

TEACHING, RESEARCH AND EXTENSION IN CELLULAR ANIMAL SCIENCE IN THE FEDERAL UNIVERSITY OF PARANÁ

ENSINO, PESQUISA E EXTENSÃO EM ZOOTECNIA CELULAR NA UNIVERSIDADE FEDERAL DO PARANÁ

ENSEÑANZA, INVESTIGACIÓN Y EXTENSIÓN EN ZOOTECNIA CELULAR EN LA UNIVERSIDAD FEDERAL DE PARANÁ

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Abstract

The rise of the global population in the next decades coupled with the meatification of diets in Asia and Africa will drive a substantial increase in global demand for meat. This raises significant concerns regarding animal welfare, public health, food security and the sustainability of conventional animal production. Cellular Animal Science offers promising response to such challenges. Training skilled

professionals in cellular agriculture is essential to support its development and integration. This study outlines the implementation process of Cellular Animal Science at the Federal University of Parana, including the development of the first courses in Introduction to Cellular Animal Science at both graduate and undergraduate levels and the establishment of the Cellular Animal Science Laboratory. Additionally, the extension project *Bife Sem Bicho* was conceptualized to propagate knowledge about cultivated animal products and other alternative proteins, engaging both university audiences and the public. Our findings indicate that the University has made significant advancement in the Cellular Animal Science field by establishing foundational courses, a dedicated laboratory, and outreach initiatives. The study reveals strong student demand for hands-on training in alternative protein production systems, underscoring the importance of further laboratory developments for teaching. Additionally, the integration of research, teaching, and outreach activities has promoted scientific knowledge and increased student interest in cellular agriculture, highlighting the potential of this model to train qualified professionals and expand awareness of and skills in sustainable food production systems alternatives to intensive animal production.

Keywords: cellular agriculture; Education; laboratory.

Resumo

O aumento da população global nas próximas décadas, aliado à carnificação das dietas na Ásia e na África, impulsionará uma demanda substancial por carne. Isso levanta preocupações significativas em relação ao bem-estar animal, saúde pública, segurança alimentar e sustentabilidade da produção animal convencional. A Zootecnia Celular oferece uma resposta promissora a esses desafios. A formação de profissionais qualificados em agricultura celular é essencial para apoiar seu desenvolvimento e integração. Este estudo descreve o processo de implementação da Zootecnia Celular na Universidade Federal do Paraná, incluindo o desenvolvimento dos primeiros cursos de Introdução à Zootecnia Celular em níveis de graduação e pós-graduação, e a criação do Laboratório de Zootecnia Celular. Além disso, o projeto de extensão Bife Sem Bicho foi concebido para disseminar conhecimentos sobre produtos de origem animal cultivados e outras proteínas alternativas, envolvendo tanto o público universitário quanto o público em geral. Nossos resultados indicam que a Universidade avançou significativamente no campo da Zootecnia Celular, estabelecendo cursos fundamentais, um laboratório dedicado e iniciativas de extensão. O estudo revela uma forte demanda dos alunos por treinamento prático em sistemas de produção de proteínas alternativas, sublinhando a importância de desenvolvimentos laboratoriais adicionais para o ensino. Além disso, a integração de atividades de pesquisa, ensino e extensão promoveu o conhecimento científico e aumentou o interesse dos alunos pela agricultura celular, destacando o potencial desse modelo para formar profissionais qualificados e expandir a conscientização e as habilidades em alternativas sustentáveis aos sistemas de produção animal intensiva.

Palavras-chave: agricultura celular; Educação; laboratório.

Resumen

El aumento de la población global en las próximas décadas y la carnificación de las dietas en Asia y África generarán una demanda significativa de carne, lo que plantea preocupaciones sobre el bienestar animal, la salud pública, la seguridad alimentaria y la sostenibilidad de la producción animal convencional. La Zootecnia Celular ofrece una respuesta prometedora a estos desafíos. Este estudio detalla la implementación de la Zootecnia Celular en la Universidad Federal de Paraná, incluyendo el

desarrollo de los primeros cursos de Introducción a esta disciplina a niveles de grado y posgrado, así como la creación del Laboratorio de Zootecnia Celular. Además, se conceptualizó el proyecto de extensión Bife Sin Bestia para difundir conocimientos sobre productos animales cultivados y otras proteínas alternativas, involucrando tanto a la comunidad universitaria como al público en general. Los hallazgos indican que la Universidad ha avanzado significativamente en este campo al establecer cursos, un laboratorio y actividades de extensión. Existe una fuerte demanda de los estudiantes por capacitación práctica en sistemas de producción de proteínas alternativas, lo que subraya la necesidad de más desarrollos laboratoriales para la enseñanza. La integración de investigación, enseñanza y extensión ha promovido el conocimiento científico y el interés de los estudiantes en la Zootecnia Celular, destacando el potencial de este modelo para formar profesionales calificados y aumentar la conciencia sobre alternativas sostenibles a la producción animal intensiva.

Palabras clave: agricultura celular; Educación; laboratorio.

1 Introduction

The global population is expected to reach approximately 8.5 billion by 2030, 9.7 billion by 2050, and 10.4 billion by 2100 (United Nations, 2022). In addition, the continuous increase in global meat demand also derives from a process known as meatification, a concept describing that meat is moving from the periphery to the center of human diets, as daily meat consumption expands from western countries to become a global phenomenon ([Hansen; Jakobsen; Wethal, 2021](#)). The ever-growing world meat demand raises critical concerns regarding the intensification of animal production and related animal welfare, public health, food security and sustainability issues (Biscarra-Bellio *et al.*, 2023; Bryant; Barnett, 2020; Phillips *et al.*, 2025).

Cellular Animal Science, also known as cellular agriculture, has emerged as a promising alternative to conventional animal production systems, offering a production perspective that does not involve animal slaughter (Biscarra-Bellio *et al.*, 2023; Post, 2014b; Slade, 2018). Such field has attracted increasing attention from the public, popular media, animal welfare organizations, the scientific community, and investors (Biscarra-Bellio *et al.*, 2023; Goodwin; Shoulders, 2013; Schneider, 2013; Stephens *et al.*, 2018; Verbeke *et al.*, 2015), especially following the production of the first prototype of a cultivated burger in 2013 (Post, 2014a). Despite the fast-growing field and high financial interest from investors and governments, cultivated meat production still faces challenges ranging from cell source

choice, affordable expansion, use of cruelty-free media, consumer acceptance, and regulatory issues (Kirsch *et al.*, 2023).

Regulations for cultivated meat must balance safety and health standards (Cabral; Pereira; Leitolis, 2024), and in Brazil, it's evaluated as a novel food, while in Germany, the European Food Safety Authority (EFSA) oversees approval. The European Union's first application for cultivated meat was submitted in September 2023 and in Singapore, United States of America and Israel cultivated chicken has already been approved (Reis *et al.*, 2025). On December 18, 2023, the Brazilian Health Regulatory Agency (Anvisa) published in the Federal Register Resolution RDC 839/2023, which provides for safety proof and authorization for the use of novel foods and novel ingredients (Anvisa, 2023).

