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**Molecular Computer Named World's Smallest**  
By Jennifer Viegas, Discovery News

**Feb. 25, 2003**—On the 50th anniversary of the discovery of DNA's structure, a team of scientists has invented a tiny computer made of DNA that requires no external energy source.

*Guinness World Records* has bestowed on it the distinction of "world's smallest biological computing device," as 60 trillion of the molecular computers can fit in the space of a teardrop. While it is unlikely the technology will impact the way personal computers are built, in the future the microscopic machine may enable biochemical reactions in pharmaceutical and biomedical applications, creating "smart" drugs that may build themselves to order.



Diagram of the DNA Computer at Work

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According to a report published in the current *Proceedings of the National Academy of Sciences*, the device consists of only three parts: two molecules of synthesized DNA and an enzyme.

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According to a report published in the current *Proceedings of the National Academy of Sciences*, the device consists of only three parts: two molecules of synthesized DNA and an enzyme, all of which operate in a saltwater solution. The first molecule serves as the input, providing data and fuel. The second acts like software, encoding the program data. The enzyme, called FokI, serves as the machine's hardware.

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While its artificially manufactured molecules are much shorter than human DNA, the device utilizes DNA's ability to store and process information and energy. With each computation, the two complementary DNA molecules — the input molecule and a software molecule — spontaneously bind together. The software molecule tells the enzyme to break two bonds in the DNA's double helix structure. The break releases stored heat, which then fuels the device.

"The energy is inherent to the chemical structure of DNA, and is independent of the actual data it encodes, (and is dependent) only on the length of the molecule," explained Ehud Shapiro, a professor of computer science, applied mathematics and biological chemistry at the Weizmann Institute of Science in Israel and one of the paper's authors.

Because of the computer's size and structure, it is limited to "two-state two-symbol finite automaton" computations. For example, it can read a list of ones and twos and determine if there is an even amount of either number. It also can detect if the list has at least one one or two, if there are no consecutive numbers, if there is no one after a two, and if the list starts with a one and ends with a two. Letters, such as "a" and "b," can be substituted for the numbers.

330 trillion operations per second can result from a spoonful of the minuscule devices with no external energy, factors that led to the *Guinness World Records* distinction.

While *Guinness World Records* does not have a record for the world's smallest universal PC computer, it does recognize the world's most powerful computer.

"Currently this is the 'Earth Simulator' in Yokohama, Japan," said David Hawksett, science and technology researcher for *Guinness World Records*. "Capable of more than 35 trillion calculations per second, its job is to create a computer simulation of the Earth's climate, for the purposes of research and prediction."

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