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An outreach and academy experience using a synthetic biology approach to aid xeroderma pigmentosum treatment

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Abstract: The International Genetically Engineered Machine (iGEM) competition aims to disseminate synthetic biology among students and to bring society closer to scientific solutions. The Design League (iDL) category of iGEM aims to explore Latin America's rich biodiversity, scientific knowledge, and synthetic biology potential to address or mitigate existing regional problems. The state of Goiás, Brazil, through the Federal University of Goiás (UFG), participated in the 2023 competition for the first time. This work aimed to describe the creation of the SynBio UFG team (a university outreach project) and analyze its impact on students' multidisciplinary skills and society through addressing local community challenges. Our methodology encompassed design thinking and the Double Diamond tools for problem and solution definition, as well as scientific dissemination through social media and university events. Additionally, business model development was facilitated via the Canvas framework. As a result, the design thinking and double diamond tools enabled the definition of Xeroderma pigmentosum – a rare genetic disease with the highest global incidence in the Araras community, in Faina, Goiás – as the core research topic and a therapeutic cream (AraraSun) based on flavonoids and an innovative synthetic peptide as the scientific project to be developed. Human practices enabled us to gain a better understanding of the disease and disseminate it to the academic community. Through CANVAS, a business model was developed to make the product commercially viable. AraraSun achieved 2nd place in the competition, receiving recognition for its scientific quality and social work toward XP-affected individuals.

Keywords: Goiás; iGEM; Design League; Scientific Extension

Uma experiencia acadêmica de extensão usando a biologia sintética como ferramenta para o auxiliar o tratamento de xeroderma pigmentoso

Resumo: A competição internacional de máquinas geneticamente modificadas (*International Genetically Engineered Machine* - iGEM) tem como objetivo disseminar a biologia sintética entre estudantes e aproximar a sociedade das soluções científicas. A categoria Design League (iDL) do iGEM busca explorar a rica biodiversidade da América Latina, seu conhecimento científico e o potencial da biologia sintética para enfrentar ou mitigar problemas regionais. O estado de Goiás, Brasil, por meio da Universidade Federal de Goiás (UFG), participou pela primeira vez da competição em 2023. Este trabalho objetiva descrever a criação da equipe SynBio UFG (projeto de extensão universitária) e analisar seu impacto nas competências multidisciplinares dos estudantes de graduação e na sociedade por meio do enfrentamento dos desafios da comunidade local. Nossa metodologia abrangeu o uso das ferramentas *design thinking* e *double diamond* para a definição do problema e da solução, divulgação científica nas redes sociais e eventos universitários, além do desenvolvimento de um modelo de negócio via CANVAS. As ferramentas *design thinking* e *double diamond* possibilitaram a definição do Xeroderma pigmentoso – uma doença genética rara com a maior incidência mundial na comunidade de Araras, em Faina, Goiás – como o tema base da pesquisa e um creme terapêutico (AraraSun) baseado em flavonoides e em um peptídeo sintético inovador como o projeto científico a ser desenvolvido. As práticas humanas permitiram compreender melhor a doença e divulgá-la à comunidade acadêmica. Por meio do CANVAS, construímos um modelo de negócio para tornar o produto desenvolvido comercialmente viável. O AraraSun conquistou o 2º lugar na competição, recebendo reconhecimento por sua qualidade científica e pelo trabalho social voltado a indivíduos afetados pelo xeroderma pigmentoso.

Palavras-chave: Goiás; iGEM; Liga de Design; Extensão Científica

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Introduction

The synthetic biology field has emerged as a dynamic interdisciplinary domain, integrating principles from biology, engineering, and computer science (Singh et al., 2019), and is quickly expanding (Abil et al., 2014). It aims to design and construct new biological systems or modify existing ones for specific purposes, for complex challenges (Yamagata, 2023). Synthetic biology contributes to solutions in several fields, including medical technologies, industrial biotechnology, and environmental sustainability (Clarke & Kitney, 2020).

The International Genetically Engineered Machine (iGEM) competition stands out as a pivotal global platform for students to engage in hands-on synthetic biology projects (International Genetically Engineered Machine [iGEM], 2023a). Originating at the Massachusetts Institute of Technology (MIT) in 2004, iGEM has become an influential annual event, fostering collaboration, innovation, and ethical practices among participants worldwide (iGEM, 2023a). The competition focuses on teams working on projects that involve engineering microorganisms, showcasing the transformative potential of synthetic biology. The iGEM competition contributes significantly to promoting learning about microbiology skills (Kelwick et al., 2015), design competencies (Mitchell et al., 2011), teamwork (Moon, 2022), risk management, safety, and security (Millett & Alexanian, 2021), collaboration and social impact (Morales et al., 2022). The social impact stems from the extension activities promoted by enrolled students, which contribute to their education and the broader community. Each team chose a theme and developed a synthetic biology project in different areas (Moon, 2022).

