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21st Century Biology
Testimony submitted by
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Committee on Science and Technology
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Introduction

Good afternoon – My name is Karl Sanford. I am Vice President of Technology Development for Genencor, and I am honored to present this testimony to your Committee.

This opportunity for my testimony comes at an exciting time for Genencor. Recently, we have made some exciting new advances in making isoprene from renewable feedstocks that promises to help our Nation increase its technological competitiveness and decrease its dependency on imported foreign oil while also protecting the environment.

Genencor Background: A Pioneer in Industrial Biotechnology

Genencor, a division of Danisco A/S, is a leader in industrial biotechnology innovation and manufacturing on a global scale. We have multiple manufacturing, R&D and sales locations throughout the world with a central location in Palo Alto, California and offices and manufacturing plants in Cedar Rapids, Iowa, Beloit, Wisconsin and Rochester, New York. Our goal is to push the boundaries of what is achievable in the realm of biotechnology and accelerate development of the bio-based economy.

Genencor started in 1982 as a spin-out company from pharmaceutical biotechnology pioneer, Genentech, with an aspiration of bringing to industrial and everyday customers the benefits of recombinant DNA technology through new product features and manufacturing efficiencies. Over the past 28 years we have roughly doubled our revenues every 5 years such that our business now approaches about one billion dollars annually. Our manufacturing processes are based on the conversion of bio-renewable feedstocks like corn and soy into enzymes using efficient large scale fermentation processes. Every day you eat, use or wear something made with Genencor enzymes. We discover, produce and market enzymes to large industrial manufacturers. Our products touch people's lives in many ways – getting dirty clothes cleaner while using less energy and water doing it; getting clothes to feel better, softer, nicer to wear with dramatic reductions to water, energy usage and backed by the first textile industry LCA; improving the nutritional efficiency of livestock while reducing environmental impact by using less chemicals; improving quality, nutrition and safety of human foods; converting biomass into sugars, a critical step in the production of cellulosic ethanol, other advanced biofuels and biochemicals; creating a suite of enzymes for biorefiners who convert grain into higher value products such as sweeteners and bioethanol; developing microbial cell factories that convert sugars to biochemicals, such as the BioIsoprene™ product we are developing with The Goodyear Rubber and Tire Company. Our manufacturing processes include innovative processes to convert bio-renewable feedstocks like corn into enzymes using efficient large-scale fermentation processes.

Networks and Partnerships make a Difference

Partnerships play an important role in getting the right products to the right customer segments in a timely manner. We have teamed with the Departments of Energy, Commerce and Defense, and some of the largest consumer, food product and chemical companies in the world. For example, we partnered with DuPont in the mid 1990's to design and develop the bioprocess for making BioPDO™ monomer from corn. That project took almost 10 years before the first commercial sale was realized in 2006. We teamed with DuPont again in 2008 to form the joint venture company, Dupont Danisco Cellulosic Ethanol LLC (DDCE), to commercialize the technology for conversion of biomass to ethanol. DDCE aims to be the world's leading cellulosic ethanol company and a key player in facilitating global energy independence and sustainable fuel supply. At present, we are working with The Goodyear Rubber and Tire Company to commercialize a bioprocess for making isoprene, a key ingredient for synthetic

rubber, from renewable feedstocks. Our technology allows for the bio-based production of isoprene and represents a significant move away from the use of and reliance on petroleum-derived isoprene. A concept tire made with our BioIsoprene™ product was on display at the United Nations Climate Change Conference in Copenhagen (the COP 15 meeting) in December, 2009.

Sustainability is Good Business

Genencor has made sustainability a centerpiece of its business strategy. The goal of sustainable development is to meet the needs of the present without compromising the ability of future generations to meet their needs.
This means that we pursue the long-term viability and progress of our business while taking responsibility for improving the environmental, economic, and social conditions resulting from our work. Examples of our commitment and leadership in business practice include winning the 2003 Presidential Green Chemistry Award for the microbial production of 1,3-propanediol along with DuPont and in 2009 winning the national Sustainable Energy Award from the American Institute of Chemical Engineers (AIChE) for our Accellerase© family of enzymes for cellulosic ethanol. The AIChE Sustainable Energy Award recognizes the critical impact of chemistry and biochemistry innovations in developing sustainable energy solutions. In addition, we recently introduced our PrimaGreen® EcoWhite product, which is a unique and first-to-market enzyme. This enzyme powers the system that will be sold by Huntsman Textile under the name Gentle Power Bleach™. This novel bio-bleaching technology significantly reduces energy and water consumption in wet textile processing, while improving fabric quality. Our commitment to sustainable and environmentally responsive innovative solutions is also demonstrated by our work on biologically based methods for producing isoprene. Our BioIsoprene™ research and development collaborator, The Goodyear Rubber and Tire Compnay, won the Environmental Achievement of the Year Award in 2010 for the concept tire made with our BioIsoprene™ product – a breakthrough alternative to petrochemically produced tires.