Thus, it seems relevant that this innovative food technology be introduced and promoted in the academic environment through teaching, research, and outreach initiatives (Newell; Glaros, 2024).

Addressing the educational needs of a new scientific domain requires a significant expansion of university initiatives, since few institutions have specialized curricula and this gap of knowledge can limit the exploration of career opportunities within the sector (Stout *et al.*, 2024). This is likely especially relevant when highly specialized professionals are needed to accelerate progress in the field. This implies opportunities for professionals who have fundamental roles in the conventional meat chain, such as veterinarians and animal scientists, as well as professionals involved in the food industry such as food engineers, bioprocess engineers, and biotechnologists, among others that has knowledge in genetics, nutrition, human health, cell development, management, as well as processing, packaging, marketing, control, and inspection of meat (Heidemann *et al.*, 2020a). The implementation of introductory and specialized courses may help; however, very few courses that focus specifically on cellular agriculture are currently available (GFI Brasil, [2023]). Cellular Animal Science not only can open doors to a wide range of careers but may also offer the chance to be part of a transformative movement towards a more sustainable future (Morais-da-Silva *et al.*, 2022a). Thus, with such robust reasons, documenting and analyzing the implementation of alternative protein initiatives at specific universities is warranted to

understand best strategies for effectively addressing the educational gaps and supporting the growth of the emerging food production chains.

Therefore, this study aims to document and analyze the implementation of Cellular Animal Science at Federal University of Parana (UFPR), in Southern Brazil, focusing on three main aspects: the offering of the first courses in *Introdução à Zootecnia Celular* – Introduction to Cellular Animal Science (ICAS) – at both undergraduate and graduate levels, including the perceptions of course attendees; the reporting of the process of conceptualizing, installing, and operating a research and educational cellular agriculture laboratory – the Cellular Animal Science Laboratory (Zoocel) of the Federal University of Parana (UFPR); and the scientific dissemination of cellular agriculture through an outreach initiative through the extension project *Bife Sem Bicho*, a Portuguese pun for steak without an animal. This article is expected to contribute to a broader understanding of how universities can address educational gaps and support the growth of alternative protein sectors, for the benefit of humans, animals and the environment.

2 Methodology

Our documentation encompassed comprehensive details on the implementation process of Cellular Animal Science at UFPR, through a period spanning from 2019 to 2024.

2.1 Teaching

In the teaching context, comprehensive surveys were conducted to outline the procedures necessary to design and implement the ICAS course at UFPR, at both undergraduate and graduate levels. These surveys included interviews and collaborative efforts with international Universities and a thorough review of online information, all of which with the essential support from the Good Food Institute Brazil (GFI Brazil). Subsequently, an analysis of the records in the Microsoft Teams groups from the editions offered was used to develop a renewed course syllabus, as well as to assess the number of enrolled students in the first course editions and their level of participation.

2.1.1 Students' opinions about their learning experiences

To better understand the impact the courses had on student learning, an online questionnaire consisting of 9 questions was administered from February 2022 to July 2024. Students from the five editions of ICAS, from 2020 to 2024, were invited to participate in this research. Additionally, individuals who attended isolated lectures, classes, or webinars on Cellular Animal Science conducted by members of the Zoocel team were invited to participate and share their opinions. This research was approved by the Federal University of Parana's Ethics Committee for Research Involving Humans under protocol number 5.669.675. The questions that make up the questionnaire are presented in Table 1. To analyze the justifications provided for the responses to open-ended questions, keywords provided by respondents were used as central ideas using the Discourse of the Collective Subject (DCS) method (Duarte; Mamede; Andrade, 2009).

Chart 1 – Questionnaire administered from February 2022 to July 2024, composed of a total of 9 questions.

Number	Question
1	How old are you?
2	Which city do you live in? (City/state)
3	If you are an undergraduate student, what program are you enrolled in?
4	If you have a postgraduate degree, what type is it? (Specialization, Master's, PhD, postdoctoral research)
5	Have you ever attended a class, course, discipline, or lecture on Cellular Animal Science (alternative proteins, plant-based meat, cultivated meat, precision fermentation)?
6	What is the impact of learning Cellular Animal Science on your career?
7	Do you feel prepared to enter this new production chain?
8	If you have had access to the content, on a scale of 1 to 10, how would you rate it?
9	If you would like to learn about something that was not mentioned, please tell us what you felt was missing.

Source: Research data (2024).

2.2 Research

Regarding the laboratorial context, equipment and facility testing activities, which included the evaluation of the Zoocel implementation, were analyzed. This involved introducing activities in the laboratory, testing the functionality of the equipment and the suitability of the facilities for specific purposes of Cellular Animal Science. The data obtained during these activities were recorded, including descriptive information about the procedures performed, results achieved, challenges encountered, and solutions implemented. This report is intended to provide an initial framework for the process of implementing routine practices in the laboratory.

2.3 Extension

Regarding the extension initiatives, the *Bife Sem Bicho* project aims to disseminate scientific knowledge about Cellular Animal Science through posts on Instagram and LinkedIn and interviews published on YouTube channel. The *Bife Sem Bicho* publications were analyzed through engagement metrics on social media, in the Insights tab on Instagram and the Analytics tab provided by YouTube Creator Studio.

3 Results

The UFPR was the first Brazilian University to implement Cellular Animal Science content in both postgraduate and undergraduate programs, with courses entitled ICAS, and first offered in 2020. Under this context, concomitant initiatives related to the insertion of the area within the University and regional scenario have arisen; however, the process of fundraising for the implementation of a Cellular Animal Science laboratory at UFPR was marked by challenges. Since 2019, there have been several attempts to secure funding, such as submitting a proposal to the Funding Authority for Studies and Projects (FINEP), which was then not successful. Additionally, attempts with the third sector did not prosper either. However, continuous efforts bore important fruits, such as the first Scientific Initiation mentorship on cultivated meat, funded by UFPR, and the mentoring of postgraduate students with Brazilian Federal Agency for Support and Evaluation of Graduate Education (CAPES)

scholarships from the Veterinary Science Post-Graduation Program, whose work resulted in relevant scientific publications. An important achievement came in 2020, with the approval of a proposal submitted to Global Action in the Interest of Animals (GAIA), a Belgian animal protection Non-Governmental Organization (NGO), which made it possible to hire a postdoctoral researcher to study the social impacts of Cellular Animal Science. The impact of this funding was decisive, as it allowed for the continuation of strategic studies and the formation of a solid knowledge base.

