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Davidson Students Are Standouts at MIT Synthetic Biology Competition

DAVIDSON, N.C., November 29, 2005 - Six Davidson students claimed standout status this fall as the only liberal arts undergraduates to present their work at the Intercollegiate Genetically Engineered Machines (iGEM) competition at the Massachusetts Institute of Technology (MIT).

The high-spirited, jamboree-style academic competition, only in its second year, is a harbinger of the burgeoning sector of the genomics field that is so new it only recently has been dubbed, more or less officially, as “synthetic biology.” The list of thirteen presenting teams at iGEM, up from five last year, included research university heavyweights such as MIT, CalTech, Princeton, ETH Zurich, Harvard, Penn State, UC Berkeley, and the University of Cambridge.

Co-advisors of the Davidson team were Associate Professor of Biology A. Malcolm Campbell and L.R. King Assistant Professor of Mathematics Laurie Heyer. Together in 2002, Heyer and Campbell co-authored the first genomics book for undergraduates, *Discovering Genomics, Proteomics, and Bioinformatics.*

The Davidson team—“The Synth-Aces,” a word play on enzymes called synthases—presented their design of a genetically-engineered, *E. coli*-based “digital decoder.” The device detects which combination of three common chemicals (with eight combinations possible) is present, and then displays a human-readable number that glows in the dark. The number is produced by genetically customized bacteria that grow

in a familiar pattern of a digital numeric display. The resulting readouts of “0” through “7” correspond to the specific chemical combination detected in solution. One real worldapplication of a decoderdevice might be to monitor water for contaminants or toxins.

To achieve such elegant simplicity, synthetic biology combines science, math, and high-powered computing to tease out virtually infinite genetic possibilities for designing and building this kind of bio-engineered “machine.” This kind of deciphering and rewriting of nature’s code with a specific cellular behavior in mind—custom-tailoring the machine’s “parts”— is where some hardcore math and computing come in. Just ask math major and Synth-Ace team member Nick Cain ’06. The Synth-Aces won the competition award for “Best Interface Logic,” as well as winning awards for “Best Debuggers,” for troubleshooting in the lab; and finally for "Best Team Name.” They even created their own Synth-Ace logo with a design made of fluorescent

bacteria.

Synergy and Synthesis

So, just what are the distinctions between “genetics,” “genomics,” and this new, fast-paced field of research and development called “synthetic biology?”

“’Genetics’ studies single genes and their functions,” explained Campbell.

Genomics, Campbell continued, builds on the understandings of genetics to delve more deeply into the study of large collections of genes and their synergistic functions. In

synthetic biology, researchers are testing

those understandings by creating small DNA circuits for specific and predictable functions.

“My dream,” said Heyer, “is that we will one day harness genetic circuitry so that cells can be engineered to serve as a new kind of computer…. What Nick discovered was that binary decoding could be done efficiently with bacteria by building biological parts that recognized the code directly. Then he designed those parts.”

Once they have determined what parts they will need, students order sub-parts from DNA suppliers, assemble them, and perform experiments with the new parts for some instructive scientific feedback. Keeping an open mind to the process of scientific inquiry is an important perspective to avoid disappointment.

“Sometimes what works on paper is not what works in the lab,” deadpanned biology major Oscar Hernandez ’06 of New Orleans. Fellow Synth-Ace biologist Matt Gemberling ’06, from Lewisburg, Pa., laughed in agreement: “There are some issues that are just off the radar until you get your cells in the lab.”

Where No Human Has Gone Before

The Synth-Aces’ radar expanded even further outward to the frontiers of their science during the week after their trip to MIT, when one of that institute’s renowned biological engineers, Drew Endy, Ph.D., visited Davidson.

Endy, a founder of the private synthetic biology company Codon Devices, is also a founder of the MIT-based BioBricks Foundation. The foundation promotes an open-source registry of modular DNA parts that can be used like Legos for the creation of designer organisms. Already more than 300 such parts are registered on the Web site. The BioBricks Foundation also advocates for the responsible and ethical use of synthetic biology.

In lectures at Davidson, Endy forecast that the rapid development of the field will be akin to the exponential expansion of personal computing in recent decades—and that there will be a corollary strain on legal systems to contain the progress, from university research labs to hacker garages. While Endy’s talks were regularly peppered with the arched-eyebrow phrase, “Don’t know that yet,” he is hopeful for the potential of sun-based clean-energy organisms, or microbes that could produce products to replace petrochemicals, or organisms that could regulate biological processes in a medical setting.

As for using the fruits of synthetic biology for the good of the planet, Endy said, that’s a question that must play out in the human realm.

“The bottom line,” he asked in a public lecture, glancing pointedly at the Davidson Synth-Aces gathered near the front, “is, ‘Do you trust these people?’”

Professors Heyer and Campbell do, supporting their cadre of math and science whizzes within the strong humanist perspective of the liberal arts tradition. Synth-Ace Kristen DeCelle ’06 is a good example. She started out her biology studies at Davidson grounded in the “macro” perspectives of evolution and ecology, but soon found herself drawn to the more “micro” aspects of the field—and even to long afternoons in the lab. At the same time, her strong interest in history, nurtured by the Davidson Humanities Program, and a full roster of pre-medical coursework, sparks a keen interest in real-world applications. Currently undecided between medicine and ministry, DeCelle plans to spend the year after her graduation from Davidson working to combat AIDS in Malawi.

As for the Synth-Aces, their trip to iGEM 2005 will doubtless remain a highlight of their Davidson careers. (For more background on the conference and BioBricks, go to http://

parts.mit.edu/ and click “iGEM 2005.”)

“I was so proud I could barely contain myself,” Campbell wrote to the Synth-Aces in an email after their return to campus. “You did a wonderful job representing your work, yourselves, and Davidson. Winning three prizes (two of them very serious and impressive) that covered both the design of our decoder and the troubleshooting is quite an accomplishment. It was so much fun to hear people rave about your presentation and research. It was also fun to hear George Church from Harvard recruit Tamar [Odle ’08] and Andrew [Drysdale ’06] for summer jobs…”

Davidson is a highly selective independent liberal arts college for 1,700 students. Since its founding by Presbyterians in 1837, the college has graduated 23 Rhodes Scholars and is consistently ranked in the top ten liberal arts colleges in the country by *U.S. News and World Report* magazine. Davidson has recently completed “Let Learning Be Cherished,” a $250 million campaign in support of student financial assistance, academic resources, and community life.

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