by a structured supervisory system involving both the university and the host institution. Professor Dr. Chee Kong Yap served as the university supervisor, providing academic guidance, monitoring the student's progress, and evaluating the educational outcomes of the internship. At the Life Science Centre, Dr. Syamimi Md. Khalid served as the industrial supervisor, providing professional mentoring, technical guidance, laboratory supervision, and continuous feedback throughout the placement. This dual supervisory framework enabled the student to strengthen technical competencies while developing scientific reasoning, professional ethics, communication skills, and an appreciation of quality management systems operating within an accredited research environment.

Throughout the industrial training, the student maintained systematic reflective records documenting laboratory activities, scientific observations, technical skills acquired, interactions with supervisors and laboratory personnel, and personal reflections on professional growth. These experiences encompassed exposure to histology, laboratory animal science, biosafety testing, toxicology, digital pathology, stem cell research, vaccine studies, and Good Laboratory Practice (GLP). Upon completion of the placement, the reflections were compiled into a comprehensive industrial training report and subsequently discussed with the university supervisor to clarify significant learning experiences and validate the interpretations presented in the report.

The present reflective article was developed through an interpretive thematic analysis of the student's written reflections, internship report, and discussions with both the academic and industrial supervisors. Recurring themes related to experiential learning, biological discovery, technical competency, scientific curiosity, workplace mentorship, interdisciplinary collaboration, and professional identity were identified and synthesised into a coherent narrative. Rather than evaluating technical performance alone, this qualitative approach explores how industrial training at SIRIM Berhad fostered the integration of theoretical biological knowledge with authentic research practice and illustrates the potential of sustained university–industry collaboration to strengthen education, research, and innovation in the life biological sciences.

Reflective observations and discussion

Industrial training as a gateway to biological discovery

Industrial training provides an important opportunity for students to experience how fundamental biological principles are applied within professional research environments. Beyond acquiring laboratory skills, exposure to daily scientific practice enables students to appreciate the close relationship between theoretical knowledge acquired in university classrooms and its practical application in biological investigations. The industrial placement at the Life Science Centre, SIRIM Berhad, demonstrated that many routine laboratory activities are deeply rooted in core concepts of cell biology, anatomy, physiology, pathology, immunology, toxicology, and regenerative medicine.

One of the most valuable learning experiences involved observing the complete histology workflow, from tissue grossing and fixation through dehydration, paraffin embedding, microtome sectioning, staining, coverslipping, and digital slide evaluation. Although these procedures follow established laboratory protocols, each stage depends upon an understanding of tissue architecture, cellular morphology, fixation chemistry, and microscopic anatomy. The preservation of biological structures throughout tissue processing directly influences the quality and reliability of pathological interpretation and biomedical research[5]. This experience demonstrated that technical precision and biological knowledge are inseparable components of successful laboratory practice.

The placement also highlighted the growing importance of digital pathology in modern biological sciences. The application of whole-slide imaging and digital image analysis has transformed traditional microscopy by enabling efficient image storage, quantitative measurements, and computational analysis while preserving the importance of careful morphological interpretation.[6] Observing digital pathology workflows illustrated how technological advances complement rather than replace the biological understanding required for accurate tissue evaluation.

Exposure to laboratory animal science further strengthened the understanding of biological processes operating at the whole-organism level. Under appropriate ethical approval and professional supervision, the placement provided opportunities to observe studies involving rabbits, rats, mice, and guinea pigs. These investigations included routine health monitoring, physiological measurements, vaccine studies, toxicological assessments, pyrogen testing, sensitisation studies, necropsy procedures, and mesenchymal stem cell research. Collectively, these activities demonstrated how laboratory animal models contribute to advancing knowledge in physiology, immunology, pharmacology, developmental biology, and regenerative medicine while supporting product safety evaluation and biomedical innovation.