A few years ago, initiatives to spread synthetic biology worldwide began to emerge, primarily in developing nations, where high biodiversity often coexists with limited educational access due to socioeconomic issues (Nadra et al., 2020). Then, expanding the reach of iGEM, the iGEM Design League (iDL) emerged in 2021 as a competition dedicated to Latin American student teams (iGEM, 2023b). This regional extension of iGEM involves addressing local challenges through synthetic biology solutions. Since iDL's creation, nine teams from Brazil have participated in the competition.

In 2023, the Synthetic Biology Club at the Federal University of Goiás (SynBio UFG) was created and established as an extension activity. SynBio UFG organized a series of activities to impact academia and has played a pioneering role in raising awareness of the links between synthetic biology, biodiversity, and rare genetic diseases, such as Xeroderma pigmentosum (XP). An extremely high incidence of XP occurs in Araras village in central Brazil – one in 410 inhabitants – due to a mutation at the POLH gene. This gene was introduced in Brazil at least 200 years ago (Castro et al., 2020) and has persisted to this day, highlighting the need for actions to be taken for this community.

This work aimed to analytically describe the creation of the SynBio UFG team (University Extension Project) and its impact on undergraduate students' multidisciplinary skills and societal development by addressing local community problems.

Metodology

To rationally structure the local problem that the SynBio UFG Team would address, the Design Thinking methodology was selected (Brown, 2009). This methodology describes the process as a sequence of divergences and convergences of choices through the Double Diamond.

To facilitate the project's development, the online project management tool Trello was utilized, based on agile methodologies such as Kanban (Hines, 2016), and utilizing the templates provided by the platform. Google

Drive, Docs, and Sheets were also essential for the project's execution, as they facilitated team organization and document creation (Mixon, 2023). The Canva design platform was used to create institutional, scientific presentations, and social media posts, as well as to edit scientific dissemination videos.

Problem definition

The choice of the problem to be addressed in the project was primarily defined as the Human Health theme as the main thematic line. This choice was made strategically, as the extension project is linked to the Institute of Tropical Pathology and Public Health (IPTSP) at UFG, and most of the student members of the project have an affinity and training aligned with this area. After this definition, themes relevant to human health in Goiás were listed through a data survey.

Subsequently, the team defined eight important criteria for participation in the iDL (Table 1). Then, each member was assigned scores from one (low potential) to five (high potential) for the diseases listed as problems for the population of Goiás. The theme with the highest score was selected based on the sum of the average scores across all criteria for each topic (Morales et al., 2022).

Solution definition

The next step after selecting the problem was to learn and understand the existing solution proposals for the target disease, as described in the scientific literature (Supplementary Material 1). Based on the results obtained in the bibliographic research, the brainstorming technique was applied to four biotechnological solutions with the greatest potential, which were analyzed using the methods already described, with a focus on synthetic biology.

To define the solution approach the team would develop, virtual meetings were held with the leader of the XP community in Araras, Goiás State, and experts in XP's research to deepen knowledge about the disease, existing solutions, and their flaws. Additionally, a priority matrix that associates cost and effectiveness was created and analyzed. The adapted priority matrix was used as a methodology to evaluate the possible solutions listed against the criteria of importance for end users and the market: manufacturing cost and effectiveness in preventing and treating the disease.

Project development: Scientific approach

The scientific methodology and results are available in Supplementary Material 2.

Table 1. Criteria for selecting the problem/theme.

1.	Regional and national impact and relevance
2.	Intellectual and financial resources available for developing the theme at UFG
3.	Potential for implementing social activities involved with the theme (human practices)
4.	Potential for innovation in dealing with the topic
5.	Potential for innovation of possible solutions for the topic
6.	The existence of previous iDL teams that worked on the same problem or theme
7.	Potential to generate scalable and business-generating solutions
8.	Application/Direct relationship of the theme with synthetic biology approaches

Human practices and partnership

The social networks Instagram (Romão & Silva Júnior, 2022) and LinkedIn were utilized as scientific dissemination tools, featuring more accessible and visually attractive language (Navas et al., 2020), and were employed in the project to increase the general population's knowledge about XP. The distribution of pamphlets at the Faculty of Dentistry - UFG was made with the same objective. For scientific dissemination, lectures were organized for undergraduate freshmen in biotechnology at the UFG Institute of Physics, and a scientific poster was developed. In addition, several reports – ADUFG, IPTSP, and Jornal O Popular - were published. Partner collaboration was achieved through interactions with the UTPrimers team and online sessions in the iDL.