One significant milestone to date was the approval of the New Research and Innovation Arrangement (NAPI) in Alternative Proteins in 2023, with funding from the State Government of Parana through its research supporting agency Araucaria Foundation. With 36 goals, NAPI Alternative Proteins aims to strengthen Parana and Brazil's food producers through innovations in biotechnology, engineering, veterinary medicine, animal science, administration, agronomy, and related areas producers by utilizing innovative production systems to develop the essential stages to produce alternative proteins, while consolidating teaching, research and outreach in the field and establishing a new food industry in the State. With a consolidated multidisciplinary team that includes six research groups in three universities across the State – UFPR, State University of Maringa (UEM), and Pontifical Catholic University of Parana (PUC-PR) –, the NAPI Alternative Proteins project represents a force in research and innovation in Brazil, as the team expertise covers a complex range of knowledge for the advancement in the production of alternative proteins. This financial support of 5.7 million reais made it possible to establish a network of researchers and broaden the research and educational laboratory infrastructure.

With such developments, the acquisition of further resources through new partnerships and successful grant applications was significantly facilitated. For example, a second major funding was secured through the project Aflorabem, recently approved in a FINEP call. This scenario opens doors for collaborations with other institutions and funding agencies, solidifying Cellular Animal Science as an area of growing innovation and relevance in the State of Parana. It also clearly demonstrates the value of investments in cellular agriculture, which can rapidly attract more funding and thus start a virtuous cycle of investment and

scientific as well as agrarian and industrial development, with evident social and economic benefits.

The Zoocel laboratory is a teaching, research, and extension unit dedicated to cellular agriculture, with its implementation being one of the objectives of the NAPI Alternative Proteins project. Established in September 2023, Zoocel offers conditions for the development of scientific projects involving food production through cell cultivation on a bench scale. It aims to support activities across various industry spheres, including education, consumer acceptance, biosecurity, and the inclusion of conventional producers in the alternative protein value chain. As a newly established laboratory, it is currently possible to glimpse short-term impacts following its creation. The laboratory is part of the Agricultural Sciences Sector at the University, on a campus that hosts the Veterinary Medicine, Animal Science, and Agronomy programs, where research, teaching, and extension activities initiated by the laboratory and its research group have been conducted. In the following sections, we analyzed teaching, research, and extension dimensions of Cellular Animal Science implementation at UFPR.

3.1 Teaching

The Federal University of Parana has offered five courses related to Cellular Animal Science, both at the undergraduate and graduate levels. In July 2020, the UFPR Veterinary Sciences Post-Graduate Program (PPGCV) launched its first course in this area, entitled *Introdução à Zootecnia Celular* or Introduction to Cellular Animal Science (ICAS), offered online through live classes and in English. This inaugural course was offered for 15 students. Later, in October 2020, the same program offered the second edition of this course, again in English and online, with an increased enrollment opportunity to 20 students. Subsequently, in November 2021, the program offered the third edition of the course ICAS, this time in Portuguese, also online, now for 30 students. All editions reached full student enrollment, with additional students on a waiting list.

The postgraduate course covered a wide range of essential topics for the study of Cellular Animal Science. The course program encompassed basic concepts from cellular agriculture and plant-based, fermentation and cell-cultivation production processes to issues

such as the power of disruption for problems related to conventional animal production chains. Topics explored included Sustainable Development Goals (SDGs), animal welfare, consumer market trends, value chain in meat transition, social impacts, one welfare and global health, and industry development. Additionally, the courses provided a comprehensive understanding of biotechnology fundamentals, food safety, technology of products of animal origin, food security, and teaching and research practices. This interdisciplinary approach offered students a global perspective of the field, enabling them to understand the various factors driving the transformation of the food and biotechnology industries. The main weakness of the ICAS courses was their completely theoretical approach, with no hands-on activities due to the absence of laboratorial infrastructure.

In 2022, a request for approval of an optional ICAS course was submitted to both the academic Programs in Veterinary Medicine and in Animal Science at UFPR and, after approval was granted; in March 2023 the Programs received their first ICAS course edition in Portuguese (Figure 1).

Figure 1 – First course of Introduction to Cellular Agriculture offered to the veterinary medicine and animal science undergraduate program at Federal University of Parana (UFPR) in March 2023.



Source: The authors (2024).

This optional course, coded AZ145, attracted 37 enrolled students. With a workload of 18 hours, the course was offered in person. Subsequently, in February 2024, the same

course was offered again for undergraduate students, with 16 enrolled students. Thus, in total, the ICAS course has attracted 118 students with its five editions offered at both graduation and post-graduation levels.

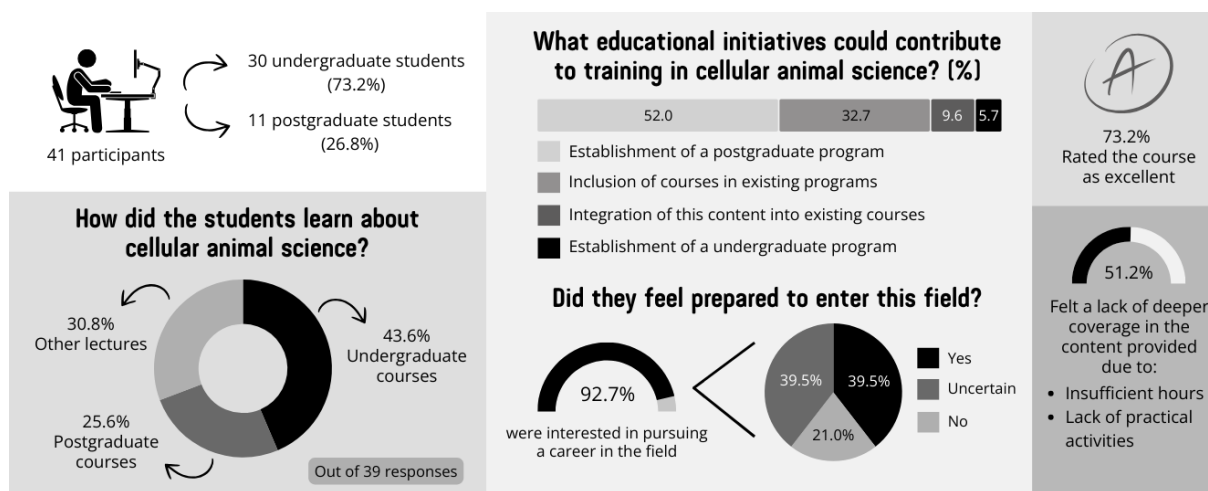
The study plan for the undergraduate course covered a variety of fundamental topics for a comprehensive understanding of the field, representing an update on the previous editions for post-graduation students. These topics included concepts related to alternative proteins, exploring different sources and production methodologies, and analyzing new food production systems, highlighting innovative technologies transforming the food industry and positively impacting animal ethics, sustainability, food safety and security, and public health. Public policies were also discussed, reflecting on how legislation and regulations may shape the development and expansion of Cellular Animal Science, and the social impacts related to this new food production method. The plan also included topics like education and research, emphasizing the importance of advancing knowledge in this field, and animal welfare, highlighting the ethics associated with reducing animal suffering through biotechnology. Global health was an important point, reflecting on how Cellular Animal Science can contribute to more sustainable food systems, which are also safer for public health, especially considering the reduction of the risk of antimicrobial resistance and new pandemics (United Nations Environment Programme and International Livestock Research Institute, 2020). Finally, economic aspects such as investments and startups both in Brazil and worldwide were covered, opening reflections on how the market is responding to cellular agriculture and how emerging companies are driving the transition to new food production methods.

