

EBRC Response to a National Science Foundation Request for Information

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Dear Colleague Letter: Request for Information on Future Topics for Workforce Development in Emerging Technology Career Pathways

NSF is seeking novel approaches that lead to the recruitment of diverse and creative individuals into emerging technologies. The objective is to develop new funding opportunities that will accelerate efforts to increase both the rate and overall composition of domestic students enrolled in traditional academic pathways into STEM disciplines that will lead to emerging technology careers. Of equal priority is the interest in developing new funding opportunities that focus on flexible, non-traditional pathways into emerging technology careers, through support of continuous lifelong learning as a critical strategy to access high-paying jobs in these areas.

Question 1: Describe the greatest opportunities and/or challenges to creating flexible and affordable training programs (for technicians, practitioners, researchers, students, etc.) needed to build an inclusive, well-paid, domestic workforce in emerging technology careers.

The U.S. Bioeconomy is poised for tremendous growth over the next 10-20 years, with many opportunities to support a robust domestic workforce at all entrance levels and in communities where industry may currently be stagnant or declining. Biotechnology-related education and training can be extremely diverse in scope, content, and delivery method. While more programs are needed to support the potential of the bioeconomy workforce, there are also many creative biotechnology training programs that already exist through community colleges that have partnered with local industry, NSF-funded programs such as InnovATEBIO, non-profit community programs like BioBuilder, and the growing number of 4-year and graduate-instruction institutions that offer biotechnology-related education and training. There are also a number of challenges existing and yet-to-be-created programs face to expand, scale, and to be sustainable:

- Awareness of biotechnology careers and educational pathways is a major challenge for existing training programs and also for workforce development more broadly. Investments need to be made into training program infrastructure and administration to be able to share about career opportunities and entry-points to education and industry.
- Training programs need support to partner with industry (locally and nationally) to learn about and coordinate on the skills and knowledge necessary for biotechnology workers to be successful. Likewise, industry needs to be incentivized to dedicate time and resources to these partnerships and engagement with educators and instructors.

Question 2: What have been some of the most effective strategies to removing barriers and providing support for a diverse, inclusive STEM student population and STEM workforce in emerging technology fields?

Effective strategies consider local and regional opportunities and teach to the required skills for those jobs. Supporting diversity and inclusivity requires activities and programs that are accessible to all, meaning that they must be low-cost, information about them must be widely-distributed, and they must be available geographically where the workforce can be developed (and hopefully, employed). High schools and community colleges can offer training and education opportunities that reach wider audiences than the 4-year higher education institutions that have traditionally provided most biotechnology education. Models for such programs include the [Biomanufacturing Training Program for High School Students at Shoreline Community College](https://www.shoreline.edu/biology-dept/high-school-biomanufacturing-training-program.aspx) (Shoreline, WA; <https://www.shoreline.edu/biology-dept/high-school-biomanufacturing-training-program.aspx>), the resources provided by the [North Carolina Community Colleges' BioNetwork](https://www.shoreline.edu/biology-dept/high-school-biomanufacturing-training-program.aspx) (<https://www.shoreline.edu/biology-dept/high-school-biomanufacturing-training-program.aspx>), and the biotechnology certificate, diploma, and Associate's degree available through [Southeast Community College](https://www.southeast.edu/biotechnology/) (Lincoln, NE region; <https://www.southeast.edu/biotechnology/>).

Mentorship, particularly mentors that represent diverse demographics, backgrounds, and experiences, is a major component and contributor to diverse and inclusive STEM education and workforce. Traditionally, the lack of diversity in the advanced STEM workforce, including biotechnology, means that these mentors are rare, and those that do exist are often overburdened with the responsibility of representation. Resources and investment is needed to support these individuals, community groups, and organizations; organizations and platforms like [LabCentral Ignite](#) can provide examples of programs to support diversity and inclusion through mentorship, capacity building, and career development.