Entrepreneurship and UN Sustainable Development Goals (SDG)

The team prepared an entrepreneurship proposal for the AraraSun therapeutic cream, through the Business Model Canvas methodology. Furthermore, the entrepreneurship project was aligned with the United Nations (UN) Sustainable Development Goals (SDGs) to create a positive impact on the community and the environment (Hansen & Wyman, 2021).

Awards

After the competition, we analyzed the results achieved and the lessons learned during the execution of the extension project. We also envision changes that teams competing in the iDL should adopt in the coming years.

Results

The project development employed a multidisciplinary approach, drawing on multiple fields, including biotechnology, bioinformatics, human practices, marketing, and entrepreneurship, which yielded several results in the final theoretical project of AraraSun. As mentioned by Dalton et al. (2021), a multidisciplinary approach to the research and development of scientific projects is a complex process and requires an in-depth analysis of each aspect that constitutes them.

The solution for the chosen problem aimed to deepen the understanding of the issue and prioritize solutions that were most beneficial to the end user, based on scientific publications and experts' experience. As described in Figure 1, this process can be summarized in a double diamond structure diagram, focused on guiding the decision-making process in the project. Therefore, it is worth highlighting the contribution of the Design Thinking approach to the research of complex and multifaceted problems, enabling the integration of different perspectives in search of the most effective solution possible (Bender-Salazar, 2023).

Problem definition

The state of Goiás is one of the 26 Brazilian states, located in the Central-West region, and is the seventh-largest state in the country. It is the state with Brazil's ninth-largest economy, primarily based on agriculture, food and beverage, automobile, medicine manufacturing, and other industries (Instituto Mauro Borges [IMB], 2018). Despite being a significant state in Brazil, Goiás faces various challenges that impact its population. With a focus on health, leprosy (Rodrigues et al., 2020), Chagas disease (Moraes et al., 2017), dengue fever (Silva et al., 2023), prostate cancer (Santos et al., 2014), XP (Castro et al., 2020), among others, place a heavy burden on the population.

As different approaches seemed equally relevant, those related to arboviruses, prostate cancer, and XP were prioritized in the first round of selection. The thematic choice that obtained the highest score according to the pre-established criteria by the members was XP.

Eight members of the extension project participated in the thematic analysis (Figure 2). As it is a rare disease, XP does not affect as many people in Goiás or Brazil when compared to the occurrence of arboviruses and prostate cancer. However, the relevance of XP in a particular region of Goiás, its high mortality rates (Cordeiro et al., 2023), and the need to expand the discussion about this disease and its sufferers directly influenced the grades obtained in criterion one.

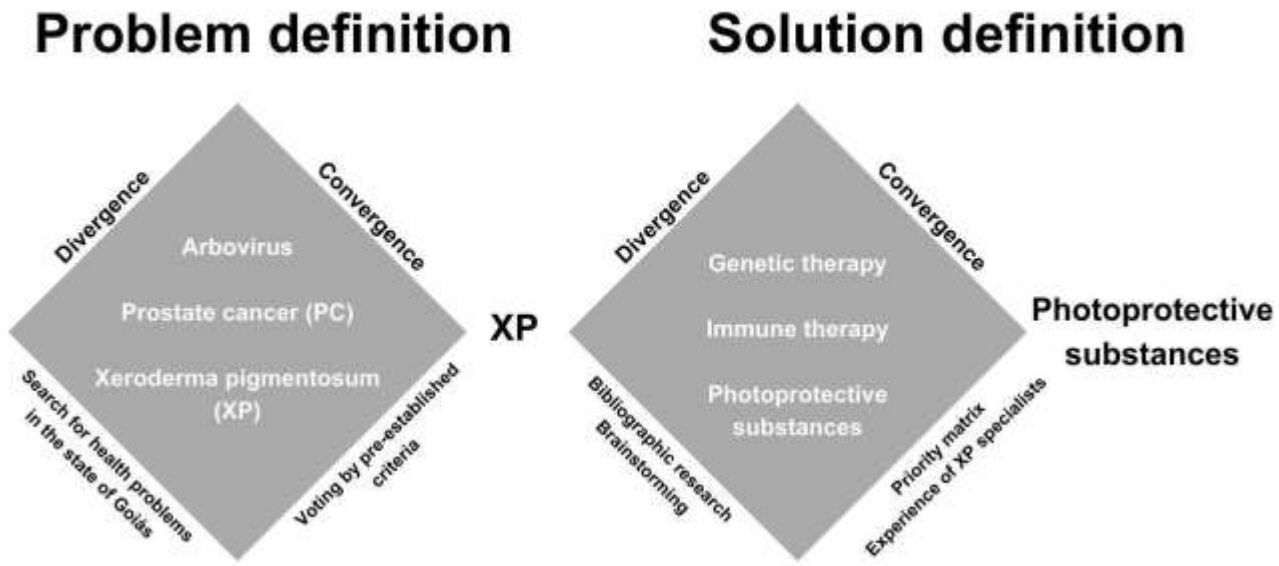

Figure 1. On the left, the process of divergence and convergence is illustrated to provide context for the problem. On the right, the same process was used to determine the most suitable approach to addressing the problem raised.

