EBRC Engineering Biology Research Consortium

Educating the Next-Generation Bioeconomy Workforce

A Policy Paper by the Engineering Biology Research Consortium

Compiled and edited by Emily R. Aurand, EBRC Director of Roadmapping and Education

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The US is poised to be a global leader in the bioeconomy in the coming age of biotechnology based on its intellectual and human resources. Since a robust and distributed bioeconomy is still emerging, forging and maintaining leadership requires a skilled, diverse workforce to (1) create new technologies and materials that spawn new companies and entire industries, and (2) execute the manufacturing and development tasks created by those companies and industries. These two components of the workforce comprise cohorts with different education levels that are each critical to US bioeconomy excellence, and across the cohorts there is serious need of programmatic and financial support to enable their training and expansion. The innovation workforce (the former above) for creating new technologies is predominantly scientists and engineers with doctoral and other advanced degrees to push the boundaries of technology and to advance the frontiers of scientific knowledge to enable new technical innovations. The execution workforce (the latter above) comprises workers with a variety of educational and professional experiences, ranging from apprenticeships to training certificates to associates and bachelors degrees, who all have unique and valuable roles within the bioeconomy. The following opportunities and recommendations focus primarily on education and training in engineering biology at educational levels where EBRC is best-positioned to provide remarks; we point to publications and commentary from other organizations (including BioMADE and BioBuilder) for further guidance and recommendations.

High School level:

There is currently no coordinated federal strategy to help secondary school students understand the way engineered biology can meet society's needs, or a roadmap that shows students how they can pursue successful careers in the field. Indeed, despite decades of calls from biotechnology practitioners to modernize the way life science is taught in our public high schools, biology is not a graduation requirement in all states and fewer than 30% of public school biology classes incorporate molecular biology-related activities, foundational to most current biotechnology innovations.

It is imperative that **federal agencies advance strategic and coordinated educational initiatives** that integrate biotechnology and engineering biology education and opportunities into public education for high school students. Foremost, the federal government must articulate national and state-level goals that require the adoption of effective biotechnology curricula, spotlighting its importance for sustainability, a robust economy, and national security. The Departments of Education, Labor, and Commerce can support teacher training and umbrella organizations that advance industry-relevant pedagogy and incentivize commercial and industrial partners to work directly with schools to establish and hire candidates who can secure a meaningful profession in the bioeconomy without post-secondary schooling. The federal government can also invest in regional infrastructure and opportunities such that access to high quality learning laboratories exists in all zip codes and students are exposed to biotechnology and bioeconomy careers through creative experiences including internships, innovation competitions, and out-of-school programs.

Undergraduate level:

At the undergraduate level, the Federal agencies can support the future bioeconomy workforce by **facilitating interdisciplinary programs and curriculum** at more US colleges and universities. Large US colleges and universities often already integrate programs that can be leveraged to make strong interdisciplinary education programs; we need to make these programs more widely available and accessible. Interdisciplinary education enables the cross-training of concepts and teaches students how to apply engineering tools to biology and to incorporate social, economic, and other concepts to their understanding of science.

The US Government can expand **direct funding and access to undergraduate research opportunities**. This can include support for formal institutional programs, student and institution participation in iGEM and similar experiences, and for internships and other experiential learning opportunities. For example, agencies including NSF, NIH, DOE, and DoD can offer federal support for innovation competitions, such as iGEM, to develop the next generation of bioeconomy workers; these competitions develop skills in creativity, entrepreneurship, and communication, with occasional tangible benefits of new IP, scientific advances, and startups. The Federal government, through the Department of Education and Department of Labor, can support and offer programs for undergraduate student internships and experiential learning within industry and other sectors connected to the growing bioeconomy. Additionally, enabling more institutions, particularly those without existing or sizable research capacity, access to tools and technologies associated with engineering biology will increase equity and participation in the future bioeconomy workforce.

In addition to undergraduate education and research opportunities, post-baccalaureate programs provide a bridge to success in graduate school for students who are underprepared due to lack of research opportunities during their undergraduate education. Post-baccalaureate participants contribute to the research enterprise while gaining experience and professional development skills that improve outcomes when they enter graduate school. A new program through NSF provides supplemental funding for career investigators to support post-baccalaureate student research and may serve as a reference point for the creation of additional opportunities.

Masters level:

There is an opportunity to **expand funding for and access to professional masters degrees, particularly those that emphasize project-based learning and training**. The Federal government can provide incentives for institutions to create masters degrees that enable undergraduate students to develop skills in another discipline after their undergraduate degree (e.g., an undergraduate physics major followed by a 1-year masters degree in bioengineering with a hands-on emphasis). The US government can support schools and students by providing fellowships for professional masters degrees in engineering biology and related disciplines. One avenue for this might be to match funding provided by companies and corporations to send their current and future employees to full- or part-time programs (which would also give colleges an incentive to expand into part-time programs).

Doctorate and Postdoctoral level:

Stipends for graduate students and salaries for postdoctoral fellows are below a living wage in much of the country. State wage laws are increasingly mismatched with minimums (for example, in the state of Washington, the salary threshold below which workers are overtime eligible is above the salary of many postdocs). At many institutions, the NSF Graduate Research Fellowship (GRFP) stipend and NIH minimum funding level for postdocs (NRSA stipend) is the de facto standard for wages, which can be out of sync with

costs of living. Because of this, there is an important opportunity for the federal government to **set a minimum standard wage for graduate students and postdoctoral fellows** that is pegged to region-specific cost of living (c.f. GSA region-specific per diem rates), independent of these particular funding mechanisms. Notably, research grant award amounts, especially for junior faculty, should increase accordingly to support students and postdoctoral fellows at or above a living wage. Adequately supporting graduate student and postdoctoral researchers ensures that the U.S. academic enterprise can sustain the scientific productivity and innovation that the bioeconomy relies upon.

In addition to increases in (and standards set for) graduate student and postdoctoral fellow stipends and salaries, a **greater number of fellowship opportunities** would supplement grant support for universities and also give individual students and postdocs independent funding that gives them more flexibility and agency. Fellowship allocation allows funding institutions to influence student population composition by incentivizing certain research areas and values like racial and gender equity. However, it is also important that the government advocate (if not require) that students and postdocs have access to the same benefits that an institution's employees have, as fellowship recipients are often not considered employees of their host university and thus are not eligible for basic benefits.