3.1.1 Students' opinions about their learning experiences

All students were invited to fill in a post-course evaluation form. Of the 41 respondents, 30 (73.2%) were between 18 and 30 years old, 3 (7.3%) were between 31 and 40, and 8 (19.5%) were over 41 years old. Of the total, 34 (82.9%) were from Curitiba, Parana, while the other 7 (17.1%) were from other five Brazilian states. Among the respondents, 30 (73.2%) were undergraduate students, with 27 (90.0%) studying veterinary medicine, 2 (6.7%) in animal science, and 1 (3.3%) in bioprocess engineering and biotechnology. The remaining 11 (26.8%) were postgraduates, including 1 (9.1%) with a

specialization, 4 (36.3%) with a master's degree, 5 (45.5%) with a doctorate, and 1 (9.1%) who had already completed a postdoctoral fellowship. Among the participants, 17 (41.4%) completed graduation, 10 (24.4%) completed post-graduation, while 12 (29.3%) accessed the content through lectures, and 2 (4.9%) did not access the content. Overall, 38 respondents (92.7%) expressed interest in pursuing a career in the field, while 3 (7.3%) felt less inclined to do so. As for the perceived readiness to enter work force in the field, 15 (36.6%) felt ready, 7 (17.1%) felt unprepared, and 19 (46.3%) were uncertain. Respondents suggested additional educational initiatives, with 17 (32.7%) supporting the establishment of a full postgraduate program dedicated to cellular agriculture, 3 (5.7%) supporting a graduate program, 27 (52.0%) the inclusion of courses in existing programs, and 5 (9.6%) the integration of cellular agriculture content into current courses within existing programs. A majority (73.2%) rated the course as excellent, with some overlapping with the 21 (51.2%) respondents who in addition expected more in-depth and practical activities (Figure 2).

Figure 2 – Opinions of respondents who participated in the Introduction to Cellular Animal Science courses or related activities at UFPR from 2020 to 2024.



Source: Elaborated by the authors (2024).

The results suggest that the cellular agriculture courses had a significant impact on students' career considerations, indicating that such courses are effective in raising awareness and interest in this field. Additionally, there is a clear demand for practical activities and a need to enhance students' confidence in their preparedness for careers in alternative proteins.

While the courses played an important role, there are opportunities to further refine the course structure, especially given the current availability of laboratory facilities at the University.

The structuring and implementation of an introductory course proved to be relatively straightforward and cost-effective, with a significant impact on student education, resulting in a positive cost-benefit ratio and demonstrating a viable alternative for integrating cellular agriculture and alternative proteins into the university curriculum. Additionally, participants' feedback highlighted the demand for the inclusion of related topics within existing courses, which could be an equally effective and less resourceful strategy for initially promoting the field. Expanding the availability of a dedicated course across various programs in agricultural sciences, biological sciences, and bioprocess engineering may further attract interested students. Overall, the offering of an introductory cellular agriculture course is both viable and worthwhile, as a strategic approach to bring students close to this new field in the absence of resources to the offering of a full course with laboratory activities. In addition, such an educational initiative facilitates attaining support for the full development of the area within the University, as it attracts student attention and puts cellular agriculture as a live topic on campus. Finally, the more institutions engage with cellular agriculture, the easier it becomes for the field to flourish, as external support is vital in the first steps. In our case, the fundamental support came through the essential work of the GFI Brazil, whose efforts we can now join to further support cellular agriculture in our country.

3.2 Research

The inauguration of Zoocel at UFPR was one of the objectives of the project NAPI Alternative Proteins. The founding goals of the laboratory were teaching and research in the field of alternative proteins, more specifically establishing primary cellular culture for cultivated meat production, developing alternative culture media free of animal-derived ingredients, producing proofs of concept of cultured meat in small-scale conditions, and training and education resulting from scientific initiation, master's, doctoral, and postdoctoral opportunities. Although this report focuses on the establishment of the Zoocel laboratory at the Agrarian Sector of the UFPR, it is important to consider that the NAPI Alternative Proteins is a broader project in which the other five research groups have as fruitful and

relevant activities as those within the Zoocel umbrella, each group with their own identities and goals.

For the purpose of creating a fully operational laboratory dedicated to cellular agriculture teaching and research, we combined our previous experiences with those of other groups within the NAPI Alternative Proteins and conducted literature research to compile essential information about the basic materials and equipment needed for such a laboratory. Equipment listed included biosafety cabinet, peristaltic compressor pump, laboratory water bath, centrifuge, CO₂ incubator, CO₂ cylinders, distiller, liquid N₂ container, vertical refrigerator, horizontal freezer, AID pipette, inverted light microscope, autoclave, sterilization and drying oven, magnetic stirrer, pH meter, adjustable volume micropipette, precision scales, simple microscope, thermocycler, bioreactor for animal cell culture, and computers, in addition to consumable chemical, biological and laboratory materials (for a more detailed list, please contact authors directly). Based on this preliminary list, an analysis of the infrastructure for setting up the laboratory was conducted, using the two rooms located in the Center for Innovations in Agricultural Sciences (CIAG) in the UFPR Agricultural Sciences Sector which were designated for setting the Zoocel up.

The biosafety level considered most suitable for working with animal cells from both established lineages and primary culture was level 2 (BSL-2). One of the rooms (Room 1) was designated for washing, sterilization, preparation, and storage of materials, also serving as a gown anteroom, while the other (Room 2) was reserved for laboratory activities where users must wear personal protective equipment, such as lab coats, caps, and masks. In addition, internal connections between the two rooms were established through the opening of a door and a window, and the outside door in Room 2 was permanently closed. According to these definitions, the placement of the listed equipment was considered, including creating floor plans and 3D models for adequate layout visualization. During this process, some difficulties were identified, such as delays in advancing activities and specific structural issues, and some adaptations were made accordingly.

To establish the workflow at the Zoocel laboratory, the facilities were first cleaned, including the biosafety cabinet, incubator, benches, and floor. The stock of reagents and

consumable materials was checked and recorded. The cabinet was tested for proper operation by placing nutrient agar plates inside the work area with the airflow on for one hour, then placing them in the incubator to check for bacterial growth. The incubator was also equipped with a CO₂ cylinder, which was tested for leaks and monitored constantly. The acquisition of our first bioreactor was an important event, providing new possibilities as well as a landmark for the Zoocel activities. It consists of a control tower and two 2-liter autoclavable glass vessels. It arrived in the laboratory in June 2024, and procedures for its operation are currently under way. The proper gases are being acquired, and the final details of its installation as well as the training sessions are planned for the first semester of 2025. In addition, the acquisition of a fermenter to be used for either yeast or bacterial growth is planned for 2025, expanding the Zoocel initiatives to include research and teaching activities with both animal cell culture and precision fermentation techniques (Figure 3).

