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Frugal Computer Uses DNA as Input, Fuel

Fifty years after the discovery of the structure of DNA, a team of scientists presents a tiny computing machine composed solely of DNA and enzymes.

In terms of speed and size, DNA computers may eventually surpass traditional computers that use silicon microchips. While many groups have proposed designs for DNA computers, previous attempts have relied on an energetic molecule called ATP for fuel. Ehud Shapiro and colleagues describe a DNA computer that uses DNA as the fuel supply and is recognized by Guinness World Records as the world's smallest biological computing device.

In each computational step, two complementary DNA molecules--an input molecule and a software molecule--spontaneously bond together. The software molecule then directs a DNA-cleaving enzyme to cut a piece of the input molecule.

The enzyme, FokI, breaks two bonds in the DNA double helix, releasing the energy stored in these bonds as heat. This process generates sufficient power to carry out computations to completion without an external energy source. The authors report that a microliter of solution could hold up to three trillion of the DNA computers, performing 66 billion operations per second.

"DNA molecule provides a computing machine with both data and fuel" by Yaakov Benenson, Rivka Adar, Tamar Paz-Elizur, Zvi Livneh, and Ehud Shapiro

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