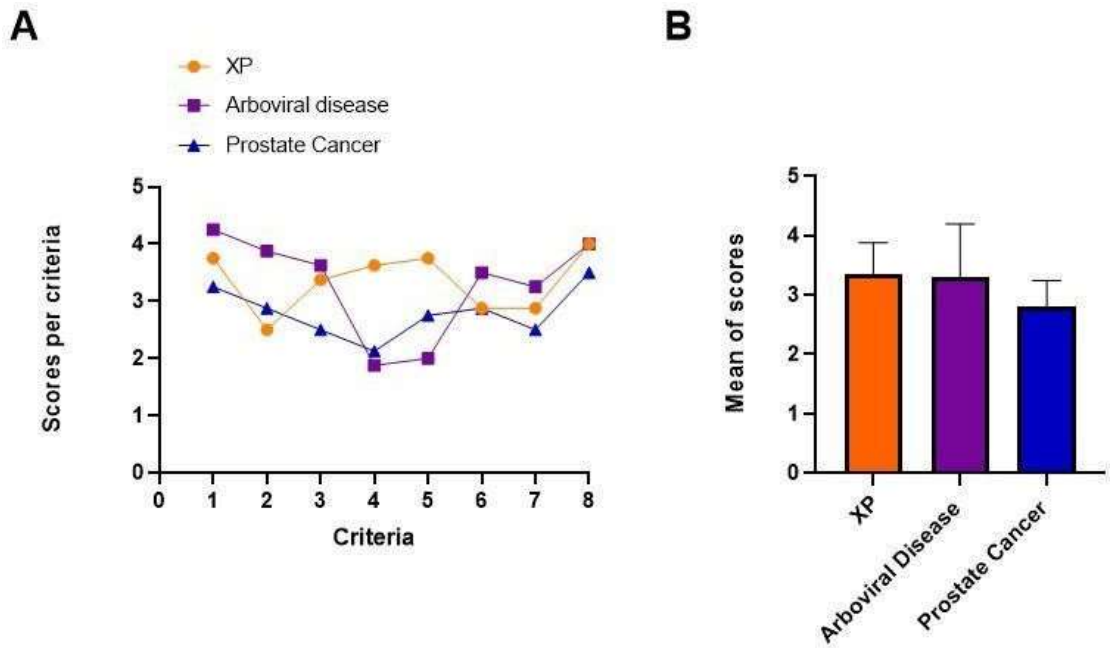

Figure 2. Average scores of each subject/theme - Xeroderma Pigmentosum (XP) is represented in orange, arboviral disease in purple, and prostate cancer in blue - concerning each criterion analyzed. Eight members of the extension project carried out the analysis of each theme based on each of the criteria, assigning a score from one to five. (A) Displays the average of each criterion for the three themes analyzed. Each line in the graph represents how each theme performs concerning individual criteria. (B) Shows the average and standard deviation of each criterion for each theme shown in A.

The Criterion two, related to possible scientific mentors with expertise in XP that we could have at UFG, presented the lowest average among those obtained in the XP theme, when compared to the other themes. However, after meetings with Professor Carlos Menck in the solution definition phase (topic 3.1), we realized the direct relationship between research on XP in Brazil and UFG. Mentoring with dermatologist Sulamita Chaibub and her scientific work also allowed us to understand the role of health professionals in Goiás concerning XP.

Human practices - criterion three - were crucial in helping us define the topic to be addressed, as they enabled us to understand the disease directly through its sufferers, bring visibility to them, and potentially provide them with assistance. Furthermore, for the iDL, this aspect is crucial and should be explored extensively in the competition (Morales et al., 2022), allowing us to execute the objectives of the extension project. It can be seen that criteria four and five resulted in significantly higher averages for XP when compared to arboviruses and prostate cancer themes. These two criteria, dealing with innovation (Criterion 4) and developing a possible solution to the problem (Criterion 5), were associated with a limited literature related to XP (Souto, 2016) and alternative treatment solutions when applied to synthetic biology.

