Synthetic Biology Engineering Research Center (SynBERC)

University of California at Berkeley (lead institution)

Developing the foundational understanding and technologies that will allow engineers to use standardized biological components to design and build integrated biological systems for a wide range of purposes

A National Science Foundation Engineering Research Center since 2006

Partner Institutions:

- ***Harvard University***
- ***Massachusetts Institute of Technology***
- ***Prairie View A&M University***
- ***The University of California at San Francisco***

Just as technicians can now assemble standardized, off-the-shelf electronic components to build computers, synthetic biologists foresee a day when engineers will assemble well-characterized biological components into robust host organisms to achieve specific functions, such as convert biomass into biofuels, or cheaply produce drugs to fight disease, or detect and destroy biochemical agents. The richness and versatility of biological systems make them ideally suited to solve such challenges. But despite great progress in engineering microorganisms, significant challenges persist that prevent engineers from easily and predictably reprogramming existing systems, let alone building new enzymes, signal transduction pathways, genetic circuits, and eventually whole cells. SynBERC aims to develop the understanding and technological tools needed to design biological systems for pharmaceuticals, renewable energy, and other areas where the high costs and long development times of conventional biological approaches are prohibitive.

Research

SynBERC is developing a conceptual framework for designing small biological components (parts) that can be combined into devices that will perform a well-characterized function under specified conditions. SynBERC is also developing a small number of chassis (stable, robust bacterial hosts with known responses) to host the engineered devices and to assemble several devices to accomplish a larger vision or goal. A challenging aspect of this work is developing standards for the interactions of the parts and devices so that the devices can be built more readily, reproducibly, and rapidly. As SynBERC's standardized components become available, they will be made available as open source to other researchers and companies on our Registry of Standard Biological Parts (parts.mit.edu).

SynBERC's scientific research is divided into three thrusts based on the conceptual approach above (Parts, Devices, and Chassis). A fourth thrust, Human Practices, represents a unique effort to examine the emerging field of synthetic biology within a social context, with reciprocal emphasis on ways that economic, political, and cultural forces might condition the development of synthetic biology and on ways that synthetic biology might significantly enhance human security, health, and welfare through the new objects that it brings into the world.

All four thrusts will be driven in large part by SynBERC's three testbeds, which will serve to demonstrate the utility of synthetic biology and the tools constructed in our thrusts:

Testbed 1: Construction of a bacterium that will swim to a target tissue or group of cells in the body (such as a tumor) and destroy it

Testbed 2: Development of a bacterium for customized chemical synthesis.

Testbed 3: Development of a bacterium to produce cheap biofuels from biomass

The underlying goal of our research is not just to deliver systems that fulfill these specific testbed applications, but rather to develop the foundational infrastructure that is needed to make routine the design and construction of any engineered biological system. For example, the research and technology developments arising out of Testbed 1 will have application in designing future devices that can swim to and destroy other biological and chemical agents.

Education

In developing the emerging field of synthetic biology, SynBERC will educate a new cadre of synthetic biologists and biological engineers capable of designing biological parts and useful biological systems. SynBERC's education program will provide general information on synthetic biology for the general public, in-depth offerings for public policy professionals, and motivational information on opportunities in higher education for K-12 students.

SynBERC's flagship education program is iGEM (the International Genetically Engineered Machines competition), which helps teams of undergraduate students from around the world to develop synthetic biology projects over the course of a summer. Student teams are given a kit of biological parts at the beginning of the summer.

Working at their own schools over the summer, they use these parts and new parts of their own design to build biological systems and operate them in living cells. They add their new parts to the Registry of Standard Biological Parts for next year's students as well as the broader scientific community. At the end of the summer, SynBERC brings these teams together to present their work and compete for prizes at the iGEM Jamboree.

