Undergraduates spend summer creating living machines

Biological wire, sketchpad emerging from lab

By Alvin Powell
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Come September, Sasha Rush, a Harvard junior, can tell his friends he spent his summer in a Harvard bio lab, breeding bacteria, manipulating them, and working with other undergraduates to create a biological machine that can transmit a signal from one point to another.

Not bad for a computer science concentrator.

Rush is one of a dozen Harvard undergraduate students from a wide variety of backgrounds taking part in the intercollegiate Genetically Engineered Machines competition this summer.

Dubbed "iGEM," the competition involves 13 schools including the California Institute of Technology, Princeton University, the Massachusetts Institute of Technology (MIT), and Pennsylvania State University. Teams from the different schools come up with their own ideas about what type of "machine" they would like to create and then get to work building it.

"The idea is for the students to design and actually try to build something," said Harvard Medical School Professor of Systems Biology Pamela Silver.

The Harvard effort has enough people for two projects, so the students are divided into two teams. Rush's team is trying to use E. coli bacteria to create a "biowire," a line of cells that can transmit a signal from one end to the other. The second team is trying to create a "biosketch," which uses light-sensitive bacteria to create a device that users can write on using a pen that emits ultraviolet light, and which could then erase the writing using exposure to high temperatures.

Silver is one of the driving forces behind the competition, having coached an MIT team last summer in the competition's first year. Silver said she thought it provided a valuable hands-on experience for students to learn about biological engineering firsthand. Professor of Genetics George Church, Assistant Professor

of Computer Science and Instructor in Systems Biology Radhika Nagpal, and Assistant Professor of Biomedical Engineering Kit Parker are helping Silver advise the students.

Silver said the teams were open to students from all backgrounds, with the result that they are made up of a mix of students with experience in biology, chemistry, computer science, and other disciplines.

"For many of them, this is totally new," Silver said. "Basically, we're saying, 'Here's a lab, here's a bunch of money, here's some toys. Go build something.' What could be cooler?"

The results will be presented at a "jamboree" at MIT in November, when representatives of all teams will present the results of their work.

Silver said the students' work mirrors an effort in the synthetic biology field to standardize commonly used biological items, such as bits of DNA known to create certain proteins or cells that have particular properties, in order to speed the work of researchers.

"[iGEM] is about design, and about trying to build on the concept of a modular-based design," Silver said. "Every week there's either forward progress or a disappointment. A lot of this is them learning about how science is done, how engineering is done."

Students themselves said they have worked hard, putting in long days - particularly early in the summer - and have learned a lot.

"I think this was a great experience because it made me design experiments independently at every step," said Yin Li, an incoming sophomore who said he's done laboratory work before, but always under someone else's direction.

After conducting 14 experiments through mid-August, the biosketch team had succeeded in getting the second half of their project to work. The students figured out how to erase the biosketch using high temperatures, but still had to finish work using the ultraviolet light-emitting pen to draw on it.

"I'm confident we'll get something to work," Li said.

As a computer science concentrator, Rush said he's being exposed to many laboratory procedures he had never experienced. Still, he said, trying to create a biological wire does have a lot in common with computer circuits.

Daniel Popper '07, who worked with Rush on the biowire project, said they'd made a lot of progress by mid-August, having designed a stamping device that allows them to lay a line of cells at one time.

"It's been a lot of fun," Popper said. "We've come a long way in the past couple of weeks."

Teaching Fellow Ira Phillips said all the students have come a long way over the summer. Phillips said he had to be in the lab almost constantly at the beginning

of the summer, suggesting things to try and guiding the iGEM teams in their efforts. As the end of summer drew near, however, Phillips said his guidance was needed far less.

"They're definitely more independent," Phillips said. "They're functioning scientists now."