How to Make a Computer from a Living Cell

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If biologists could put computational controls inside living cells, they could program them to sense and report on the presence of cancer, create drugs on site as they're needed, or dynamically adjust their activities in fermentation tanks used to make drugs and other chemicals. Now researchers at Stanford University have developed a way to make genetic parts that can perform the logic calculations that might someday control such activities.

The Stanford researchers' genetic logic gate can be used to perform the full complement of digital logic tasks, and it can store information, too. It works by making changes to the cell's genome, creating a kind of transcript of the cell's activities that can be read out later with a DNA sequencer. The researchers call their invention a "transcriptor" for its resemblance to the transistor in electronics. "We want to make tools to put computers inside any living cell—a little bit of data storage, a way to communicate, and logic," says Drew Endy [1], the bioengineering professor at Stanford who led the work.

Timothy Lu [2], who leads the Synthetic Biology Group at MIT, is working on similar cellular logic tools. "You can't deliver a silicon chip into cells inside the body, so you have to build circuits out of DNA and proteins," Lu says. "The goal is not to replace computers, but to open up biological applications that conventional computing simply cannot address."

Biologists can give cells new functions through traditional genetic engineering, but Endy, Lu, and others working in the field of synthetic biology want to make modular parts that can be combined to build complex systems from the ground up. The cellular logic gates, Endy hopes, will be one key tool to enable this kind of engineering.

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