The overall mean for the XP theme was 3.34, compared to 3.29 for the arboviruses theme. The theme "prostate cancer" presented a mean of 2.79 (Figure 2B). Even though they presented very similar results, the XP theme was chosen over the arboviruses theme, as criteria four and five of the arboviruses theme yielded the lowest scores among the three themes (Figure 2A). These criteria were decisive, as one of the ways of analyzing the iDL competition is to evaluate innovation in terms of both the theme and the solution. As the topic of arboviruses has already been widely discussed and addressed in synthetic biology competitions (iGEM 2021a; iGEM, 2021b), dedicating the XP theme presented a greater potential for local impact and development of an innovative approach.

Solution definition

XP is a rare genetic disease, and its treatment encompasses multiple socioeconomic aspects in Goiás state, including a per capita income of R$441.39, an extreme poverty rate of 6.51%, and a Gini index of 0.44 (Saneamento e Saúde Ambiente Rural, 2019). Therefore, the project's proposal prioritized a solution that would improve the quality of life for these patients (Souto, 2016) and could be applied with the lowest possible research and development costs.

A scientific literature review (Supplementary material 1) regarding the main existing therapeutic approaches for XP was conducted. Highlighting immunotherapy, photoprotective substances, and gene editing as the primary alternatives, the brainstorming technique, followed by the adapted priority matrix (Figure 3), revealed a financially accessible and more effective possible solution.

The brainstorming results (Isaksen & Gaulin, 2005) of the main solutions based on synthetic biology techniques and their respective characteristics were obtained. The first finding is that some solutions, such as gene therapy, present the possibility of curing XP; however, access to this technology by the Faina community was very low due to the previously mentioned socio-economic conditions. Biomaterials were another strategy considered for preventing tumor occurrence by shielding XP patients from sun exposure. However, various accessible solutions have already been developed and are available in the market. Our priority matrix-related cost and effectiveness variables enabled us to choose the use of therapeutic creams over other possible solutions from an economic perspective - the lowest cost among the alternatives, and effectiveness, as they are easily applied by patients themselves.

Therapeutic creams for various purposes, such as wound care (Gwarzo et al., 2022), are already described in the literature as highly effective in personal care and facilitating regenerative medicine.

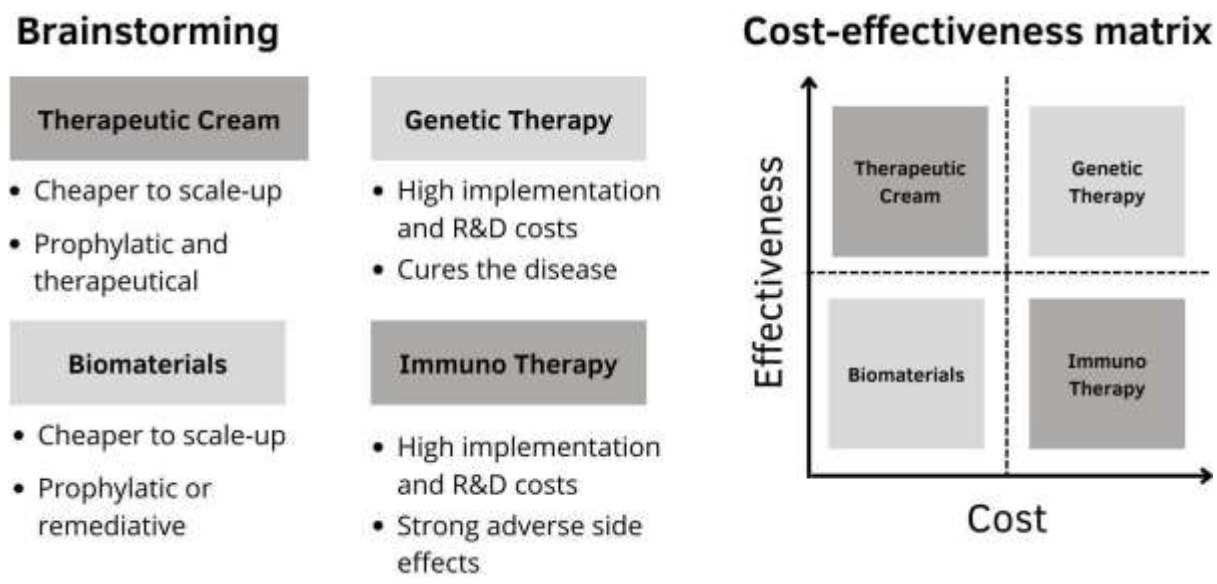

Figure 3. Brainstorming results followed by the priority matrix. Brainstorming focused on four XP handling strategies, detailing the respective strengths and weaknesses of each technology. The priority matrix relates to the cost of developing and implementing each technology, as well as its effectiveness in terms of ease of use for the XP user, and the results already described in the literature.