Figure 3 – Washing room (a) and cell culture room (b) at the Cellular Animal Science Laboratory (Zoocel), Federal University of Parana at the Agricultural Sciences Sector, Curitiba, Parana, Brazil in September 2024.



Source: The authors (2024).

The laboratory's functionality was assessed through a test culture with a commonly used immortalized cell line, the Vero cells which derive from kidney epithelial cells of the African green monkey (Figure 4).

Figure 4 – Testing equipments and procedure workflow for cell culture at the Cellular Animal Science Laboratory (Zoocel), Federal University of Parana (UFPR) with an immortalized cell line.



Source: The authors (2024).

In summary, significant progress has been achieved so far, transforming the Agrarian Sector of UFPR into an agricultural campus fully prepared to perform research and teaching within the domains of cellular agriculture. In terms of research, such achievements have yet another layer of benefits, as they have created a positive feedback loop through which a sensible increase in our success regarding research grant applications has recently become evident.

This is an important message for public and private institutions considering support for cellular agriculture, as seed investments seem to open a potential flow of further financial support from multiple sources.

3.2.1 Scientific Publications

Research on Cellular Animal Science, coordinated by Professor Carla Forte Maiolino Molento, began before the establishment of Zoocel, by members from the Animal Welfare Laboratory (LABEA) at UFPR and was likely key for garnering the needed support for the foundation of the Cellular Animal Science Laboratory. Again, the strategic approach was to create low-cost research activities, due to the low availability of funding. The group of researchers was composed of professors, post-graduation students – masters, doctoral, and

postdoctoral fellowship –, and undergraduate students engaged in scientific initiation and term papers holding a wide range of topics in their research. The published papers from members of research groups in cellular agriculture, Federal University of Parana, from 2019 to 2024 are presented in Chart 2.

Chart 2 –. Published papers from members of research groups in cellular agriculture, Federal University of Parana, from 2019 to 2024.

Authorship	Title	Journal	DOI	Citations
Valente <i>et al.</i> (2019)	First glimpse on attitudes of highly educated consumers towards cell-based meat and related issues in Brazil	PLoS One	https://doi.org/10.1371/journal.pone.0221129	81
Reis and Molento (2020)	Emerging Market Multinationals and International Corporate Social Responsibility Standards: Bringing Animals to the Fore.	Journal of Business Ethics	https://doi.org/10.1007/s10551-019-04144-5	22
Heidemann <i>et al.</i> (2020a)	Critical Perspective of Animal Production Specialists on Cell-Based Meat in Brazil: From Bottleneck to Best Scenarios	Animals	https://doi.org/10.3390/ani10091678	24
Heidemann <i>et al.</i> (2020b)	Uncoupling meat from animal slaughter and its impacts on human-animal relationships	Frontiers in Psychology	https://doi.org/10.3389/fpsyg.2020.01824	44
Reis <i>et al.</i> (2020a)	Cell-based meat and firms' environmental strategies: new rationales as per available literature	Sustainability	https://doi.org/10.1016/j.techsoc.2020.101286	14
Reis <i>et al.</i> (2020b)	Livestock value chain in transition: Cultivated (cell-based) meat and the need for breakthrough capabilities	Technology in Society	https://doi.org/10.3390/su12229418	51
Letti <i>et al.</i> (2021)	Cultivated meat: recent technological developments, current market and future challenges	Biotechnology Research and Innovation	http://dx.doi.org/10.4322/biori.202101	27
Reis <i>et al.</i> (2021)	Can radical innovation mitigate environmental and animal welfare misconduct in global value chains? The case of cell-based tuna	Technological Forecasting and Social Change	https://doi.org/10.1016/j.techfore.2021.120845	22
Reis,	Governance and Standardization in	Journal of	https://doi.org/	4

Molento, and Souza (2021)	Fish Value Chains: Do They Take Care of Key Animal Welfare Issues?	Agricultural & Environmental Ethics	10.1007/s10806-021-09870-3	
Moreira <i>et al.</i> (2021)	Social Media Analysis to Understand the Expected Benefits by Plant-Based Meat Alternatives Consumers	Foods	https://doi.org/10.3390/foods10123144	14
Góes, Reis, and Abib (2021)	When stakeholder theory meets justification theory: An intersection proposal	Cadernos EBAPE.BR (FGV)	https://doi.org/10.1590/1679-395120200179	7
Morais-da-Silva <i>et al.</i> (2022a)	The expected impact of cultivated and plant-based meats on jobs: the views of experts from Brazil, the United States and Europe	Humanities & Social Sciences Communications	https://doi.org/10.1057/s41599-022-01316-z	12
Morais-da-Silva <i>et al.</i> (2022b)	The social impact of cultivated and plant-based meats as radical innovations in the food chain: Views from Brazil, the United States and Europe	Frontiers in Sustainable Food Systems	http://dx.doi.org/10.3389/fsufs.2022.1056615	12
Morais-da-Silva <i>et al.</i> (2022c)	The social impacts of a transition from conventional to cultivated and plant-based meats: Evidence from Brazil	Food Policy	https://doi.org/10.1016/j.foodpol.2022.102337	32
Góes, Zeny, and Reis (2022)	When Justification Theory Meets Responsible Innovation: A Study of Cell-Based Meat.	Science, Technology and Society	https://doi.org/10.1177/09717218221075158	-
Moreira <i>et al.</i> (2022)	Reducing meat consumption: insights from a bibliometric analysis and future scopes	Future Foods	https://doi.org/10.1016/j.fufo.2022.100120	26
Silva <i>et al.</i> (2022)	What about an alternative meat? The effect of neophobia and negative affection on willingness to buy meat substitutes.	Remark. Revista Brasileira de Marketing	https://doi.org/10.5585/remark.v21i4.20166	1
Reis <i>et al.</i> (2022)	The interplay of entrepreneurial ecosystems and global value chains: Insights from the cultivated meat entrepreneurial ecosystem of Singapore.	Technology in Society	https://doi.org/10.1016/j.techsoc.2022.102116	10
Biscarra-Bellio <i>et al.</i>	Demand changes meat as changing meat reshapes demand: The great	Meat Science	https://doi.org/10.1016/	18

