Subcommittee on Research and Technology Hearing - The Future of Biotechnology: Solutions for Energy, Agriculture and Manufacturing

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2318 Rayburn House Office Building

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Testimony

Good morning. Thank you Chairwoman Comstock, Ranking Member Lipinski, and the rest of the Committee for the opportunity to testify on a topic that I have devoted my career to: expanding the impact of advanced biotechnology.

A decade ago I was one of hundreds if not thousands of early-career scientists and engineers who left academia to devote our human capital to extending the reach of biotechnology. Whereas the term 'biotechnology' is synonymous for many people with the field dedicated to medical therapeutics, biotechnology also has the potential to transform other fields including energy, agriculture, and manufacturing. The prospect of vastly expanding the societal and economic impact of our technical expertise attracted me and many other scientists to new endeavors focused on realizing these potential – and far-reaching – applications.

Single-celled organisms—microbes—are the most versatile chemical factories on the planet. When they consume carbon (often some form of sugar), their normal metabolic processes convert that carbon into a wholly different product. Which is to say that if we are able to reliably program these microbes, we can essentially use them as microscopic "biofactories" that churn out valuable raw materials. This is the basis for what's been dubbed the "New Bioeconomy," in which companies increasingly rely on biology to source the materials used in their products.

This bioconversion process is traditionally called fermentation. You know it as the process that gives us beer and wine, but ethanol is just one of many products generated through fermentation. Today, chemicals made via large-scale fermentation are employed in a wide variety of agricultural and industrial applications and, excluding ethanol, comprise over $66B in revenue globally [1], or roughly ten percent as much as petrochemicals [2]. While a relatively small percentage, the rate of growth of chemicals made biologically is greater than ten percent annually [1] whereas the petrochemical market is growing at less than seven percent [2]. The difference in the rates is also growing. In time, chemicals made via fermentation may come to dominate the overall chemicals market.

My company, Zymergen, was founded in 2013 to contribute to this expanding market. Our core business is to use biotechnology to rapidly and reliably engineer microbes used in the manufacture of chemicals for a variety of applications. Zymergen is under contract with Fortune 500 companies to improve the manufacturing economics of chemicals they currently make in large-scale fermentation by engineering the single-celled "biofactories" they already use.

Our ability to realize this incredible potential relies not only on our scientists and engineers, but also on government policy that supports this type of research and innovation. Having interacted with dozens of large domestic producers of goods through fermentation, I should mention that Zymergen fully supports the July 2nd White House Memorandum on Modernizing the Regulatory System for Biotechnology Products, which directs the relevant federal agencies to develop a long-term strategy to ensure that the biotechnology regulatory system is prepared for the rapidly-changing future of our industry [3]. I can confidently say that the current regulatory system is full of inconsistency and scientifically unsound categorizations. The regulatory systems have not kept up with changes in the technology, creating business-sapping confusion, delays, and inefficiencies. It is our hope that the EPA, FDA, and USDA can effectively and rapidly update the Coordinate Framework.

Additionally, I'm pleased to see that Congress is considering the ways the Federal government can proactively support biotech research through H.R. 591, introduced by Congresswoman Johnson and Congressman Sensenbrenner. Bills like H.R. 591, the Engineering Biology Research and Development Act of 2015, help facilitate a comprehensive strategy to ensure the United States remains globally competitive in biotechnology as it shapes nearly every industry of our economy.

Two and a half years ago Zymergen had just three founders. Today we have 93 employees. Growth has not slowed and we are on pace to more than double in staff size in 2016. This rapid growth is not based on speculation. Quite the contrary, our challenge to date has been excessive market demand; we are working day and night to keep up. Our customers are large, established manufacturers of chemicals made through fermentation. As they seek to reduce costs and increase manufacturing productivity, they see Zymergen and our technology as essential to maintaining competitiveness.

Zymergen depends on cross-disciplinary research; our engineers and scientists are trained in fields including microbiology, genetic engineering, robotics, chemical engineering, and machine learning. Our most valuable employees are rare individuals with expertise in multiple relevant domains, able to bridge the gaps between, for example, genome editing and software engineering. Federally supported educational and training programs are critical to providing us with the staff we need to grow and fulfill our potential.

Recent activity in our space, supported through both public and private sector investment, has dramatically altered what is now possible through biotechnology. So while Zymergen has initially devoted our insights to improving the economics of existing products, the approaches developed enable us also to expand the palette of chemicals that can be made through biology. This amounts to a technological revolution likely as important to advancing societal well-being, national security, and economic productivity and competitiveness as the invention of the transistor or the invention of heavier-than-air flight.

In keeping with this promise, we recently contracted with DARPA's new Biological Technologies Office under their "Living Foundries: 1000 Molecules" program. This program is developing new capabilities that will enable the biomanufacturing of known or novel chemicals on demand and at scale. As few as three years ago, entire companies in this arena were founded to develop a single chemical product. With the support of DARPA, we at Zymergen are pushing the technology to develop new biosynthetic pathways for over 300 specific chemicals of interest. We are targeting an overall 20-fold cost reduction in new product development. Further, our team of biologists, engineers, and materials scientists are choosing these chemicals to form the basis for new materials. These materials are expected to have

novel properties in categories as wide ranging as thermostable plastics, underwater adhesives, and antiseptic battlefield dressings.

While the potential application of each new material generates considerable interest, what excites me and my colleagues at Zymergen most is the creation of a cutting-edge technological platform designed to accelerate innovation in new materials development, an area where innovation has slowed and, importantly, an area historically unrelated to biotechnology. This is but an example of the myriad ways biotechnology can impact the US economy and improve society. I'm pleased that this hearing presents an opportunity to engage in dialogue about the ways we can work together to realize the potential of this industry.

Thank you.

References:

[1] Carlson, R. Bioeconomy Capital LLC; Biodesic LLC. Estimating the Contribution of Biotechnology to the Economy of the United States. [DRAFT]. October, 2015.

[2] Transparency Market Research. Petrochemicals Market - Global Industry Analysis, Size, Share, Growth, Trends and Forecast 2014 – 2020. July, 2015.

[3] Executive Office of the President. Office of Science and Technology Policy, Office of Management and Budget, United States Trade Representative, and Council on Environmental Quality. Modernizing the Regulatory System for Biotechnology Products. July 2, 2015. Retrieved December, 6 2015, from https://www.whitehouse.gov/sites/default/files/microsites/ostp/modernizing_the_reg_system_for_biotech_products_memo_final.pdf