Live From the Lab, a Culture Worth a Thousand Words

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Your portrait in a petri dish?

Scientists have created living photographs made of bacteria, genetically engineering the microbes so that a thin sheet of them growing in a dish can capture and display an image.

Bacteria are not about to replace conventional photography because it takes at least two hours to produce a single image. But the feat shows the potential of an emerging field called synthetic biology, which involves designing living cellular machines much as electrical engineers might design a circuit.

"We're actually applying principles from engineering into designing cells," said Christopher A. Voigt, assistant professor of pharmaceutical chemistry at the University of California, San Francisco, and a leader of the photography project, which is described in a paper being published today in the journal Nature.

One team of synthetic biologists is already trying to engineer bacteria to produce a malaria drug that is now derived from a tree and is in short supply. And J. Craig Venter, who led one team that unraveled the human DNA sequence, has said he now wants to synthesize microbes to produce hydrogen for energy.

The technology could also be used to create new pathogens or synthesize known ones.

So far, however, most synthetic biology accomplishments have been like the bacterial film - somewhat bizarre demonstrations of things that can easily be done with electronics. Synthetic biologists have, for instance, made the biological equivalent of an oscillator, getting cells to blink on and off.

To make the bacterial film, common E. coli bacteria were given genes that cause a black pigment to be produced only when the bacteria are in the dark.

The camera, developed at the University of Texas, Austin, is a temperature-controlled box in which bacteria grow, with a hole in the top to let in light. An image on a black-and-white 35-millimeter slide is projected through the hole onto a sheet of the microbes.

Dark parts of the slide block the light from hitting the bacteria, turning those parts of the sheet black. The parts exposed to light remain the yellowish color of the growth medium. The result is a permanent, somewhat eerie, black-and-yellowish picture.

Scientists involved in the project said they envisioned being able to use light to direct bacteria to manufacture substances on exquisitely small scales.

"It kind of gives us the ability to control single biological cells in a population," said Jeffrey J. Tabor, a graduate student in molecular biology at Texas.

Scientists, of course, have been adding foreign genes to cells for three decades, and the distinction between synthetic biology and more conventional genetic engineering is not always clear.

Proponents of synthetic biology say genetic engineering so far has mainly involved transferring a single gene from one organism into another. The human insulin gene, for instance, is put into bacteria, which then produce the hormone.

Each project, they say, requires a lot of experimentation, in contrast to true engineering, like building a microchip or a house, which uses standardized parts and has a fairly predictable outcome.

"We haven't been able to transform it into a discipline where you can simply and predictably engineer biological systems," said Drew Endy, an assistant professor of biological engineering at the Massachusetts Institute of Technology. "It means the complexity of things we can make and can afford to make are quite limited."

Professor Endy and colleagues at M.I.T. have created a catalog of biological components, which they call BioBricks, which are sequences of DNA that can perform particular functions like turning on a gene. Still, since cells differ from one another and are extremely complex, it is open to question how predictable biological engineering can ever be.

M.I.T. has also begun holding a competition for college students to design "genetically engineered machines." The bacterial camera was an entrant in 2004 and was made in part using BioBricks.

Mr. Tabor said the idea for bacterial photography came from Zachary Booth Simpson, a digital artist who has been learning about biology at the university. By chance, the Texas team learned that Professor Voigt in San Francisco and one of his graduate students, Anselm Levskaya, had already developed a bacterial light sensor. So the two groups teamed up.

The E. coli bacterium was chosen because it is easy for genetic engineers to work with. But since E. coli live in the human gut, they cannot sense light.

Mr. Voigt and Mr. Levskaya put in a gene used by photosynthetic algae to respond to light. The bacteria were also given genes to make them produce an enzyme that would react with a chemical added to the growth medium. When that reaction occurs, a black precipitate is produced.

The scientists created sort of a chain reaction inside the bacteria. When the bacteria are in the dark, the enzyme is produced, turning the medium black. When the bacteria are exposed to light, production of the enzyme is shut off.

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