(2023)	meat revolution		j.meatsci.2022.109040	
Bogueva <i>et al.</i> (2023)	Will the Cows and Chickens Come Home? Perspectives of Australian and Brazilian Beef and Poultry Farmers towards Diversification	Sustainability	https://doi.org/10.3390/su151612380	4
Reis <i>et al.</i> (2023)	David vs Goliath: The challenges for plant-based meat companies competing with animal-based meat producers.	Journal of Cleaner Production	https://doi.org/10.1016/j.jclepro.2023.138705	7
Abrahao <i>et al.</i> (2023)	Cultured Manatee Meat Aiding Amazon Biodiversity Conservation: Discussing a Proposed Model	Conservation	https://doi.org/10.3390/conservation3020021	1
Garbin <i>et al.</i> (2024)	Ética animal e proteínas alternativas: questões atuais em terminologia da língua portuguesa	Archives of Veterinary Science	https://doi.org/10.5380/avs.v29i1.93963	2
Soccol <i>et al.</i> (2024)	Cultivated Meat: Technologies, Commercialization and Challenges	Springer Nature	https://doi.org/10.1007/978-3-031-55968-6	3
Newton <i>et al.</i> (2024)	Price above all else: An analysis of expert opinion on the priority actions to scale up production and consumption of plant-based meat in Brazil.	Frontiers in Sustainable Food Systems	https://doi.org/10.3389/fsufs.2024.1303448	5
Mendes <i>et al.</i> (2025)	How much do opinions regarding cultivated meat vary within the same country? The cases of São Paulo and Salvador, Brazil	PLoS One	https://doi.org/10.1371/journal.pone.0317956	-
Goes <i>et al.</i> (2025)	Stakeholders' justifications in innovation: the case of cell-based meat.	Innovation: The European Journal of Social Science Research	https://doi.org/10.1080/13511610.2024.2352744	2
Casnici <i>et al.</i> (2024)	The Role of NGOs in the Transition Towards More Sustainable and Innovative Agri-food GVCs	Emerald Insight	https://doi.org/10.1108/S1745-886220240000018023	-
Reis <i>et al.</i> (2025)	Promises and uncertainties in the cultivated proteins market: Perspectives from Germany and		https://doi.org/10.1016/	-

	Brazil	Food Policy	j.foodpol.2025.102820	
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Source: Elaborated by the authors (2024).

3.2.2 Works presented at events

Some members of the LABEA and Zoocel research groups presented works regarding Cellular Animal Science at events from 2021 to 2024 such as seminars, congresses, and conferences in different locations (Chart 3).

Chart 3 – Abstracts accepted at events from members of the Animal Welfare Laboratory (LABEA) and the Cellular Animal Science (Zoocel) research groups, Federal University of Parana, from 2021 to 2024.

Authorship	Title	Event	Place
Biscarra-Bellio <i>et al.</i> (2021)	Intenção de Consumo de Carne Celular no Brasil	VI Animal Defense Seminar – National Forum for Animal Protection and Defense	Curitiba, PR. Brazil
Paolini <i>et al.</i> (2021)	Proposal for Brazilian Higher Education in Alternative Proteins.	VI Animal Defense Seminar – National Forum for Animal Protection and Defense	Curitiba, PR. Brazil
Biscarra-Bellio <i>et al.</i> (2021)	Introduction to Cellular Animal Sciences	SEE-U Conference International Relations Office at University Federal do Parana.	Curitiba, PR. Brazil
Morais-da-Silva <i>et al.</i> (2021)	The animal stance in the socio-technical transition to sustainability: the case of cultivated meat.	Proceedings of the 37th European Group for Organizational Studies. EGOS Colloquium.	Amsterdam, Netherlands.
Paolini <i>et al.</i> (2022)	Possibilities for higher education in alternative proteins in Brazil	29 ^a – EVINCI Evento de Iniciação Científica 13 ^a SIEPE Semana Integrada de Ensino Pesquisa e Extensão UFPR	Curitiba, PR. Brazil
Grenzi <i>et al.</i> (2022)	Nutrição de animais de companhia baseada em proteína de carne celular	29 ^a – EVINCI Evento de Iniciação Científica 13 ^a SIEPE Semana Integrada de Ensino Pesquisa e Extensão UFPR	Curitiba, PR. Brazil
Biscarra-Bellio <i>et al.</i> (2022)	Avoiding the Risk of Deepening Inequalities In The Food Production Chain: An Initial Framework for Higher	RGS-IBG Annual International Conference: Geographies beyond recovery	London, United Kingdom.

	Education Regarding Alternative Protein		
Mendes <i>et al.</i> (2023)	Zootecnia Celular: Bife Sem Bicho? Conhecendo Carne, Ovos, Leite e Derivados sem Sofrimento e Abate de Animais	21º ENEC - Encontro de Extensão e Cultura 14ª SIEPE Semana Integrada de Ensino Pesquisa e Extensão UFPR	Curitiba, PR. Brazil
Mendes <i>et al.</i> (2023)	Consumer Acceptance of Cultivated Meat in Brazil	30ª – EVINCI Evento de Iniciação Científica 14ª SIEPE Semana Integrada de Ensino Pesquisa e Extensão UFPR	Curitiba, PR. Brazil
Mendes <i>et al.</i> (2023)	Consumer Acceptance of Cultivated Meat in Brazil	1º International Conference of the Portuguese Association for Cellular Agriculture	Braga, Portugal
Moraes-da-Silva <i>et al.</i> (2023)	The Potential Relevance of Associations for the Progress of Cellular Agriculture: The Case of Cell Agri Brazil	1º International Conference of the Portuguese Association for Cellular Agriculture.	Braga, Portugal
Valim <i>et al.</i> (2023)	Zootecnia Celular: Bife Sem Bicho? Conhecendo Carne, Ovos, Leite e Derivados sem Sofrimento e Abate de Animais	41º SEURS Seminário de Extensão Universitária da Região Sul	Ponta Grossa, PR. Brazil
Coelho <i>et al.</i> (2024)	Crescimento De Células Vero e MDBK em Meio Livre de Soro Fetal Bovino	29º CBCTA 2024 - Brazilian Congress of Food Science and Technology	Florianópolis, SC. Brazil
Biscarra-Bellio <i>et al.</i> (2024)	A glimpse on students' perceptions of education in Cellular Animal Sciences in a Brazilian University	2 nd International Conference of the Portuguese Association for Cellular Agriculture	Portugal
Mendes <i>et al.</i> (2024)	Cellular Agriculture at UFPR: Research, Teaching, and Extension Initiatives	I COAP – 1 st Conference on Alternative Proteins	Campinas, SP. Brazil
Biscarra-Bellio <i>et al.</i> (2024)	Cell Ag Brazil: Accelerating the Alternative Proteins Sector In Brazil	I COAP – 1 st Conference on Alternative Proteins	Campinas, SP. Brazil
Garbin <i>et al.</i> (2024)	Preliminary analysis of animal-derived inputs in cultivated meat patents: the importance of technical descriptions	I COAP – 1 st Conference on Alternative Proteins	Campinas, SP. Brazil