Contact with healthcare professionals, researchers, and political representatives of the community allowed us to obtain and reinforce different data and results, including (1) the visibility of XP and its carriers within the state of Goiás is still low; (2) current solutions for XP are palliative and do not prioritize patient well-being; (3) interventions, especially surgical ones, are often only made when melanoma is already advanced, a fact which goes against the recommendations of specialists (Lindsey et al., 2018); (4) socio-economic conditions aggravate the situation of XP carriers.

In this way, the theoretical proposal for the AraraSun therapeutic cream was constructed, which was based on the heterologous production of enzymes involved in the synthesis pathways of different flavonoids from plants in the Cerrado biome, combined with the design of a synthetic peptide with antitumor and antioxidant activities.

Human practices and partnership

During the extension project, the general community was impacted through social networks. With the participation of all extension project members, 18 posts were created for Instagram and LinkedIn that were visually attractive and written in an accessible language. Among the 18 publications, 11 focused on exploring and deepening the topic of XP and synthetic biology (SynBio UFG, 2024), thereby corroborating the scientific dissemination of the extension project. The importance of social networks in disseminating scientific information to diverse audiences has already been described in the literature (Navas et al., 2020), a fact that facilitates the expansion of dialogue on various topics with different audiences. The generation of a scientific poster was also one of the project's outcomes, contributing to both internal and external understanding of AraraSun (Supplementary Material 4).

Contact with the academic community was also established through lectures, such as the biotechnology freshmen lecture at the UFG Institute of Physics (Leno, 2024), as well as various reports, including ADUFG (Union of Teachers of Federal Universities of Goiás [ADUFG], 2024), IPTSP (Sousa, 2023), and the daily Jornal O Popular (Tomazini, 2023). Such strategies enabled us to recruit more students for the extension project, democratize

knowledge about synthetic biology and the iDL competition both within and outside UFG, and, most importantly, contribute to increasing visibility of XP.

The meetings with the Brazilian team UTPrimers allowed us to share technical knowledge and experience with other students. The team's participation in connection sessions at the iDL also allowed us to create connections with students from other countries and learn about the different themes covered and their respective solutions. These activities align with what is expected from extension projects, as they should serve as catalysts for connections that facilitate societal changes through the development of academic knowledge (De Almeida Matos et al., 2022).

Entrepreneurship and UN Sustainable Development Goals (SDG)

The AraraSun therapeutic cream was essentially linked to an entrepreneurial approach, considering the importance of its economic viability for the real benefit of the community of patients with XP. This is because, historically, there has been less funding and public-private interest in the development of new therapies and medicines for rare diseases (Beacon for Rare Diseases, 2024).

This approach resulted in a business model creation (Figure 4), from which the inclusion of other groups of patients susceptible to the development of melanomas as potential customers allowed the projection of a sustainable financial model for the production of the cream.

The Business Model Canvas development was a facilitating activity that visualized the different areas and discussed the strategies involved in creating the business model, such as key partnerships, value proposition, and sales channels (Murray & Scuotto, 2015). It also contributes to expanding the entrepreneurial vision of the project's members, which is valuable and fostered by scientific competitions, such as iGEM (Tay, 2022).