Question 3: Describe the opportunities and challenges to facilitating a learner's ability to transition from one educational pathway to another (e.g., from a technical training program to an undergraduate program) to support lifelong continuous learning.

One of the barriers to entry into the biotechnology workforce is career awareness. The advanced bioeconomy is still emerging and employs technologies and infrastructure that is relatively new and intersectional. Investment is needed in organizations, programs, and partnerships that aim to improve awareness of biotechnology-related careers and the educational pathways to develop the necessary skills and knowledge to enter the workforce across all stages. The bioeconomy needs workers at entry level, skilled technicians across many different platforms and industries, and those in leadership positions with advanced degrees. This means there are many different entry- and exit-points for learning and training in biotechnology.

Biotechnology education and jobs are interdisciplinary and many formal training programs for these careers do not yet exist sufficiently to support the market. Because biotechnology melds many different fields (engineering, chemistry, data science, and biology, among others), educational

pathways must be diverse and oriented around applied skills and critical thinking. NSF can support institutions (including community colleges, four-year colleges and universities, educational and training nonprofits, and community organizations) to develop interdisciplinary, skills-based programs designed around workforce needs. Progressive skills-based learning can enable a learner to continue or return to the educational pipeline at any time that they want to build onto their abilities. This also requires incentives and investment for strong academic-industry partnerships to ensure that the skills are applicable across the biotechnology landscape. Further, these skills and educational attainment need to be transferable across institutions. NSF can support institutional collaborations that ensure that credits and credentials transfer between institutions.

Mobility within the educational pipeline also requires sufficient support for the learners. Financial realities often result in premature exits from educational pipelines. For example, a learner with a family to support may take and remain in an entry-level position, rather than pursuing further (expensive) advanced education, even if that education would ultimately lead to higher-paying opportunities. Support for students and trainees must take into account financial responsibilities beyond the individual, particularly if the goal is to produce a diverse and inclusive workforce.

Question 4: Describe current gaps or new opportunities to attract more domestic students at the undergraduate level (associate and bachelor's) and at the graduate level (master's and doctoral) into specific STEM majors that lead to emerging technology career pathways.

As noted, the U.S. bioeconomy is poised for tremendous growth. Now is the time to be promoting and supporting educational opportunities in biotechnology and connecting students to the careers that matter to them. The bioeconomy can offer the current and future generation of learners jobs that directly impact areas that concern them, such as climate change, human health and wellness, and the interface of humanity and technology. Likewise many STEM majors and educational pathways can contribute to careers in biotechnology, including degrees in chemical engineering, computer science, botany, or biomedical engineering. Key to this is awareness: educational programs, both formal and informal, that increase engagement in future industry and better prepare students to take advantage of emerging opportunities.

In order to realize this potential domestically, U.S. students need to have more opportunities for experiential learning, including on-the-job training, laboratory classes, research theses, and internships. Students with undergraduate and graduate degrees will be expected to join a workforce that is rapidly expanding and will need transdisciplinary education that will train them not just in STEM knowledge, but also prepare them with business skills and strengthen their capacity to engage with the social sciences. They need to be supported to launch startups, with more training in translational research and application, with NSF I-Corps (and I-Corps-like) programs more broadly available and integrated into the traditional educational pipeline. Education and training programs need to be built around not just imparting knowledge, but preparing students for future careers.

Question 5: Describe strategies to leverage cross-sector resources, including those of industry, academia, government, philanthropy, non-profits, and any other sectors interested in the future

emerging technology workforce. Name key partners with whom NSF could work in this endeavor and provide their expertise and contact information.