<u>Collaboration boosts Innovation</u>

Genencor is a leader in industrial biotechnology and a participant along with university, business and government laboratories in further developing the underlying technologies that propel this platform of innovation forward. Collaboration is a key theme for success. The rate of improvement in the seminal technologies of DNA synthesis, DNA sequencing and synthetic biology is continuing to provide accelerating innovation opportunities. No single enterprise

can to go it alone and hence the need for developing effective networks that connect the players. As an example, we are industrial members of SynBERC, The Synthetic Biology Engineering Research Center, which is an NSF funded multi-institution research effort establishing a foundation for the emerging field of synthetic biology. SynBERC's vision is to catalyze biology as an engineering discipline by developing the foundational understanding and technologies to allow researchers to design and build standardized, integrated biological systems to accomplish many particular tasks. In essence, SynBERC is making biology easier to engineer. It is also engaged in training students who can leverage the investments and training as they go forward into industry. Powerful new technologies such as synthetic biology must also include governance and oversight to fully understand any potential unintended consequences. Hence, centers such as SynBERC also provide initiatives in which ethics and biosafety approaches are purposely incorporated into synthetic biology research and development. The collaborative Human Practices model within the NSF-funded SynBERC project was the first initiative in which social scientists were explicitly integrated into a synthetic biology research program. The Woodrow Wilson International Center for Scholars also provides new opportunities for collaboration emerging between scientists and social scientists working on synthetic biology.

Making Biotechnology Interesting Enough to Learn About

Increasing the science and technology acumen of our society and engaging young minds in science and engineering are key success factors for improving our innovation potential and social receptivity for technology based solutions. Science Bound, Iowa State University's premier pre-college program, prepares and empowers Iowan ethnic minority students to earn college degrees and pursue careers in science. In its 20th year, Science Bound has worked with more than 800 middle and high school student and offered college scholarships to 200 program graduates. The program asks 12 and 13 year olds to make a 5-year commitment. Working in tandem with expert teachers, students can emerge academically equipped as well as socially and culturally empowered to earn a college degree in science or engineering. We need to further support and expand this concept of making science fun and exciting and a learning process friendly enough to encourage commitment to a career in technology. To this end, we have a very active summer intern program that brings undergraduate and graduate level college students to Genencor to work on a variety of biotechnology projects over the summer months. In addition, we have representatives engaged with various community and local industry boards to help educate and foster public awareness

and policy. We are also active members in industry groups such as the Biotechnology Industry Organization (BIO), Europabio and BayBio, an association serving the life science industry in Northern California.

International Awareness

Biotechnology and technology in general are played on an international stage. U.S. centricity is insufficient in providing the education and training necessary to be among the best, brightest and most successful. Language skills, cultural perceptivity and a global persective are requirements for biotechnology players of the future. International awareness is an area for improvement in U.S. education and training.

The Golden Triangle

The President's Innovation and Technology Advisory Committee (PITAC), has identified a technological congruence that is called the "Golden Triangle." Each side of the Golden Triangle represents one of three areas of research that together are transforming the technology landscape today: "information technology, biotechnology, and nanotechnology. Information technology (IT) encompasses all technologies used to create, exchange, store, mine, analyze, and evaluate data in multiple forms. Biotechnology uses the basic components of life (such as cells and DNA) to create new products and new manufacturing methods. Nanotechnology is the science of manipulating and characterizing matter at the atomic and molecular levels. Each of these research fields has the potential to enable a wealth of innovative advances in medicine, energy production, national security, agriculture, manufacturing, and sustainable environments—advances that can in turn help to create jobs, increase the nation's gross domestic product (GDP), and enhance quality of life." In combination, these fields have an even greater potential to transform society. It is this interplay of technologies along with ever more demanding societal needs, which creates grand challenges. Industrial biotechnology is one of the tributary themes to this Golden Triangle. Continued investment in research, education, business and legal developments is necessary to achieve our collective aspiration of meeting the needs of the present without compromising the ability of future generations to meet their needs. Interdisciplinary collaborations that work the Golden Triangle in different patterns of innovation may offer routes to success provided the membership, results and ownership to outcomes are based on transparency, trust and data-based decision making.

A recent study by the National Research Council, "A New Biology for the 21st Century", recommends the integration of the many sub-disciplines of biology, and the integration into biology of physicists, chemists, computer scientists, engineers, and mathematicians. The most effective leveraging of investments would come from a coordinated, interagency effort to encourage an integrated approach to biological research focused on key problem solving areas. This study provides a roadmap to '21st Century Biology'.

Fostering University – Industry Collaboration

The Bayh-Dole Act provides the process through which technology transfer from university laboratories to industry happens. University patents and start-up companies based on these intellectual assets have provided a significant boost to U.S. economic growth over several decades. There is opportunity to do more and a process to assess current barriers and potential new incentives should be undertaken. Examples are the following: current procedures do not allow companies that fund work in universities to own the IP; legal processes are cumbersome and the opportunity exists to slim-line these processes so that investments are largely for the technology development not the legal negotiation.

I thank the Committee for the opportunity to present these views and welcome any questions or comments.

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