Among these activities, mesenchymal stem cell research illustrated the expanding role of industrial laboratories in regenerative biology. Mesenchymal stem cells possess considerable therapeutic potential because of their capacity for tissue repair, differentiation, and immunomodulation, making them important subjects in translational biomedical research.[7] Similarly, observations of vaccine development and toxicological investigations demonstrated the complexity of biological interactions between living organisms and external agents. Understanding immune responses, tissue injury, physiological adaptation, and toxic effects requires an integrated appreciation of biological organisation from the molecular level to the whole organism.[8]

Another significant lesson from the industrial placement was the central role of scientific quality systems in ensuring reliable biological research. Compliance with GLP demonstrated that scientific quality depends not only on sophisticated experimental techniques but also on rigorous documentation, traceability, validation, and quality assurance. These internationally recognised standards enhance the reproducibility, credibility, and integrity of biological observations and ensure that research findings are scientifically defensible.[9] The experience reinforced the understanding that careful adherence to standard operating procedures forms an integral part of responsible scientific practice rather than merely fulfilling regulatory requirements.

Perhaps the most enduring outcome of the industrial training was the development of scientific curiosity. Routine laboratory observations frequently stimulated broader biological questions regarding tissue organisation, cellular responses, physiological regulation, pathological mechanisms, and experimental outcomes. Rather than viewing laboratory procedures as isolated technical tasks, the placement encouraged continuous observation, critical thinking, and evidence-based reasoning. Such experiences strengthened the appreciation that biological discovery often begins with careful observation followed by thoughtful questioning.

Overall, the industrial training experience demonstrated that professional laboratory environments provide far more than technical instruction. They expose students to the biological foundations underpinning applied research, reinforce the importance of scientific rigour and ethical practice, and cultivate analytical thinking that supports lifelong learning. By bridging theoretical knowledge with authentic laboratory experience, industrial training serves as an important educational pathway for developing competent, reflective, and scientifically inquisitive life scientists.

Building sustainable research collaboration in life biological sciences

The observations gained during industrial training demonstrate that university–research institute partnerships should extend well beyond short-term student placements into structured and sustained scientific collaborations. While industrial attachments provide valuable experiential learning, their greatest long-term contribution lies in creating opportunities for joint research, knowledge exchange, and innovation. Universities contribute strengths in biological theory, hypothesis development, experimental design, and postgraduate education, whereas national research institutes such as SIRIM Berhad offer specialised facilities, internationally recognised quality systems, regulatory expertise, and close engagement with industrial applications. Integrating these complementary capabilities creates an environment in which fundamental biological research and translational science can advance simultaneously.[10]

Hydrological science examines the occurrence, movement, distribution, storage, and quality of water within the Earth's atmosphere, surface, and subsurface environments. Its fundamental components include precipitation, infiltration, evapotranspiration, groundwater recharge, runoff generation, streamflow dynamics, and interactions between water, soil, vegetation, and human activities.[11,12] Understanding these processes is essential for addressing practical challenges such as flood mitigation, drought management, watershed conservation, groundwater sustainability, water resource planning, and pollution control, all of which have become increasingly important under global environmental change.[13] Many hydrological problems also involve biological processes because aquatic organisms, microbial communities, and ecosystem responses provide sensitive indicators of changing water quality. Consequently, hydrological investigations increasingly integrate biological monitoring, ecotoxicology, environmental microbiology, and water quality assessment to evaluate ecosystem health and the impacts of contaminants. Collaboration between life biological scientists and hydrologists therefore enables comprehensive solutions that combine physical hydrological measurements with biological evidence, supporting sustainable management of freshwater resources under changing environmental conditions.

Beyond biomedical and life science research, SIRIM Berhad also participates in multidisciplinary collaborations that support environmental monitoring and water resource management through its specialised analytical laboratories and technical services. Hydrology-related collaborations are typically organised through partnerships among universities, government agencies responsible for water resources and environmental management, and industrial stakeholders. Within these collaborations, hydrologists contribute expertise in watershed processes, groundwater systems, surface water dynamics, and hydrological modelling, while environmental biologists investigate ecological responses, aquatic biodiversity, biomonitoring, ecotoxicology, microbial water quality, and ecosystem health. SIRIM contributes accredited analytical facilities, quality assurance systems, specialised instrumentation, and internationally recognised testing standards that support reliable environmental analyses. Such collaborative projects commonly involve field sampling, laboratory analysis of physical, chemical, and biological water quality parameters, interpretation of environmental data, and development of evidence-based recommendations for pollution control, ecosystem restoration, and sustainable water resource management. This multidisciplinary framework illustrates how biological sciences complement hydrological investigations in addressing complex environmental challenges.