Student teams at the 2006 iGEM Jamboree at MIT

Industrial Collaboration and Technology Transfer

As catalyzed by SynBERC, synthetic biology promises to transform the biotechnology, high-technology, pharmaceutical, and chemical industries, as well as suppliers of genetic tools and custom DNA synthesis companies. This can only be accomplished through active partnerships with companies to help guide SynBERC research on questions of science and technology that are critical to industry. SynBERC's Industrial Affiliates Program offers both large and small companies the opportunity to participate at various levels. Partner companies benefit from increased access to research results, publications, tools, graduate students, faculty, and facilities. Industry feedback also helps speed the transfer of technologies and innovation to industry. From an educational perspective, SynBERC partners provide valuable input into the development of education and outreach programs. SynBERC and its partners both benefit from research internships for undergraduate and graduate students. SynBERC strongly encourages industrial support and grants to support educational and research activities within the Center. Finally, SynBERC has a unique Venture Capital Advisory Board to help provide venture capitalists with critical information that will allow them to fund new companies in the area of synthetic biology, potentially around technology developed in SynBERC.

Facilities

As a multi-institution center, SynBERC benefits from having access to equipment and facilities at several leading universities. Common laboratory and administrative space of approximately 36,000 square feet houses the majority of the faculty, graduate students, and post-doctoral fellows employed by SynBERC at UCB. There, these students and post-doctoral fellows work on the Center's tools and challenge problems under supervision of SynBERC faculty. In addition, this space houses the SynBERC headquarters including offices for the Center Director and staff. The space includes facilities for videoconferencing as well as two conference rooms. The laboratory space is equipped with refrigerators, freezers, centrifuges, analytical equipment, and the latest molecular biology equipment for all experiments. SynBERC continues to improve the publicly-available Registry of Standard Biological Parts, and is developing plans for a dedicated facility for high-throughput screening, cultivation, and characterization of newly constructed and naturally-occurring microbes, in order to identify and improve their biological function for applied use.

Center Configuration, Leadership, Team Structure

SynBERC investigators have been at the forefront in the development of synthetic biology, from the discovery and adaptation of bacterial genetic circuits to the complete redesigning of the entire genome of a bacteriophage. SynBERC investigators developed the first standard for assembling biological components (Biobricks), founded a non-profit research organization to promote open biotechnology, and established the Registry of Standard Biological Parts to publicly serve data on parts, devices, and systems. SynBERC researchers continue to push the boundaries of experimental tools in biotechnology, and have developed a number of computational and modeling tools related to biological networks analysis, reconstruction and rational design of biological parts, and comparative genomics. Educational accomplishments of the Center's faculty include the development of modular synthetic biology curricula (online at www.openwetware.org), the organization of seminar series and international conferences on synthetic biology, and active participation on synthetic biology study groups for both federal and private agencies.

Center Headquarters

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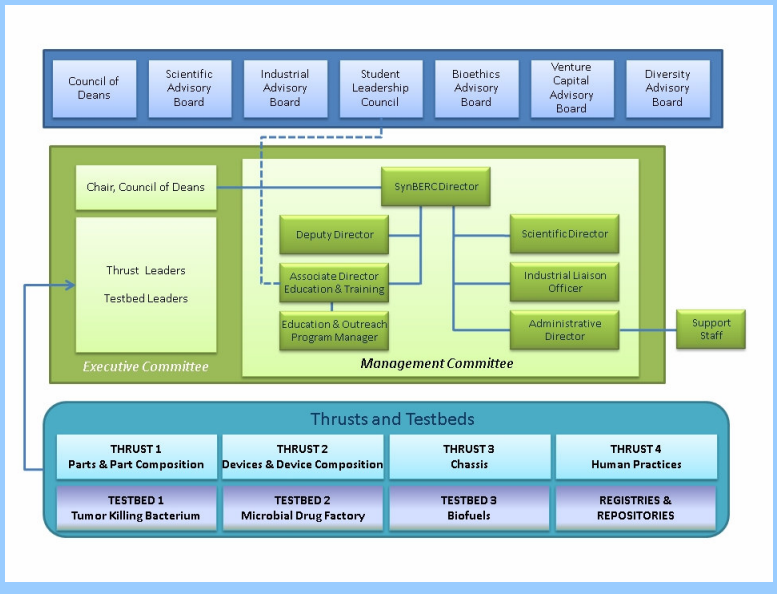

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