Do-it-yourself biology: Learning to build a better microbe

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(PhysOrg.com) -- Building a cell from scratch is a lot more complicated than building a computer. But that's just what synthetic biologists, including many at MIT, are trying to figure out how to do.

Using engineering principles, researchers and students in MIT's Department of Biological Engineering are building a set of "off-the shelf parts" for cells, cataloging and assembling bacterial DNA sequences to produce microbes tailored for a specific task. Such bacteria could have numerous applications in medicine, energy and environmental cleanup.

MIT biological engineering instructor Natalie Kuldell and recent PhD recipient Reshma Shetty will discuss the possibilities of and obstacles facing synthetic biology at a Soapbox talk, "Do-It-Yourself Biology," at 6 p.m. Wednesday at the MIT Museum.

"If you could really program a cell to do your bidding, you could have it spit out drugs really quickly, or spit out biofuels," Kuldell said. "It would be wonderful to replace refineries with small microbial factories."

Before that can happen, biologists and biological engineers need to figure out whether engineering approaches can be practically transferred to the life sciences, which tend to be much more unpredictable, Kuldell said.

Such efforts have been underway at MIT for several years, launched by engineers Randy Rettberg and Tom Knight. An IAP course in synthetic biology they started in 2003 with Drew Endy, now at Stanford University, has grown into the iGEM (international Genetically Engineered Machine) competition, which now attracts more than 1,000 students from around the world. Each team of eight to 12 students develops its own custom-built bacteria and presents the results at MIT in November.

iGEM is built around the Registry of Standard Biological Parts, a catalog of all the "parts" (DNA sequences) that participants have developed. Students design bacteria for specific functions by assembling various parts, including protein-coding sequences (genes), promoters, ribosome-binding sites, etc.

Past prize-winning projects have included an arsenic detector for drinking water, artificial blood ("Bactoblood"), and bacteria that can digest lactose in the intestines of lactose-intolerant people.

Though some iGEM projects turn out to be impractical or would meet considerable regulatory hurdles, Rettberg is encouraged by the early successes he's seen so far.

"Many fields have huge amounts of potential but never get going. This is one where we already have 1,000 people working on it and they are making new and interesting things, and a fair amount of it is working," said Rettberg, a principal research engineer in the Department of Biological Engineering.

Kuldell also teaches several classes in synthetic biology, including one for freshmen (Course 20.020) in which students design solutions to problems they identify on their own. She tells her students they are pioneers in an emerging field, and they are eager to tackle the challenge, she said.

"Electrical engineering students should be able to program a computer and build some of the hardware, so it makes sense that biological engineering students should be able to genetically program and build a cell," Kuldell said.

Provided by MIT