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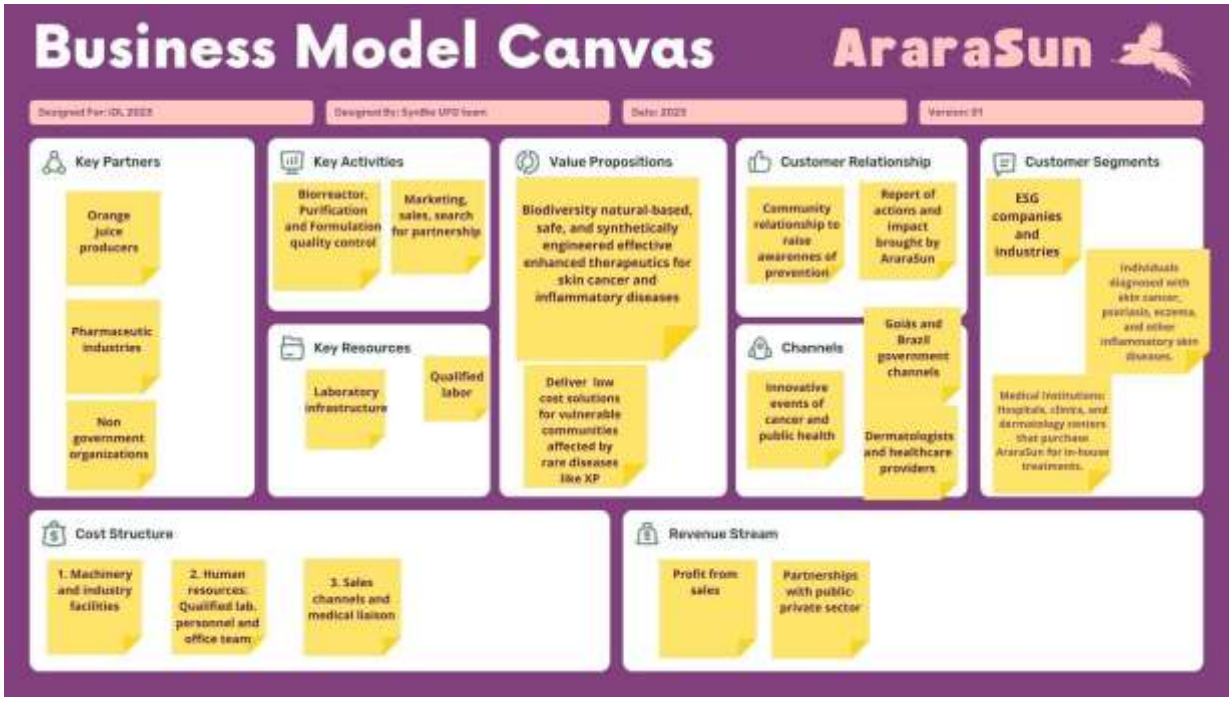

Figure 4. Ararasun Business Model Canvas. This business model outlined the intended socio-environmental impact, financial structure, key activities, and resources required for its development, as well as other relevant aspects. The development of Canvas allowed the team to envision a commercial application for AraraSun.

The SynBio UFG team explored the UN SDGs through an entrepreneurial lens, with the extension project's goals and indicators being fundamentally grounded in these objectives. The main SDG explored was number three, "Human Health and Well-being". Other SDGs achieved were number 10 - "Reduced Inequality" - and 12 - "Ensure sustainable consumption and production patterns". More details about the Business Model Canvas and the target SDGs can be accessed in Supplementary Material 3.

Awards and media coverage

The SynBio UFG team received 2nd place overall in the competition and was named the best project in the Human Health and Biomedicine track as a result of the iDL 2023 competition. Furthermore, among the 15 special awards, 12 nominations were made, resulting in four winners (Supplementary Material 5). Reports from the university media and state newspapers highlighted SynBio's performance in and outside the competition.

Discussion

The SynBio UFG team was the first from the state of Goiás to participate in the iDL competition and the first team from the Central West of Brazil to be on the competition podium (Gomez-Hinostroza et al., 2023). The 2023 edition was the first in which Brazilian teams were awarded first place in the iDL general classification. The iGEM team from the National Center for Research in Energy and Materials (CNPEM) took first place overall in the competition, while SynBio UFG came in second place. In the global iGEM competition, until 2023, no teams from the Central West had participated or won (Gomez-Hinostroza et al., 2023), a fact that highlights the need to encourage participation and increase discussion on synthetic biology in our state and region.

The SynBio UFG team designed a creative proposal to help people with a rare genetic disorder highly prevalent in Araras, Goiás: XP (Lehmann et al., 2011). It contributed scientifically and personally, fostering empathy and addressing the unique needs of those impacted by the disorder. The iGEM club's dedication to community-oriented solutions and synthetic biology applications that address scientific and societal challenges aims to encourage students to think and act innovatively (Jian et al., 2022). Additionally, the project's innovative approach lies in its unique integration of XP, synthetic biology, and biodiversity, a combination not previously observed in iGEM teams before 2023 (Gervásio et al., 2022).

The methodology for our extension project was developed to integrate local community needs with applied innovative scientific knowledge (Stemerding, 2015). Problem and solution themes were chosen using a methodology that combined technical development (Supplementary Materials 1 and 2) with a critical understanding of the ethical and social impacts of biological technologies, meeting community needs, as demonstrated in Figures 1, 2, and 3. This approach encourages innovative solutions and develops scientific and social skills, essential for training responsible microbiology professionals (Kelwick et al., 2015).

SynBio UFG's human practices methodology and results are aligned with iGEM's promotion of collaboration with stakeholders, as well as the development of education and public engagement activities (iGEM, 2021c), as demonstrated in Supplementary Material 3. Similar to our findings, Gill et al. (2022) reported on the BioExperience Research and Entrepreneurship Challenge, drawing inspiration from the iGEM competition. This initiative emphasizes human practices (HP) by engaging students in addressing real-world bioeconomy issues, thereby promoting a more comprehensive understanding of the social, ethical, and environmental implications of their projects. Our work with HP resulted in the Integrated Human Practices and Local Heroes awards.

