

# Biodesign Challenge

## Biodesign Challenge After-School Case Study

PRESENTED BY

### Siegel Family Endowment

We are a foundation focused on understanding and shaping the impact of technology on society.

#### About Siegel

Siegel Family Endowment employs an inquiry-driven approach to grant making that is informed by the scientific method and predicated on the belief that philanthropy is uniquely positioned to address some of the most pressing and complex issues facing society today. Our grant making strategy positions us to be society's risk capital. We support high quality work that will help us derive insights to timely questions and has high potential for future scale. Our focus is on organizations doing work at the intersection of learning, workforce, and infrastructure. We aim to help build a world in which all people have the tools, skills, and context necessary to engage meaningfully in a rapidly changing society. Siegel Family Endowment was founded in 2011 by David M. Siegel, co-founder and co-chairman of financial sciences company Two Sigma.

#### Our Focus on Learning

We strive to understand how we can better equip individuals with the knowledge they need to contribute to and engage with a rapidly changing society. Yet, we also recognize that every factor in a learner's education – from broadband access to safe and affordable housing to the development of social-emotional skills – can widen inequality and impact success. Our work supports and shapes programs and solutions that build lifelong learning opportunities and envision an education system that works for everyone, by addressing long standing social and economic inequities.

#### Enduring and Frontier Skills

Siegel Family Endowment is committed to supporting organizations that are on the frontlines of building an equitable future by helping to nurture **enduring skills** and **frontier skills**. We seek to foster “**enduring skills**,” or the competencies and mindsets needed to thrive both in the present and in a changing world. These include both technical capabilities, as well as a variety of attitudes and mindsets. Examples of enduring skills include computational thinking, problem solving, collaboration, creativity, resilience, and the ability to learn, to name a few. At the same time, we want to ensure that emergent fields, such as biotechnology and generative AI, are equitable for all. Thus, we also support the development of “**frontier skills**,” that is the abilities, literacies, and pathways necessary to participate in and drive emergent industries - acknowledging that these skills also apply across many areas of life today.





## About Grantee

Biodesign Challenge is an international education program and competition that partners high school and college students with scientists, artists, and designers to create projects that envision, create, and/or critique transformational applications in biotechnology. Biodesign Challenge's After-School (BDC After-School) initiative works with high school instructors from underserved communities to prepare students to compete in the Biodesign Challenge. Through these activities, Biodesign Challenge encourages students to explore ways that biotechnology and biodesign principles and processes can be leveraged to address some of the world's most pressing problems. In doing so, Biodesign Challenge is equipping a new generation of leaders with enduring and frontier skills and mindsets that they will need in order to contribute substantially to emerging industries.

### KEY TAKEAWAYS

- **Interdisciplinary, real-world, project-based educational programs for university students can be successfully deployed to high school students.** Reaching students earlier in their educational trajectories allows supplementary programs a chance to engage more diverse students, and an opportunity to reach students before they have settled on a path of study or career.
- **There are few spaces within traditional school classrooms and curricula to develop these skills.** High school students don't generally have the opportunity to imagine and create new applications for the latest advances in biotechnology as part of their standard coursework. Afterschool programs and other informal learning spaces that leverage existing K-12 school communities, personnel, and expertise offer an opportunity.
- **Offering fluency in biotech to more diverse students unlocks a greater range of problems that can be identified, questions that can be asked, and solutions that can be developed.** Students from historically excluded and/or non-majority experiences fold in different perspectives, concerns, and innovations.
- **Participants in education programs may have different - and surprising - goals from program organizers.** Organizers should seek to understand those goals and when possible, adjust designs and strategies in order to realize them. Doing so may offer new areas of impact and greater trust and sense of belonging among and between participants.

## Executive Summary

**M**any of us imagine biodesign and biotechnology as realms of the future: experiments run in labs portrayed in sci-fi films or projects that inform Nobel Prize-winning discoveries. But Biodesign Challenge's After-School (BDC After-School) program reveals that opportunities to interact with biodesign - the practices through which biotechnology is developed and critiqued in service of society - are all around us. Indeed, the questions that we ask, the ways that we apply strategies and guardrails, and the solutions that we develop are all immeasurably enriched when we begin to think about biotech as a realm that is accessible to all people, not just to sci-fi or lab scientists.

BDC After-School brings BDC's signature program for university students and instructors to a high school audience, with a special focus on historically excluded communities. BDC After-School trains, funds, and supports Champion Instructors from high schools across the country as they help prepare students to compete in the annual Biodesign Challenge to develop and present biotechnology projects in response to real-world challenges. These projects

range from biomaterials-based personal protective equipment for agricultural workers, to biodegradable fashionwear, to new models for reproductive health.