Garbin <i>et al.</i> (2024)	The role of food bioprinting in sensory food aversion of individuals with Autism Spectrum Disorder (ASD)	I COAP – 1 st Conference on Alternative Proteins	Campinas, SP Brazil
Gularte <i>et al.</i> (2024)	Perception of vegetarians and vegans regarding the inclusion of cultivated meat in their dogs' diet	I COAP – 1 st Conference on Alternative Proteins	Campinas, SP. Brazil
Biscarra-Bellio <i>et al.</i> (2024)	Cellular Agriculture: Who Wants to Learn About This New Technology?	I International Conference Cell Ag Brazil and I NAPI Alternative Proteins Meeting.	Curitiba, PR. Brazil
Mendes <i>et al.</i> (2024)	Intenção de Consumo da Carne Celular nas Cidades de Salvador e São Paulo, no Brasil	VII Animal Defense Seminar – National Forum for Animal Protection and Defense	Brasília, DF. Brazil
Mendes <i>et al.</i> (2024)	Bife Sem Bicho: Conhecendo a Carne, Ovos, Leite e Derivados sem sofrimento e morte de animais	VII Animal Defense Seminar – National Forum for Animal Protection and Defense	Brasília, DF. Brazil
Mendes <i>et al.</i> (2024)	Zootecnia celular na UFPR: iniciativas de pesquisa, ensino e extensão	31 ^a – EVINCI 15 ^a SIEPE Semana Integrada de Ensino Pesquisa e Extensão UFPR	Curitiba, PR. Brazil
Gularte <i>et al.</i> (2024)	Percepção de vegetarianos e veganos sobre a inclusão de carne celular na dieta de seus animais de estimação	31 ^a – EVINCI 15 ^a SIEPE Semana Integrada de Ensino Pesquisa e Extensão UFPR	Curitiba, PR. Brazil
Chaudhary <i>et al.</i> (2024)	Toward a global protein transition: urgency, potential, and international cooperation	G20 Brasil 2024	Brazil

Source: Elaborated by the authors (2024).

3.3 Extension

The UFPR's first extension project in cellular agriculture, entitled *Bife Sem Bicho*: understanding meat, eggs and dairy without the suffering and death of animals, was created in February 2023. The project aims to offer meaningful contact with Cellular Animal Science, in an accessible and inviting manner, to the university community as well as the public. The project goals are to disseminate and to promote knowledge about scientific advancements

related to environmental, social, economic, public health, food safety and security, and animal ethics aspects associated with alternative proteins.

In this context, the project includes two subprojects organized according to the type of content produced and its presentation format. Subproject 1, entitled *Zoocel Na Rede*, focuses on developing and managing a website for the Zoocel laboratory, as well as creating social media profiles to disseminate and expand access to information on Cellular Animal Science and Zoocel's daily activities. Activities in this subproject range from website planning to producing content for social media posts to generate engagement and interaction with the public, broadening knowledge and the debate on the topic. The second subproject, *Pod Bife Sem Bicho* offers a podcast featuring interviews with professionals who work or are involved with Cellular Animal Science, both within and outside UFPR. The podcast target audience is composed of undergraduate students interested in deepening their knowledge on the subject, as well as society in general, with the goal of informing about innovations in the field. Its development involves planning episodes, selecting interviewees, preparing questions, and recording, posting episodes on digital platforms, and promoting them.

The LinkedIn (Zoocel Laboratório de Zootecnia Celular | LinkedIn) and Instagram (@zoocel.ufpr) accounts were created to provide information about Cellular Animal Science, including highlights from researchers and their projects at Zoocel. So far, LinkedIn has 244 followers and 114 connections, and it features 33 posts. The Instagram account has shared 59 images and 17 videos, mainly aiming to clarify common doubts about the topic. From August 2024 to October 2024, the profile @zoocel.ufpr reached approximately 3,5 thousand accounts, with current number of 767 followers. The most popular post to date is the video *Carne cultivada é agro!* – cultivated meat is agriculture in Portuguese – which alludes to a catchphrase referring to the powerful agricultural activities in Brazil, with a total of 5,007 views. Additionally, a LinkedIn profile was created to replicate the content posted on Instagram. The website (<https://zoocel.ufpr.br/>) includes information on research projects, team, scientific productions, and news related to the laboratory (Figure 5).

Figure 5 – *Bife Sem Bicho* extension project within the

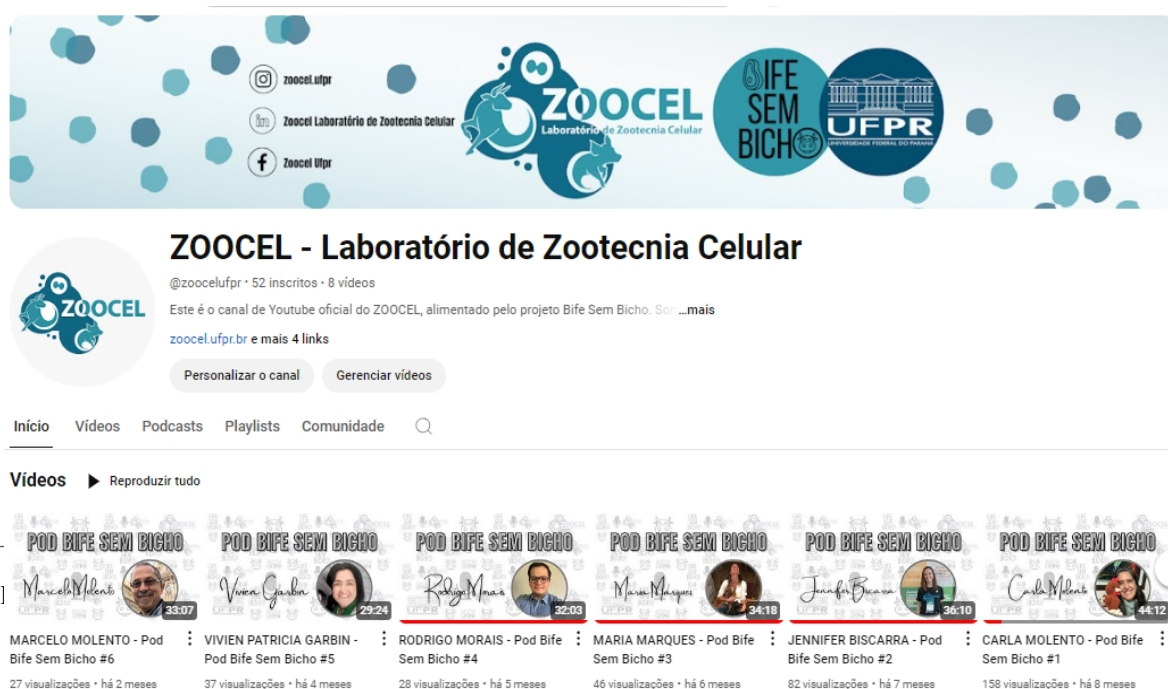
Cellular Animal Science Laboratory (Zoocel), Federal University of Parana, logo and QR code for the access to the social media.



Source: Elaborated by the authors (2024).