Competitions can serve as a valuable tool for developing entrepreneurship skills in students, addressing the increasing need for innovation and entrepreneurial training (Scheepers et al., 2018). Our sustainable business model project (Figure 4 and Supplementary Material 4), which also promotes synthetic biology and its

sustainable solutions, was developed at iGEM and nominated for the Best Entrepreneurial Approach and SDG Impact awards.

According to Singh and Aggarwal (2021), innovation can be considered as "the operationalization of creative potential with a commercial and/or social motive by implementing new adaptive solutions that create value, harness new technology or invention, contribute to competitive advantage and economic growth.". Therefore, by creating a novel synthetic biology compound that could become an important treatment alternative and is feasible to produce, the SynBio UFG team contributed directly to the innovation process in the field of biological therapeutics.

The SynBio UFG team just did not have nominations in the special categories related to biosafety - "Best Biosafety and Biosecurity Approach" and "Best Policy and Regulation Approach" - and in the "Best Arts Project" categories (Supplementary Material 5). We believe this may have been influenced by the absence of students from other undergraduate courses and professionals with different expertise, which should also be encouraged in the next years of the extension project and iGEM competition. Complementary teams are desired for iGEM, as the competition requires multidisciplinary skills across various areas of knowledge and provides scientific, communicational, and social support, thereby increasing the chances of success in the competition (Morales et al., 2022).

Another significant learning experience for the project was the feedback provided by the AbraXP manager, who emphasized the importance of aligning research and extension projects to increase the visibility of XP-holders. This feedback corroborates the awards linked to the Human Practices aspect that we received, specifically the "Local Heroes" and "Integrated Human Practices" awards, and aligns with Tay's (2022) argument that scientific competitions, such as iGEM, contribute to increasing the impact of science on society.

Linking the competition to the extension project "Synthetic Biology Club at UFG, an activity of human connection and innovation" was essential for us to obtain such results, as it allowed several achievements, including (1) financial support from FUNAPE (Research Support Foundation) through PROEC (Dean Department of Culture and Outreach) of UFG, which enabled our participation in the competition; (2) encouraging future actions with the Faina community and scientific dissemination; (3) greater reliability from the external community regarding what was generated and published by the team; (4) encouraging the generation of scientific publications. The institutional support of UFG and the results generated from it corroborate the findings of Mahmood et al. (2014), which suggest that the success of a research project often depends on having present and encouraging administrative support.

Thus, the team's history in 2023 and the results obtained by the SynBio team are directly related to the establishment of the extension project. In the next editions of the competition, the extension project should be further developed at UFG. Furthermore, the present study represents another pioneering strategy to amplify the authors' experience and encourage other students to participate in projects like this.

Conclusion

The Synthetic Biology Club at UFG developed a multidisciplinary project through the AraraSun. Our pioneering participation in the iDL 2023 marked a milestone as the first team from Goiás, Brazil, to compete and the first team from the Brazilian Center-West region to be victorious in the iDL. Through our extension project focused on XP, we demonstrated the potential of addressing local challenges using synthetic biology solutions and the importance of scientific innovation coupled with extensionist actions. Moreover, the AraraSun development enhanced the students' skills in multidisciplinary areas, including biotechnology, bioinformatics, scientific communication, entrepreneurship, community outreach, and others. This demonstrates that the article's

primary objective was met. We successfully detailed the club's creation and development methodology, along with its subsequent effects on both society and participating students.

The project's future perspectives include establishing direct contact with the Araras community and XP holders to increase the community's visibility and awareness of their problems, and to explore financial and intellectual resources and opportunities for developing the therapeutic cream. Additionally, we hope to develop volunteer activities directly with the Araras community. The AraraSun project contributed to the advancement of synthetic biology in Goiás and the UFG extension initiatives, serving as an example for future extension projects in the biological sciences area.

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Contribution of each author

The authors A.A.C., A.S., B.C., E.P.S.D., J.E.B., J.C.J., and A.K. designed the study and wrote the final draft of the manuscript; A.A.C., E.P.S.D., J.C.J., and A.K. established the article's methodology; A.A.C., A.S., B.C., E.P.S.D., J.E.B., J.C.J., and A.K. contributed to the literature review; A.A.C., E.P.S.D., and A.K. analyzed the data, and A.K. served as the project coordinator and manuscript reviewer. All authors have read and agreed to the published version of the manuscript.

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