BDC After-School aims to create value for all stakeholders - high school student participants, Champion Instructors, the larger school communities from which participants hail, and the BDC program and network as a whole. In the process of creating their projects, students practice enduring skills such as user-focused design, problem solving, and presenting, as well as develop the skills and content knowledge necessary to succeed in the emerging industries of biotech and design. Over the long-term, organizers hope that BDC After-School will be a vehicle for hastening the inclusion of biodesign pedagogical approaches and concepts in the general high school curriculum, enriching science, art, and a myriad of other disciplines. At the same time, Biodesign Challenge has allowed itself to be enriched by its high school participants, altering its university program to expose participants to a more expansive set of questions due to issues raised among the after school students. ■

## Program

High school students don't generally have the opportunity to imagine and create new applications for the latest advances in biotechnology as part of their standard coursework. Even access to standard lab sciences is [limited](#), especially in schools serving high proportions of students of color. At the same time, learning biodesign principles and participating in project-based learning around biodesign can be enormously beneficial for high school students - and for their communities. It not only develops subject matter expertise, but also helps students develop the collaboration and project management skills necessary to succeed in higher education, careers, and as community members. It helps teachers to bring new, interdisciplinary, and real-world pedagogical approaches to instruction and engagement. And it inspires new questions, new approaches, and new solutions to community challenges.

BDC After-School provides a platform for high school teams to realize these values. The high school teams undertake a semester-long exploration that culminates in Biodesign Challenge's annual competition featuring both high school and university teams. As an afterschool program, the program sits at the intersection of formal and informal education. It leverages the social and physical infrastructure of schools in the form of meeting space, Champion Instructors, and students. At the same time, BDC After-School has the flexibility to be directly responsive to community needs and can seize opportunities to leverage community resources.

Early evidence suggests that the approach is working. "Without the biodesign project, I probably wouldn't have been as sure as I am about [pursuing] agriculture and sustainability as I am now," said one BDC After-School student. "That feedback is really encouraging to us," said Daniel Grushkin, BDC Executive Director.

## Core Elements: What Makes the Program Work?

1

### Removing Learning from Disciplinary Silos

Biodesign integrates approaches from biology, design, art, and a host of other disciplines. Yet these disciplines are typically siloed at the high school level, if they are taught at all. High school coursework also presents few opportunities for students to apply biology knowledge to develop solutions to community challenges. This may be one factor contributing to why students fail to see biotech as relevant to their career paths.

"Biodesign needs to be taught within a social context. It requires practitioners to consider the social, environmental and ethical aspects of the technologies they use," says Program Director Veena Vijayakumar. By teaching across disciplines,

BDC After-School Champion Instructors model how real-world problem solving takes place. For example, one team prototyped floating community garden pods in waterways to both cleanse local rivers and provide fresh produce in urban food deserts.

At the same time, Champion Instructors learn interdisciplinary approaches such as project-based learning and design thinking, and biotechnology lessons that can be applied in their own discipline-specific classrooms. Teachers can adapt these lessons to the academic standards and disciplinary constraints within their schools.

2

### Blending Community and School Through Real-World Learning

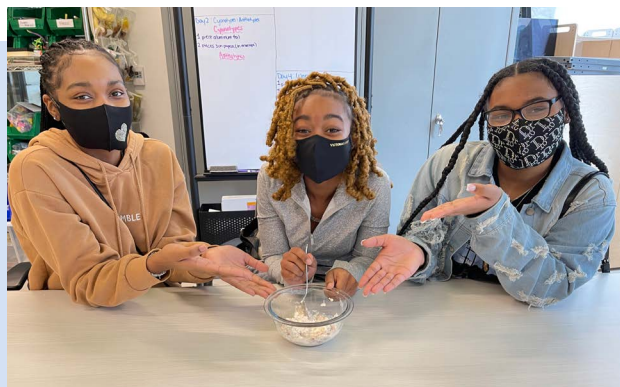
BDC After-School challenges teams to respond to real-world problems through the lens of biodesign. In considering what problems are worthy of being addressed, students seek solutions for their own community's needs - needs that might go unnoticed by the biotech community. They also have an opportunity to build community with each other, with other teams and Champion Instructors, with experts in the field, and with members of the wider society of which they are a part.

For example, the Alisal High School team from Salinas, California, considered the experience of their own family

members who worked as fruit pickers and typically had few educational opportunities. In developing a learning opportunity for the community, the Alisal High School team wanted to honor their own Latin American heritage and the sacrifices that their families had made for them. This led the group to construct a paletero cart based on the iced desserts carts common in Spanish-speaking areas. Instead of summer treats, the [Biotech Paletero Cart](#) contained hands-on biotech learning materials and experiments, such as DNA extraction experiments using strawberries, dish soap, and rubbing alcohol.



Students from Alisal High School spray-paint their biotech paletero cart before bringing it to a community picnic at their local park. This team won the 2021 Science Sandbox Prize for Public Engagement for developing a science engagement platform that creatively used a cultural hallmark in a new way.



Students from Robeson High School present their homemade yogurt in the lab as part of a learning module about the gut microbiome.