The Zoocel YouTube channel has seven published videos (Figure 6). The first video was a glossary covering essential terminology in Cellular Animal Science. The following six videos are videocasts where extension project members interview researchers involved in cellular agriculture. The interviews explored topics such as animal welfare, professional training for the field, the integration of rural producers into the alternative protein production chain, potential social impacts, and appropriate terminology to use for alternative proteins in Brazilian Portuguese, and global health. The Zoocel YouTube channel has 52 subscribers and a total of 600 views. Additionally, the channel achieved 4,3 thousand impressions, representing the frequency with which videos were shown to viewers.

Figure 6 – YouTube channel of Pod *Bife Sem Bicho*, part of the extension project *Bife Sem Bicho*, Cellular Animal Science Laboratory (Zoocel), Federal University of Parana, since February 2023.



Source: Screenshot of the Zoocel YouTube channel (2024).

3.4 Miscellaneous

For planning and execution of many of the works already completed and those in progress, certain partnerships have been fundamental for the Cellular Animal Science Laboratory. The Good Food Institute (GFI) was instrumental in initial educational initiatives carried out by our group, providing important collaboration involving the Technion University of Israel, which made a significant contribution of educational materials. More recently, Zoocel group was able to contribute to the development of a teaching plan currently made available by GFI Brazil (GFI Brasil, [2023]).

The partnership with Global Action in the Interest of Animals (GAIA) – a Belgian NGO based in Brussels – focused on the social impacts of alternative meats and resulted in three scientific publications, which can be considered the inauguration of the scientific approach to the social impacts of alternative proteins in Brazil: “The expected impact of cultivated and plant-based meats on jobs: The views of experts from Brazil, the United States and Europe” (Morais-da-Silva *et al.*, 2022a) in the journal *Humanities and Social Sciences Communications*; “The social impacts of a transition from conventional to cultivated and plant-based meats: Evidence from Brazil” (Morais-da-Silva *et al.*, 2022b) in the journal *Food Policy*; and “The social impact of cultivated and plant-based meats as radical innovations in the food chain: Views from Brazil, the United States and Europe” (Morais-da-Silva *et al.*, 2022c) in the journal *Frontiers in Sustainable Food Systems*.

The partnership with Curtin University in Australia facilitated joint activities related to understanding the needs of farmers in the context of new food production systems, leading to the publication of the article *Will the cows and chickens come home? Perspectives of Australian and Brazilian beef and poultry farmers towards diversification* (Bogueva *et al.*, 2023) in the journal *Sustainability*. Negotiations with the University of Alberta in Canada resulted in the signing of a memorandum of understanding between the institution and the State of Parana's funding agency, Araucaria Foundation, for the mobility of up to 10 students per year between research institutions in Parana and the Canadian university. Similarly, there is also a partnership with Wageningen University in the Netherlands in synergy with Zoocel,

hence the coordinator of this proposal was invited to participate as a visiting researcher within the scope of a project funded by the Dutch government to develop the production of milk and derivatives through precision fermentation. Thus, the international universities with which the Zoocel group maintains partnerships are establishing permanent institutional research and teaching structures in the field of alternative proteins, creating high-potential scenarios for joint work in the coming years.

The Pollination Project Foundation (TPPF) focuses on global transformation and social change; although it emphasizes small grants, the partnership between our team and TPPF was crucial as it provided the necessary resources for the founding of Brazilian Association of Cellular Agriculture (Cell Ag Brazil). Currently, Cell Ag Brazil is part of the Network of Cellular Agriculture (NCA), in which the Cell Ag Greece, Portugal, the Netherlands, Italy, Germany, the UK, and Canada, among others, also participate. The Cell Ag Brazil is expected to contribute by promoting and accelerating cellular agriculture and by acting as a facilitator of national and international dialogue on emerging technologies for food production. In a second round of support, TPPF significantly contributed to the organization of the I International Cell Ag Brazil Conference and the I NAPI Alternative Proteins Meeting. During the event, the recently published book *Cultivated Meat: Technologies, Commercialization and Challenges* (Soccol *et al.*, 2024) published by Springer Nature was launched. This book was edited by four UFPR professors involved with the NAPI Alternative Proteins, and features contributions from members of the group as well as the work of additional Brazilian researchers in an array of institutions and States, providing a solid platform for the dissemination of Brazilian excellence in research regarding alternative proteins.

Additionally, undergraduate students from the Veterinary Medicine and Animal Science programs at UFPR, along with graduate students in Veterinary Sciences from the Animal Welfare and Cellular Animal Science laboratories, have recently created the Alternative Protein Project (APP) UFPR. The Alt Protein Project is a global student movement dedicated to transforming universities into engines for alternative protein education, research, and innovation. Students at all levels of training, from first-year

undergraduates to graduate students about to defend their theses, are the driving force behind the Alt Protein Project, which is gaining momentum at universities worldwide. There are currently 79 universities involved globally, with six in Brazil. In addition to UFPR, the Federal University of Minas Gerais (UFMG), Federal University of Santa Catarina (UFSC), São Paulo State University (UNESP), São Paulo University (USP), and University of Campinas (UNICAMP) have also established their own APPs.

Throughout 2025, the Zoocel has been expanding its research lines in cellular agriculture, incorporating new approaches beyond animal cell cultivation for food production. One of the emerging areas is fermentation for alternative protein production, creating new research opportunities for both undergraduate and graduate students. A significant milestone will take place in the first semester of 2025 with the first practical class of the Introduction to Cellular Zootechny course being held in the laboratory. Previously, the lack of proper infrastructure limited students' hands-on experience, but this barrier has now been overcome with the recent structuring of the space. Additionally, by the end of 2026, when the third year of the NAPI Alternative Proteins project concludes, one of the main objectives is to produce a proof of concept of cultivated bovine and pork meat at a gram-scale, solidifying the laboratory's technological advancements in this field.

4 Final considerations

Our results indicate that UFPR is successfully entering the field of Cellular Animal Science, with advancements in teaching, research, and outreach. The progression highlights the need for ongoing efforts and a broader expansion of these three pillars, to encompass an increasing number of students and professionals interested in the field as well as to support advancements in other institutions. Further research and teaching efforts seem warranted to solidify this field at both undergraduate and postgraduate levels in Brazil.

In terms of teaching, the creation of new courses or the adaptation of existing ones across different academic programs are the next logical steps. Moreover, students have expressed a predictable demand for hands-on experience in alternative protein production techniques. In this context, universities may consider upgrading their laboratories or

establishing new facilities to meet the practical training demands. The results may then add up to the broad and complex range of developments required for Brazil to participate in the new food production systems that are being set up across the world. This may, in turn, strengthen the regional and national landscape of alternative proteins, contributing to increased sustainability and ethics in food production. A last word of caution: the time for investments in research and education is now. If Brazilian institutions are caught with resistance from incumbents or bureaucratic entanglements, we may repeat the consequences of previous disruptive innovations to which we did not react in a timely fashion, such as digital technologies for instance. However, due to the magnitude of agricultural activities in our country, this can be a completely different story. Will Brazil play a leadership role in cellular agriculture? The answer depends largely on what we do now.

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