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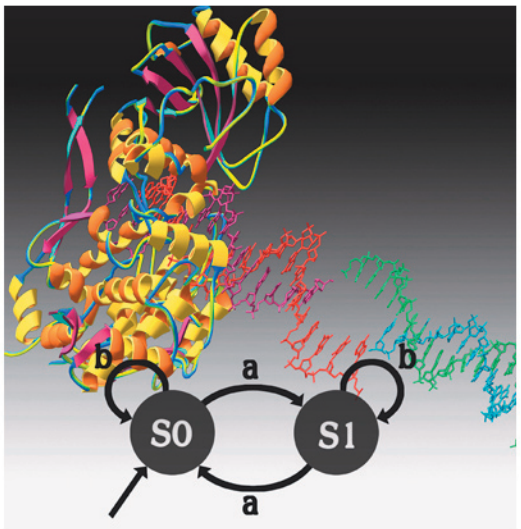
Self-powered DNA Computer

With a few snippets of DNA and a handy enzyme, scientists have created a self-powered molecular computer. The machine is the first step toward biochemical computers that might one day be used to monitor and remedy conditions inside the body.



DNA computer. The latest version generates its own energy.
CREDIT: *PNAS*

Two years ago, computer scientist Ehud Shapiro of the Weizmann Institute of Science in Rehovot, Israel, and his team developed DNA computers that can perform a simple series of computations (*Science*NOW, 21 November, 2001). A specific sequence of DNA, the so-called software, works with an enzyme to make stepwise cuts in a DNA "input" sequence, transforming it into an "output" sequence that reveals the answer to a simple question (such as whether a string of a's and b's has an even number of a's). The downside to these machines was that one of the enzymes gobbled up energy at each step. They also ruined the software DNA with each cut, rendering it unusable for subsequent computations.

To create a more energy-efficient computer, Shapiro and colleagues sought to tap into the energy released when DNA is broken into pieces. They found that an enzyme in the earlier machines occasionally worked on DNA without consuming any energy. By optimizing the sequence of the software and input DNA molecules, they got this enzyme to work consistently. In the newest model, described online this week in the *Proceedings of the National Academy of Sciences*, the DNA software molecule hooks up with the enzyme and gloms onto the input molecule. The enzyme then cuts the DNA input molecule in specific places, freeing energy in the process. An added bonus is that the new version leaves the software DNA intact and ready for use in future computations.

"It's solid work," says computer scientist Erik Winfree of the California Institute of Technology in Pasadena. The simple system is a good first step toward understanding how such biochemical computers might operate, Winfree says. He and Shapiro agree that the current model isn't likely to have real-world applications. But the concept works, Shapiro says, and more improvements could lead to nifty biocomputers that analyze and synthesize DNA in a test tube or even diagnose disease and release drugs inside the body.

--SOLANA PYNE

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A description of how the new machine works
Shapiro's site

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