The industrial placement revealed that many laboratory platforms routinely employed for product evaluation and regulatory compliance also possess considerable value for biological research. Facilities supporting histology, digital pathology, laboratory animal science, biosafety assessment, toxicology, stem cell research, vaccine development, and quality-assured analytical testing generate extensive biological information that can contribute to investigations in cell biology, physiology, pathology, immunology, regenerative medicine, pharmacology, and environmental health. Rather than viewing these activities solely as technical or regulatory services, they should be recognised as valuable research resources that can support collaborative scientific discovery across multiple biological disciplines.

Establishing formal collaborations between universities and research institutes would enable students, academic staff, and industrial scientists to work together on research projects that combine fundamental biological questions with practical applications. Undergraduate industrial placements could evolve into final-year research projects, postgraduate theses, and jointly supervised doctoral programmes. Academic researchers would gain access to specialised instrumentation, accredited laboratories, and industrial datasets, while research institutes would benefit from university expertise in biological theory, data interpretation, and scientific publication. Such reciprocal partnerships strengthen both scientific productivity and workforce development by connecting education, research, and innovation within a unified framework.

These collaborations also create opportunities to integrate emerging technologies into life biological sciences. Advances in digital pathology, image analysis, artificial intelligence, bioinformatics, and quantitative data science allow biological observations to be analysed with increasing accuracy and efficiency[4]. Collaborative research involving biologists, pathologists, computer scientists, engineers, and data analysts can generate new approaches for understanding tissue organisation, disease progression, therapeutic responses, and environmental influences on biological systems. Interdisciplinary research of this nature is becoming increasingly important for addressing complex biomedical and ecological challenges.

An equally important outcome of sustained collaboration is the cultivation of scientific curiosity. Industrial training exposes students to authentic research environments where routine laboratory observations frequently generate new biological questions. Encouraging students to investigate the mechanisms underlying these observations transforms technical training into scientific inquiry and promotes the development of analytical thinking, problem-solving skills, and independent research capability. Universities and national research institutes therefore share a common responsibility in creating learning environments that inspire lifelong scientific exploration rather than limiting industrial training to the acquisition of technical competencies alone.

Ultimately, sustainable collaboration between universities and national research institutions represents an investment in the future of life biological sciences. By combining complementary expertise, shared infrastructure, interdisciplinary perspectives, and a common commitment to scientific excellence, these partnerships can accelerate biological discovery while producing graduates who are equipped to address emerging challenges in biomedical research, environmental sustainability, biotechnology, and public health. Industrial training should therefore be regarded not as the conclusion of professional preparation but as the foundation upon which enduring scientific collaborations and future biological innovations are built.

Reflections from three perspectives

As indicate in Figure 1, from an institutional perspective, industrial training programs foster a bidirectional flow of knowledge that simultaneously advances academic and industrial sectors while driving student development. The collaborative model facilitates the transition of biological theory into practical application, which enhances university teaching and provides industrial partners with fresh scientific perspectives and critical interdisciplinary networks. Students experience a transformative journey, evolving from learners into active scientific contributors. This process allows them to appreciate biology as a dynamic field and provides essential technical skills, ultimately strengthening the collective biological research capacity.

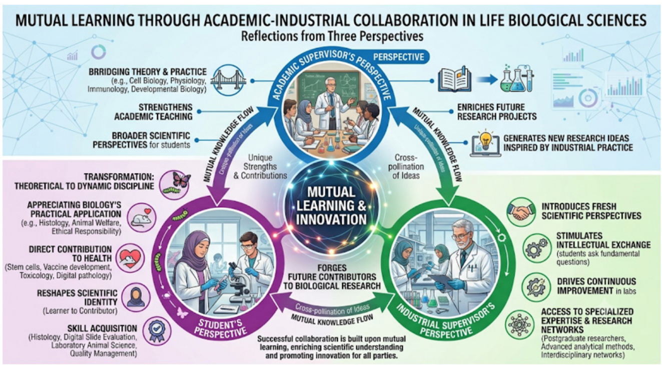

Figure 1 Mutual Learning and Innovation Through Academic-Industrial Collaboration. A conceptual diagram illustrating the intersecting perspectives and synergistic benefits of scientific internships.