Leveraging cross-sector resources requires investment and incentives for partnerships and *engaged* collaborations. Further, NSF must know that this capacity requires financial support for administration and human resources, not just equipment and infrastructure. For the emerging biotechnology workforce, these potential partners include nonprofit community organizations like EBRC and BioMADE, educational and workforce development organizations like BioBuilder and LabCentral Ignite, NSF-funded programs like InnovATEBIO, and philanthropy like the Schmidt Futures Foundation (details and contact information below). Engaging these organizations to coordinate between traditional academic institutions and industry enables them to bring together the important players for focused actions on relevant challenges/needs and opportunities. NSF can support these partners to conduct workshops and community building activities and to develop resources and tools to aid in biotechnology workforce development alongside NSF. The potential partners listed above are highly experienced in education and workforce development in biotechnology and have significant experience in helping NSF to set agendas and create programs in support of the advancement of emerging biotechnologies.

Potential partners:

- [EBRC](https://ebrc.org) (https://ebrc.org) – The Engineering Biology Research Consortium is a non-profit, public-private partnership organization dedicated to bringing together an inclusive community committed to advancing engineering biology to address national and global needs. Focus areas include Education, Technical Research Roadmapping, Security, and Policy & International Engagement. Contact: Emily Aurand, Director of Roadmapping and Education; eaurand@ebrc.org
- [BioMADE](https://biomade.org) (https://biomade.org) – BioMADE is securing America’s future through bioindustrial manufacturing innovation, education, and collaboration. BioMADE is building the biomanufacturing workforce of the future by pairing industry-driven competencies with program development through K-12 schools, community colleges, universities, and professional development organizations. Contact: Tom Tubon, Chief Workforce Development Officer; tctubon@biomade.org
- [BioBuilder](https://biobuilder.org/) (https://biobuilder.org/) – BioBuilder is a nonprofit committed to access and equity. BioBuilder takes a comprehensive approach to the emerging field of synthetic biology, providing exceptional programming available for students and educators alike. Contact: Natalie Kuldell, Founder and CEO; natalie@biobuilder.org
- [LabCentral Ignite](https://labcentralignite.org/) (https://labcentralignite.org/) – LabCentral Ignite offers a range of equity-driven programs and a powerful member network of industry partners, startups, higher education, and nonprofits, Ignite connects underrepresented students and innovators to academic, technical skills-building, mentoring, job placement, and board and leadership preparation opportunities that fuel biotech diversity and transform careers. Contact: Gretchen Cook-Anderson; ignite@labcentral.org
- [InnovATEBIO](https://innovatebio.org/) (https://innovatebio.org/) – The InnovATEBIO National Biotechnology Education Center is working to advance the education of highly skilled technicians for the nation's biotechnology workforce. Toward this goal, InnovATEBIO is providing leadership in biotechnology technician education, including support for development and sharing of best

practices and emerging technologies in biotechnology workforce development. Contact: Linnea Fletcher, Principal Investigator; linneaf@austincc.edu

- [Schmidt Futures, BioFutures](https://www.schmidtfutures.com/our-work/biofutures/) (https://www.schmidtfutures.com/our-work/biofutures/) – The BioFutures Program aims to accelerate the translation of bioeconomy research into public and economic benefits by focusing on repurposing sustainable waste biomass, overcoming engineering constraints, and mobilizing talent for bioeconomy-related federal agencies. Contact: Mary Maxon, Executive Director of BioFutures; mmaxon@schmidtfutures.com

Question 6: Other considerations. Share other relevant aspects or considerations to facilitate STEM pathways into emerging technology fields.

Biotechnology is recognized by NSF, the U.S. federal government, and countries worldwide as an increasingly important and necessary emerging technology. The future bioeconomy also requires the involvement and expertise of other key emerging technologies, including artificial intelligence, microelectronics, and advanced manufacturing, among others. The bioeconomy is poised for major growth over the next 10-20 years and will require a robust and diverse domestic workforce to meet expectations. NSF investment and facilitation of engineering biology and biotechnology education and workforce development is crucial. Key challenges (and opportunities) that NSF must address for building pathways into the biotechnology workforce and bioeconomy include:

- Multidisciplinary education, that focuses on skills-based experience and critical, comprehensive, application-oriented thinking;
- Translation of foundational research knowledge and expertise into viable technologies and applications;
- Support for STEM-trained individuals to launch companies and careers in industry.