## 3

## Broadening Impact Through Diversity

BDC After-School builds on BDC's original offering for university students and high school students participate in the Biodesign Challenge alongside university teams. The process for participation and the role of Champion Instructors is similar for high school and university teams. But BDC leaders have found that high school students - especially those from historically excluded communities - offer a unique perspective that enriches the experience and potential for proposed solutions for all participants.

Because high school students are at an earlier point in their own career exploration they are often more comfortable incorporating multiple disciplines into their work. Grushkin cites this "longer runway for career training" as an opportunity for BDC After-School to expose more students to biodesign earlier. This, in turn, allows students to more effectively construct careers that draw on biodesign, and to become comfortable with the cross-functional relationships that are important for workplace success.

There are also real benefits to the larger community including high school students. Veena Vijayakumar, Program Director at Biodesign Challenge explains that not all high school students in the program are college-bound and reflect the socioeconomic, racial, and cultural diversity of their communities. As such, they often ask different questions than university students. Vijayakumar says, "The ideas that come from our high schoolers, who are generally in Title I schools and generally in underserved neighborhoods, are very different from what we see in more exclusive higher ed institutions. These students are bringing new ideas to the field." As an example, Vijayakumar points to [Sista-Sis Biodoula Services](#), a doula service that includes mRNA therapies. The service is designed to respond to the crisis of maternal mortality among pregnant Black women - a challenge that leaders of the Sista-Sis project observed in their own community. By championing diversity, BDC After-School is enriching the biodesign field as a whole.

## 4

## Adapting to the Needs and Goals of Stakeholders

BDC After-School leaders asked Champion Instructors what goals they had for the program. The responses were surprising. The BDC team expected teachers to name the importance of students attaining a certain level of technical mastery—being able to use the equipment in a biology lab or developing public speaking skills, for example. Instead, Champion Instructors told BDC After-School staff that they were most interested in students developing enduring skills and mindsets such as confidence, ownership over their own learning, and a sense of belonging.

Knowing the goals of key stakeholders led BDC After-School leaders to "pivot" to discussing a different set of questions than they typically do during professional development programs. And it also caused the BDC team to rethink their teacher training. They now focus on belonging goals such as developing comfort engaging with experts in the field who serve as mentors and resources for students, rather than solely on particular pieces of technical knowledge, such as learning about DNA and amino acids, for example. That responsiveness to the needs of stakeholders creates the conditions for positive impact.

# Impact and Next Steps

## Impact

Biodesign Challenge tracks the usual metrics related to educational programming: number of students served, number of teachers involved, percentage of schools from underserved communities, number of program hours completed, percentage of participants satisfied with the experience, and a host of other stats. At the same time, Biodesign Challenge also seeks to understand precisely how BDC After-School affects the mindsets and trajectories of students, Champion Instructors, school communities, and society as a whole.

This more holistic view of impact requires alternate questions and measurements, and BDC has only begun to scratch the surface in its capture of those outcomes. BDC After-School is still a new program and results may not be known for some time, particularly when it comes to long term impact. But some of BDC After-School's measures of impact suggest a new, more equitable, responsive, and meaningful approach:

- 1 **Transferability of skills.** Early anecdotal evidence suggests that students are developing transferable skills that are useful in further education and in the workforce. Many teachers and students see their futures reshaped by what they learn in BDC After-School. For example, one Champion Instructor explained, “This project gave the students an opportunity to explore what they wanted to do professionally and speak to experts in the field.”
- 2 **Shift in high school curricula.** Some high school curricula are shifting to reflect a more holistic, interdisciplinary, and real-world approach to science education as a result of their participation in BDC After-School. For example, one of BDC After-School's public high school partners in New York City recently built a biodesign-focused maker lab at their school.
- 3 **Community-responsive problem solving.** Early signs indicate that students are surfacing and developing meaningful responses to challenges in their community. For example, [one student participant](#) explained that he was taking what he learned in BDC After-School to find new ways to support his mother's sustainable agriculture business in Mexico.



## Next Steps

BDC Afterschool is seeking to expand its reach, particularly in underserved and historically excluded communities.

- Interested high school teachers and staff can serve as Champion Instructors in their school communities, benefitting from professional development, funding, and networking opportunities.
- BDC After-School welcomes queries from high school administrators, enrichment program coordinators, and community activists about bringing BDC After-School programming to their communities.
- Attend the BDC summit live in NYC or online. [Information from the most recent Summit](#), as well as an [archive of past summits](#), are available online.
- Buy the [Grow the Future](#) book, a compilation of projects and ideas that are influencing the emerging field of biodesign.
- Check out their online magazine at [Biodesigned.org](#).
- Subscribe to their newsletter and follow them on Instagram, LinkedIn, and TikTok (@biodesigned).
- Reach out to [Biodesign Challenge](#) at [info@biodesignchallenge.org](mailto:info@biodesignchallenge.org) to learn more about BDC After-School or any of their other projects.

To learn more and contact Siegel Family Endowment, visit [www.siegelendowment.org](http://www.siegelendowment.org)