From the perspective of the academic supervisor, industrial training provides an invaluable opportunity to bridge biological theory with contemporary scientific practice. Concepts introduced during undergraduate courses in cell biology, physiology, histology, immunology, and developmental biology become directly observable through practical laboratory activities. Students return to the university not merely with improved technical competencies but with broader scientific perspectives that enrich future research projects. The collaboration therefore strengthens academic teaching while simultaneously generating new research ideas inspired by industrial practice.

From the perspective of the industrial supervisor, collaboration with universities introduces fresh scientific perspectives into established laboratory programmes. Undergraduate students frequently ask fundamental biological questions that experienced practitioners may no longer consciously consider during routine operations.

Such interactions stimulate intellectual exchange and encourage continuous improvement within industrial laboratories. Academic collaborations also facilitate access to specialised expertise, postgraduate researchers, advanced analytical methods, and interdisciplinary research networks that enhance institutional research capacity.

From the perspective of the student, industrial training represents a transformation from learning biology as a collection of theoretical concepts to appreciating biology as a dynamic scientific discipline. Histological tissue preparation became more than a sequence of laboratory procedures; it revealed the remarkable structural organisation of living tissues. Laboratory animal handling extended beyond technical competence to encompass animal welfare, ethical responsibility, physiological monitoring, and experimental design.

Exposure to stem cell studies, vaccine development, toxicological investigations, and digital pathology demonstrated how life biological sciences directly contribute to improving human and animal health. These experiences fundamentally reshape scientific identity by allowing students to view themselves not only as learners but also as future contributors to biological research. The acquisition of technical skills in histology, digital slide evaluation, laboratory animal science, and quality management further illustrates how industrial experiences can support future academic research and professional development. Collectively, these three perspectives reveal that successful collaboration is built upon mutual learning rather than one-directional knowledge transfer. Universities, research institutes, supervisors, and students all contribute unique strengths that enrich scientific understanding and promote innovation in the life biological sciences.

Conclusion

The industrial training experience at the Life Science Centre, SIRIM Berhad, demonstrates that collaborations between universities and national research institutes have enormous potential to strengthen life biological sciences. Activities involving histology, laboratory animal science, biosafety testing, toxicology, stem cell studies, vaccine research, and digital pathology illustrate that routine laboratory practices frequently generate questions of fundamental biological significance. Rather than serving solely as professional training, industrial placements provide environments where scientific curiosity, critical thinking, and biological discovery naturally emerge.

This reflection also highlights that the future of biological sciences depends increasingly upon collaborative partnerships that integrate education, research, and industrial expertise. Universities contribute theoretical knowledge, scientific creativity, and research training, whereas research institutes contribute specialised infrastructure, regulatory experience, and practical applications. Together, these complementary strengths create opportunities for innovative research that benefits science, industry, healthcare, and society.

Ultimately, biological discovery does not begin only with sophisticated research grants or advanced technologies. It often begins with careful observation, thoughtful questioning, and meaningful collaboration. Industrial training provides precisely such opportunities, transforming everyday laboratory experiences into the foundation for future scientific discovery and lifelong contributions to the advancement of life biological sciences.

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Declaration on the use of artificial intelligence

The authors declare that generative artificial intelligence tools were used in a supportive capacity during the preparation of this manuscript. These tools assisted with language refinement, structural organisation, and stylistic clarity of the text. All ideas, interpretations, reflections, and conclusions presented in this paper are the author's own and are grounded in personal experience and scholarly judgment. The authors retain full responsibility for the content, accuracy, originality, and integrity of the manuscript.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this reflective article.

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